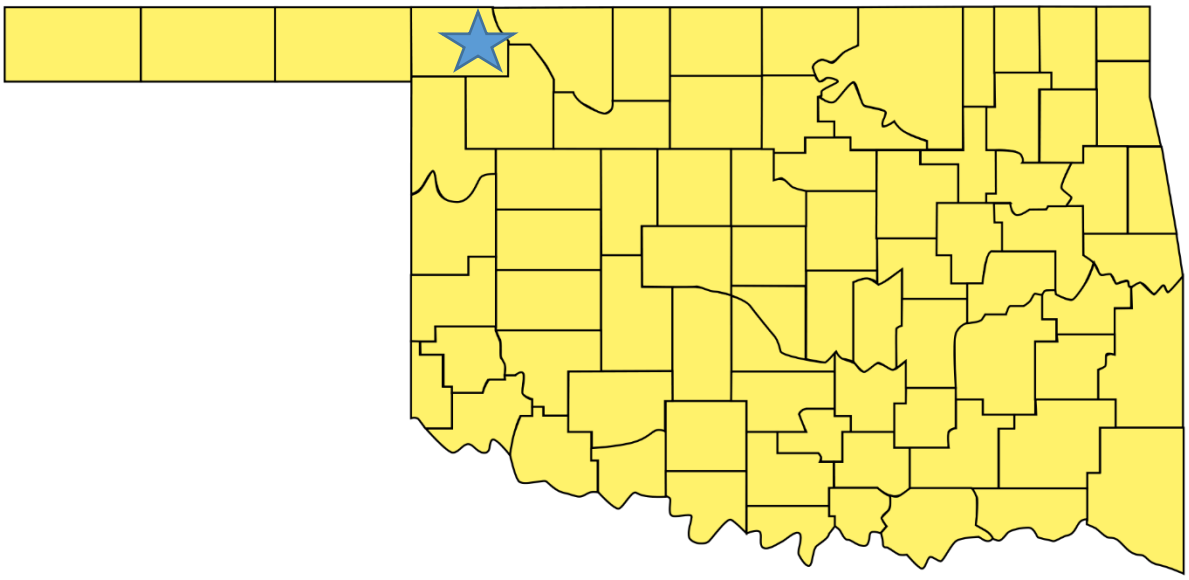
HARPER COUNTY OK



2020 Hazard Mitigation Plan Update

Document produced by OEDA

Contents

CHAPTER ONE: INTRODUCTION

1.1 Overview of Planning Area

Harper County is located in the northwest part of the state of Oklahoma and lies in a transition zone between a humid subtropical region of eastern Oklahoma and the semi-arid steppe to the west. Part of the Central Great Plains geographic region, western Harper County also lies in the Southwestern Tablelands. Average annual precipitation ranges from about 21 inches in the west to 27 inches on the east. May and June are typically the wettest months. Virtually every winter has at least one inch of snow, with one year in three having ten or more inches (Harper County Ok, 2019).

The Beaver River flows through the southwestern part of the county and drains the southern part. The Cimarron River flows across the northwestern part of the county, then along the northeastern edge of the county and drains the northern and eastern parts of the county. Buffalo Creek flows easterly, draining the center part of the county, and connects with the Cimarron River in Woodward County (NRCS 2019).

Agriculture is the basis for much of the economy in Harper County. Small grains, livestock, hay, and alfalfa are the main products. Livestock is usually beef cattle, swine, dairy cattle and sheep. Several commercial feedlots are located in the county. The oil and gas industry provides a number of jobs in the county. There is an extensive network of oil and natural gas wells and pipelines throughout the county. A large natural gas plant is located near Laverne.

Population

As of the 2017 American Community Survey conducted by the US Census Bureau (ACS), the population was estimated to be 3,943. The county seat is Buffalo.

2017	Median Age	Median Household Income	% of Individuals in poverty
Harper County	43	46,915	13.2
Oklahoma	35	49,767	16.2

The population density is stated by the Census Bureau to be about 3 persons per square mile. There were 1,895 housing units, of which 1,348 were occupied and 547 were vacant at an average density of 1.3 occupied housing units and 3.5 people per square mile.

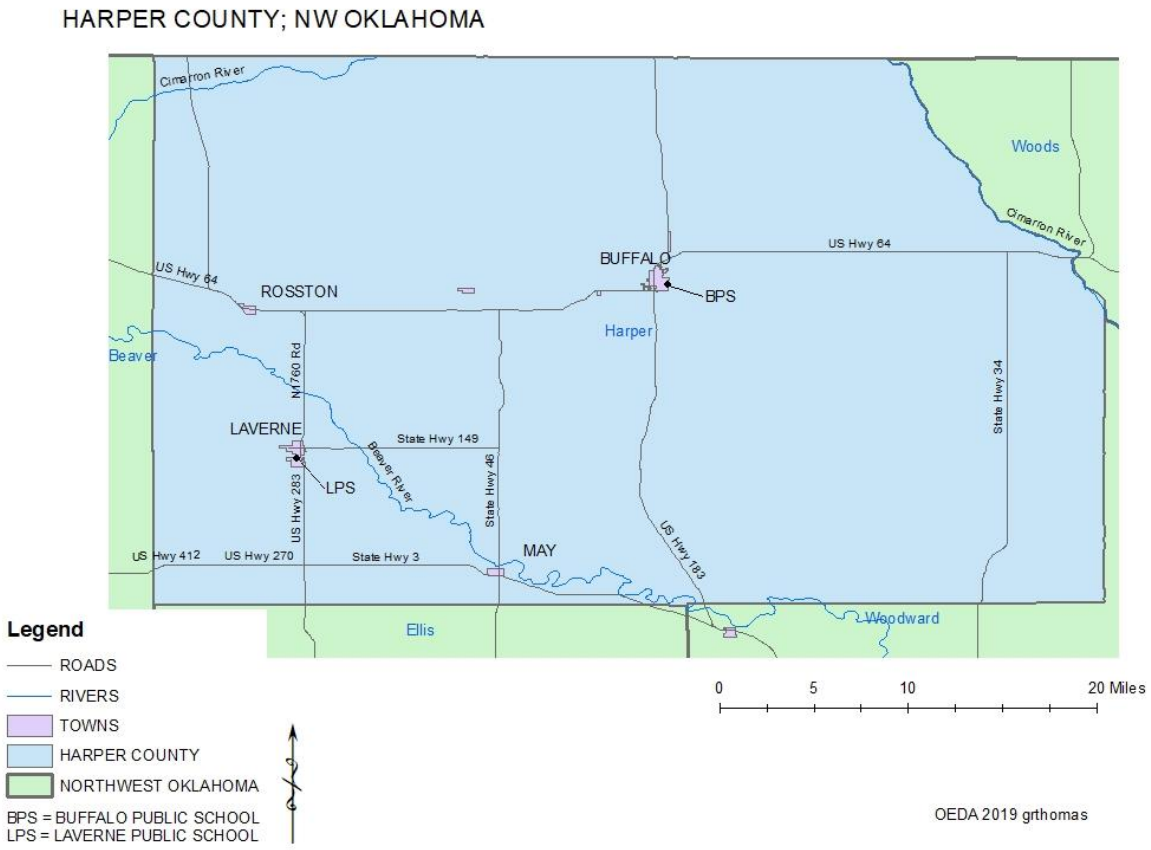
These general facts do not fully represent conditions when the distribution of population and housing is considered. According to the US Census Bureau, the county has a total land area of 1,041 square miles, of which 1,039 is land and 2 mi^2 water. Of total population, 1,299 live in Buffalo and 1,344 live in Laverne, accounting for 71% of total population within about 1.6 square miles of land. Another 400 people live in population clusters such as May, Rosston and the unincorporated community of Selman. This shows the rural population to be less than 1 person per square mile; 900 people/1039 mi^2, or .86 persons, and about 409 occupied dwellings for a density of .4 DU's per square mile and 2.2 persons per rural household; one occupied home per about two square miles.

1.2 Participating Jurisdictions

Participating jurisdictions include Harper County, the Town of Buffalo, Town of Laverne, Town of May, Town of Rosston; Buffalo and Laverne Public School Districts.

POC: Dale Spradlin, Harper County Emergency Manager is the Primary Point of Contact for the 2020 Hazard Mitigation Plan Update. Mr. Spradlin is also the Superintendent of Schools for the Buffalo School District.

Contact Dale Spradlin at: harpercountyem@gmail.com or dspradlin@buffalo.k12.ok.us



CHAPTER TWO: PLANNING PROCESS

2.1 Overview of Planning Process

The Harper County Hazard Mitigation Plan was developed through a series of Commissioner Meetings and LEPC meetings. All meetings were open to the public.

Initiate Plan Update:	Commissioner's meeting	6/03/2019
Hazard identification, Capability assessment, Risk assessment; distribution of surveys	LEPC Team meeting	8/6/2019
Review draft Goals, determine Hazard Mitigation needs	LEPC Team meeting	11/19/2019
Risk assessment review, discuss and develop Goals and mitigation strategies, Prioritize Mitigation strategies	Commissioner's meeting	11/25/2019
Draft Plan review, Plan Maintenance update, initiate 30 day comment period	Commissioner's meeting; LEPC Team email of draft and 30 day comments requested	12/19/2019
Final Draft submitted to Co Commissioners and OEM	Final draft print copies to Commissioners, email copies to LEPC Team and OEM	2/10/2020

2.2 Planning Committee Members

Below is a list of planning team members. Meetings were posted and open to the Public.

Organization	Name	Title	Contribution to Planning Process
OEDA	Gail Thomas	Planner	Research, organization, draft documents
Harper County & Buffalo PSD	Dale Spradlin	Harper Co EM & Buffalo School Supt	Organize and coordinate meetings; grant administration; OEM; contracts; provided hazard data, Hazard impacts to the schools
Laverne Schools	Kendra Allen	Laverne School Supt.	Provided information on hazards that have impacted the school
Harper Co	Karen Hickman	Buffalo Co Clerk	Provided hazard impact data for the county; provided comments on draft plan
Harper Co	Gary Nielsen	Co Commissioner D2	Provided knowledge about county infrastructure and hazard history; assisted with setting goals and prioritizing action steps; reviewed plan components and made comments on Draft Plan
Harper Co	Rex Brewer	Co Commissioner D1	Provided knowledge about District 1infrastructure and hazard history; assisted with setting goals and prioritizing action steps; reviewed plan components and made comments for Draft Plan
Harper Co	Steve Myatt	Co Commissioner D3	Provided knowledge about county Fire and hazard history; assisted with setting goals and prioritizing action steps; reviewed plan components and reviewed Draft Plan

Harper Co	Larry England	District 1 Crew member	Provided information about county roads and erosion due to flood; made comments regarding goals and priorities; assessed feasibility of action steps
Harper Co	Kerri Love	District 1 Crew member	Provided information about emergency response needs in the county; made comments about goals and strategies; discussed feasibility of action steps
Town of Laverne	Mary Chris Barth	City Manager	Provided historical insight into Hazards that have affected Laverne; led discussion of water infrastructure capability and vulnerability
Town of Buffalo	Brian Bowles	City Manager	Provided historic insight into events that have impacted the Town of Buffalo; made comments about goals, strategies and action steps
Town of May	Liz Dotson	Mayor	Provided information about the Town of May infrastructure; expressed concerns of the citizens of May; Evaluated Goals and action steps
Town of Rosston	Roxie Luckie	Town Clerk	Represented the Town of Rosston; discussed the flood zones that affect Rosston; assisted with setting goals and identifying preferred Action steps; provided information about RWD#1

2.3 Other Stakeholders

Organizations and agencies contacted are listed in the table below. Other comments were collected and recorded from surveys and contact with citizens throughout the County.

Each of these participants attended meetings, provided information and helped with capability and risk assessments, hazard assessments and organizing local priorities:

Community	Name	Association	How invited to participate
Harper Co	Gaylon Love	Citizen	Press release, phone call
Harper Co	Diann Adams	Citizen	Press release
Harper Co	Jacob Lemms	Phillips 66 business Owner	Press release, Phone
Harper Co	Kerry Stafford	Director Health Dept	Phone
Harper Co	Clif Brinson	Harper Co SO Chief	Email
Buffalo	Melissa Headlee	Harper Co Comm Hospital	Phone
Buffalo	Amy Yauk	Harper Co Comm Hospital	Press release; Email
Buffalo	Bill Buss	Harper County Hospital	Press release, Phone
Buffalo	Robin Daley	Town Trustee – EM	Phone

Buffalo	Steve Wilson	Chief - Buffalo Fire Dept	Email
Laverne	Chad Scoggins	Laverne PD Officer	Phone
Laverne	Ted Bozarth	Chief - Laverne FD	Phone
Laverne	Jan Love	Administrator, Parkview Pointe	Email
May	CJ Breon	Chief - May FD	Email
Rosston	Kevin Terry	Chief - Rosston FD	Email
Selman	Richard Manass	RWD #1 Supervisor	Phone
State of OK	Raylene Somerlott	OEM	Email
State of OK	Lynn Gould	Oklahoma Em Management	Email

Neighboring Communities, Businesses, and Non-Profit Agencies Contacted

Name	Title	Agency	How Agency Was Invited	Contributions to Plan
Keith Shadden	Emergency Manager	Beaver County	Personal contact	Provided hazard information
Tom Sheats	Regional Fire Coordinator	OEDA	Personal contact	Capability, risk assessments, provided fire data

State and Federal Agencies Contacted

Name	Title	Agency Represented	How Agency Was Invited	Contributions to Plan
Matt Rollins	Hazard Mitigation Planner	State Agency: OEM	Email	Guidance on document preparation, Grant requirements
Joe Remondini	USACE (Retired)	OFMA	Personal contact	Information on Flood
Jon Philipps	Planner	OWRB	Personal contact	Information on Flood
Rick Smith	Meteorologist	National Weather Service	Email	Provided information
Troy Collier	Conservationist	NRCS	Email, phone	Provided information and data
Drew Daily	Fire Staff	Oklahoma Forestry Services	Email, Phone	Provided data and information

2.4 Public Involvement

The public was involved in all stages of the planning process. Public feedback was incorporated into the plan. The public was invited to attend all Commissioner and LEPC meetings. Public meetings were posted at the Courthouse, Buffalo City Hall and Laverne City Hall.

Additional public comments were requested by press release, personal contacts and use of a survey. Public concerns were addressed in the mitigation strategies that were developed and adopted.

Table of Citizen Participation:

Activity	Entity	Date	Comments
Interviews	Business Owners & Various Citizens	From 6/03/2019 to 12/03/2019	More than 30 Individuals were Interviewed
Press Release	Newspaper	7/3/2019	Harper County Journal
Presentations to Governing Bodies	Harper Co Commissioners	6/3/2019	Commissioners meeting
	Harper Co Commissioners	11/25/2019	Commissioners meeting
	Town of Buffalo	11/19/2019	Public meeting
	Town of Laverne	11/19/2019	Public meeting
	Town of May	11/19/2019	Public meeting
Flyers requesting Public comment	Harper Co Courthouse	12/20/2019	Posted
	Town of Laverne	12/20/2019	Posted
	Town of Buffalo	12/20/2019	Posted
	Laverne Chamber of Commerce	12/20/2019	Posted
Surveys	Town of Rosston, Buffalo and Laverne Schools, community of Selman	From 6/3/2019 to 10/3/2019	28 Surveys were collected and Tabulated. Comments were preserved & incorporated into discussion and prioritization of action steps
Forum/Roundtable	General Public, Stakeholders invited & attended	11/19/2019	Public meeting
Social Media	Town Laverne FB page	12/20/2019	Posted
Website	OEDA	8/03/2019 thru 1/31/2019	Information about the Hazard Mitigation Planning update was posted on the OEDA website. Drafts were posted.

2.5 Plans, Documents, and Literature Reviewed

During development of the Harper County Hazard Mitigation Plan Update, several existing plans and documents were reviewed. Data and information from these documents was incorporated into the plan. Of particular importance was disaster history and strategies recommended to mitigate the effects of such disasters. Location of critical infrastructure was reviewed and updated.

2.5.1 Literature and Resources Reviewed

Agency/Document	Relevant Information Incorporated into Plan
US Census Bureau Population Data	Demographic, economic, housing data, ACS 2017
National Climatological Data Center (NCDC)	Storm history, Climate data 2000-2019
OWRB Panhandle Watershed Region Report	Watershed and Groundwater information, 2019
OWRB Hydrologic Drought 2011 Report	Drought information 2012
OK State University Extension Service	*Drought and Its Impact on Agricultural Water Resources* February 2018
Oklahoma Conservation Commission	Watershed Fact Sheet; Harper County 2018
US Department of Environmental Quality (DEQ)	Hazardous waste permit sites 2019
US Department of Environmental Quality (DEQ)	WaterWeb, Impaired waters 2019
US Department of Environmental Quality (DEQ)	NPDES Discharge sites 2019
US Department of Environmental Quality (DEQ)	Brownfields 2019
FEMA Map Service Center	Flood data, maps, NFIP information
NRCS, Woodward office	Flood data, information; Red Cedar
US Geological Survey	Data on seismic activity 2000-2017
State University Agricultural Extension Service	Drought, Land management
State Department of Transportation	Disaster history, Roads and Bridges

2.5.2 Plans Reviewed

During development of this Update of the HCHMP, other State and regional plans were reviewed for information on known hazards and disaster history in Oklahoma. A list of those plans is shown in the table below.

Plan Title	Relevant Information Incorporated into Plan
Harper Co Hazard Mitigation Plan	Storm history 1950 to 2009, risk assessment, mitigation strategies; 2009
Oklahoma State Hazard Mitigation plan	Hazards affecting the State, Disaster history, Mitigation strategies; 2019
Harper County Emergency Operations Plan	Comments HCEM
Capital Improvement Plans (CIP); Buffalo 2016, Laverne 2019	Mapping of critical infrastructure and public safety features such as communications and sirens
Oklahoma Comprehensive Water Plan 2012	Water availability, long term needs projection
School Emergency Operations Plan	Buffalo Public schools, Laverne Public Schools, evacuation plans

2.6 Continued Public Involvement

The Harper County Emergency Manager with the assistance of OEDA and the planning team will conduct an annual review of the Plan. The plan will be updated every five years. The public will be able to directly comment on and provide feedback about the Plan by contacting the Harper County Emergency Manager or OEDA directly. Public meetings will be publicized and open for public comment.

After the Hazard Mitigation Plan Update is adopted, a copy of the plan will be available at the Harper County Court House and available to the public. Copies of the plan will be distributed to each City/Town Hall, Emergency Management Director, School Superintendent and local Library. The public will be invited to become involved in fund raising for specific Hazard Mitigation activities and educational opportunities over the life of the plan.

2.7 Plan Monitoring, Evaluating, and Updating

The Harper County Emergency Management Director will be responsible for monitoring, evaluating, and updating all aspects and components of the HM Plan. The monitoring, evaluating, and updating procedures will follow HM plan requirements as outlined in 44 CFR. The Emergency Manager will be the lead contact for calls and scheduling of meetings. The plan will be monitored, evaluated and updated by the Harper County Emergency Management Director with the assistance of the Local Emergency Planning Committee (LEPC) over a five-year period.

Monitoring – tracking the implementation of the entire plan over time
Evaluating – assessing the effectiveness of the plan in achieving its stated purpose and goals
Updating – reviewing and revising the plan at least once every five years

Monitor. The Harper County Emergency Management Director (EM) will maintain contact with a representative of each jurisdiction who will monitor the progress of the mitigation actions on an annual basis. Each jurisdiction will provide a list of completed action items. The Harper County EM will provide a report to the LEPC each year. The EM will be the point of contact for the scheduling of meetings. The EM will monitor all aspects of the HM Plan, to include the following actions:

- Monitor the hazard analysis for changes and additions; record new data as events occur
- Monitor objectives and determine if they continue to meet hazardous conditions
- Monitor the implementation of the plan's action items; document the completion of action items
- Determine if there are implementation problems, such as financial, technical, political, legal, or issues of coordination with other agencies

Evaluate. The Harper County Emergency Manager will review the Hazard Mitigation Plan annually to ensure progress on mitigation objectives. Post disaster reviews will be utilized to evaluate the effectiveness of stated objectives as implemented. The planning committee members will meet annually to discuss the post disaster reviews, and to evaluate the risk assessment to ensure the vulnerabilities and hazards originally addressed are still valid. The planning committee will also evaluate the goals and the mitigation strategies to ensure they continue to address the priorities of each participating jurisdiction. These findings will be documented by the Harper Co EM.

Update. Two years before this plan expires, the plan update process will begin with the Harper County Emergency Manager and the Local Emergency Planning Committee (LEPC). The emergency manager and the planning committee will reconvene the plan development meetings for the Harper County Hazard Mitigation Plan Update, to discuss the progress made on this plan, update the capability and risk assessments, and revise the objectives and strategies as needed. A draft plan will be submitted to Oklahoma Emergency Management for review twelve months before the current plan expiration. Any revisions will be incorporated into the document as necessary, and the plan resubmitted to FEMA for approval. Once approved, participating jurisdictions will adopt the plan by resolution.

CHAPTER THREE: HAZARD IDENTIFICATION AND RISK ASSESSMENT

3.1 List of Identified Hazards included and excluded

Hazards that were considered for this update and jurisdictions likely to be affected are listed below in alphabetical order, and are prioritized in Chapter 4, Mitigation Strategies. The hazards included are identical to those addressed in the Oklahoma State Hazard Mitigation Plan with the exception of Dam Failure, Expansive soils, Landslide and Subsidence.

Hazards not addressed. *Dam Failure.* There are no High-hazard dams in the planning area. One small water control dam is on Paint Creek, in the SW quadrant of the county where failure would result in low to no loss of life and property damage would be limited to the dam itself. *Expansive soils*. According to the Oklahoma State Hazard Mitigation Plan, the relative abundance of Expansive Soils in the Planning Area is low-medium. The Planning Area has not experienced issues related to Expansive Soils. In addition, low residential density in rural areas and few structures with basements indicate a very low risk of damage due to shrink-swell potential. *Landslide.* Due to development patterns of existing structures and infrastructure, there is a low risk of damage or injury from landslide in the county and no significant events have been recorded. *Land subsidence* is primarily a concern in Eastern Oklahoma; areas associated with historic mining activity. No underground mining activity is known to have occurred in Harper County (OKHMP, 2019).

Committee members and stakeholders discussed the frequency and severity of past disasters and completed the Hazard Vulnerability Assessment. Presidential disaster declarations, fire data, weather events, climate history, flood conditions, soil types and geological records were evaluated and recorded in this plan. Public comments and surveys were used to identify known risks and set the priorities of the community.

Hazards considered

Hazards listed below are applicable to the jurisdictions of Harper County.

Hazard	Jurisdictions Affected
Drought	All jurisdictions
Earthquake	All jurisdictions
Extreme Heat	All jurisdictions
Flood	All jurisdictions
Hail	All jurisdictions
High Wind	All jurisdictions
Lightning	All jurisdictions
Tornado	All jurisdictions
Wildfire	All jurisdictions
Winter Storm	All jurisdictions

3.2 Disaster History

Fourteen Federally-declared disasters have occurred in Harper County since the year 2000. Eight were severe storms (three of which were severe ice storms), 2 fires, and 1 hurricane evacuation (Disaster Declarations by State & County, 2019). Information on Federally Declared disasters prior to 2000 in Harper County were documented in the previous Plan.

FEDERALLY DECLARED DISASTERS		
Date	Disaster #	Event
2019	4438	Severe storms, tornados & flooding
2017	5177	Wildfire outbreaks
2017	4299	Severe winter storms
2011	3316	Severe winter storms
2010	3308	Severe winter storms
2008	1775	Severe storms & flooding
2008	1803	Severe storms, tornados & flooding
2007	1712	Severe storms, tornados & flooding
2007	3280	Severe winter storms
2007	3272	Severe winter storms & flooding
2006	1623	Extreme wildfire threat
2005	3219	Hurricane Katrina Evacuation
2002	1401	Severe winter ice storm
2001	1384	Severe storms, tornados & flooding

3.3 Hazard Probability Rating

The method used to determine the probability of future hazard events was to document the number of events of each type and divide by the number of years being considered. In this case, the Storm and event data was drawn from the National Center for Climate Data (NCDC), a division of the National Oceanic and Atmospheric Administration (NOAA).

Probability was determined by calculating the:

Total number of events/Total number of years = Probability % of event occurring each year

Based on the above calculation, probability is quantified as follows:

High = > 80%
Medium = 30 - 79%
Low = 10 - 29%
Very Low = < 10%

Harper County Hazard	Percent probability Events/years	Probability Rating
Drought	7/10 = 70%	Medium
Earthquake	43/10 = >100%	High
Extreme Heat	634/10 = >100%	High
Flood	2/10 = 20%	Low
Hail	35/10 = >100%	High
High Wind	35/10 = >100%	High
Lightning	2-4 strikes per sqkm/yr = >100%	High
Tornado	6/10 = 60%	Medium
Wildfire	>100%	High
Winter Storm	22/10 = >100%	High

3.4 Profiled Hazards

Each hazard listed in the plan has been profiled individually, and includes the following sections: Description, Location, Extent, Previous Occurrences, Probability of Future Events, Vulnerability and Impact.

3.4.1 Drought

Description. A drought is a period of drier-than-normal conditions. If dry weather persists and water supply problems develop, the dry period can become a drought.

The Oklahoma State Extension website states that "Drought is different from other natural hazards such as flood or wildfire, where negative impacts are felt very quickly. Drought follows a slow and accumulating process . . . This characteristic makes drought preparedness very challenging (OKState 2018)." The article points out three types of drought, Meteorological, Agricultural and Hydrological. Together, these contribute to social (economic) effects of drought.

Meteorological drought is lower precipitation than is typical for a specific area, and precedes the other types. The terms Agricultural drought and Hydrological drought are most pertinent to this assessment. *Agricultural drought* depends not only on precipitation, but soil conditions, groundwater or surface water as well. Crops are also more susceptible to insufficient moisture at certain stages of development. *Hydrological drought* refers to the impact of precipitation deficiency on water levels in streams, lakes, reservoirs and groundwater. This is a long-term type of drought that can have an impact on wells and public water supplies.

Location

Drought is a hazard that affects the water supply for all jurisdictions.

Extent

The planning area uses the Palmer Drought Severity Index (PDSI) to classify a deficiency or excess of precipitation. Values in Harper County may fall at any point on the scale. All participating jurisdictions have experienced drought conditions ranging from 0 to <-4.0 on the scale, and may expect such conditions to occur in the future. Because the county has a semi-arid climate, overly moist conditions occur less frequently.

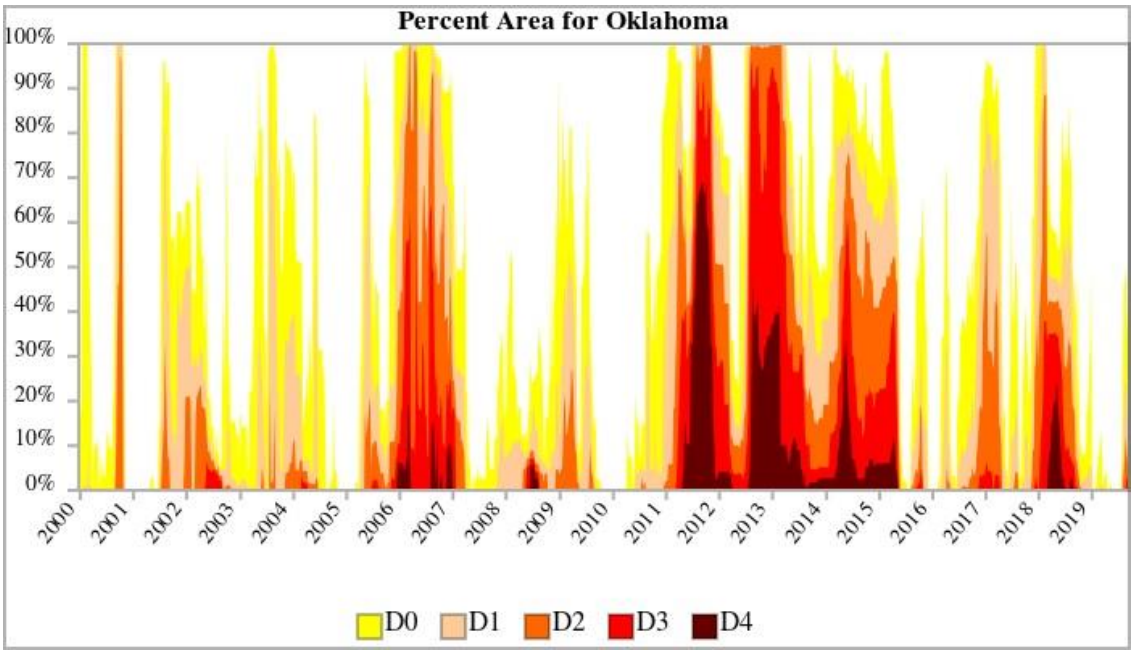
Palmer Drought Severity Index		
	< -4.0	Extreme Drought
	-3.99 to -3.0	Severe Drought
	-2.99 to -2.0	Moderate Drought
	-1.99 to -1.0	Mild Drought
	-0.99 to -0.5	Incipient Drought
	-0.49 to 0.49	Near Normal
	0.5 to 0.99	Incipient Moist Spell
	1.0 to 1.99	Moist Spell
	2.0 to 2.99	Unusual Moist Spell
	3.0 to 3.99	Very Moist Spell
	> 4.0	Extreme Moist Spell

Previous Occurrences

Drought has always been part of Oklahoma's climate because of highly variable precipitation patterns. The history of drought and the history of Oklahoma are closely tied. The land in Harper County was unbroken prairie sod until the late 1800's when people began to build homesteads and establish agriculture. In the early 1930's, a combination of drought conditions combined with poor soil management practices throughout Oklahoma and Texas resulted in a devastating situation known as the Dust Bowl, which people endured from 1931 until 1939. That period represents the worst drought in American history. Harper County was severely impacted.

Oklahoma. Records reveal several other periods of devastating rainfall deficits for much of western Oklahoma. Drought periods are recorded by NOAA and can be accessed on their website in the Storm Events Database. The U.S. Drought Monitor started in 2000. Since 2000, the longest duration of drought in Oklahoma lasted 239 weeks beginning on November 2, 2010 and ending on May 26, 2015. The most intense period of drought occurred the week of October 4, 2011 where Extreme drought affected 69.82% of Oklahoma land, including Harper County (Drought in OK, 2019).

The graph shown below illustrates drought periods in the State of Oklahoma from 2000 through 2019 (Drought in OK, 2019).



Harper County. The table below documents a history of drought conditions in Harper County during the period from 2010 through 2019 (NOAA, 2020).

DROUGHT PERIODS IN HARPER COUNTY 2010-2019

August 1 2010	Very dry conditions had existed over Harper county for a few months with below normal precipitation totals occurring since June. It is too early to tell what impacts the dry conditions would have on area crops.
March 1 2011 to March 1, 2012	Severe drought, or D2, either continued or developed over much of Oklahoma by late in the month. Much of Oklahoma continued with another month of below normal precipitation. In some cases, only a few hundredths were recorded for the entire 31 days. Since Thanksgiving, much of central and western Oklahoma has seen its driest precipitation totals since the 1920s and 30s. Much of the wheat crop planted in the fall had all but been declared a total loss. The conditions have gotten worse with the emergence of the wheat crop. The lack of precipitation has made for low water levels on stock ponds for livestock, and the water level in irrigation reservoirs used for crops is falling. The exact monetary number for the crop loss cannot be determined, although it would probably be in the millions.

May 1, 2012 to May 1, 2015	While October 2011 was not a drought breaker, more rain fell during the month at several locations than had fallen over the previous few months combined. Widespread totals of 3 to 6 inches were common. Northwest Oklahoma did not receive as much rain, and D4 drought continued through the month. However, further east, a slight improvement to D3 occurred, generally along the I-35 corridor. The continuation of much needed rainfall occurred during the month of November, which helped alleviate the devastating drought somewhat over Oklahoma.
	An early February 2012 snow blanketed a large part of Oklahoma, which provided a nice slow soaking into the soil. Parts of northwest Oklahoma improved its drought status as a result of the increased precipitation.
	With continually dry conditions across western Oklahoma, a few areas reached D2-Moderate to D3-Severe drought status by the end of May 2012. By May of 2013, extreme to exceptional drought persisted over much of western Oklahoma, including some worsening along the border with the Texas Panhandle.
	May 2014, With only a handful of rainfall events, drought conditions persisted or worsened across Oklahoma.
	With record rains occurring through the month of May 2015, drought was completely eradicated.
April 12 -26, 2016	With a lack of rain, moderate drought set in over parts of northwest Oklahoma by the 12th. Abundant rainfall through the middle of the month cleared this drought away by the 26th.
Dec 1, 2016 to Jan 1 2017	With a lack of any significant rainfall, severe drought conditions spread into central and northwest Oklahoma through the month of December. Severe drought conditions persisted over central Oklahoma and northwest Oklahoma through the month of January 2017.
March 1, 2017 to April 1, 2017	With a lack of significant rainfall, severe drought expanded in northwest Oklahoma.
Dec 1, 2017 to July 1, 2018	With a lack of rainfall, severe drought began to develop across western Oklahoma and persisted across south central Oklahoma. By April 2018, drought intensified over western Oklahoma and western north Texas.

Probability of Future Events

NOAA records indicate that drought conditions occurred 7 times in a ten year period for a probability of 70%; Medium probability. It should be noted that Harper County was in an almost continuous state of drought from March 2011 through May of 2015; a period of more than 4 years.

According to the State of Oklahoma HMP, "Droughts are projected to increase in severity and frequency due to climate change. Even if annual precipitation amounts do not change much, higher temperatures will increase evaporation from lakes, soils, and plants, stressing agricultural and natural systems. Models project that Oklahoma will experience a decrease in soil moisture across all seasons by the end of the century, with the greatest decrease in the summer (Wehner et al. 2017). Further, rising temperatures will lead to increased demand for water and energy, which could stress natural resources (Shafer et al. 2014)" (SCIPP, 2018).

Projected water demand

At the same time, water demands are expected to increase over the next few decades and aquifer levels may be expected to fall. Such conditions would intensify the vulnerability of Harper County to drought.

Table 28 - Summary of Water Demands by County, All Sectors (AcreFoot/Year)*

County	2007	2010	2020	2030	2040	2050	2060
Harper	13,112	13,416	14,311	15,238	16,210	17,105	18,326

(OWRB, 2012)

Vulnerability and Impacts

Due to its geographical location in a semi-arid ecological zone, Harper County is more vulnerable to drought than the eastern parts of the state. Some impacts are described in the Table below; impacts are further detailed in narrative below.

DROUGHT

Harper Co	
Vulnerability	Harper County is a rural area with an economy heavily based on agriculture; during drought, surface water may be reduced, therefore water supplies for rural residents, crops and livestock are drawn more heavily from wells and aquifers
	The Ogallala Aquifer is a water supply utilized in a seven state region and cannot be placed under local control
	Drought causes a reduction in quality and quantity of water supply from both surface water and groundwater sources for humans, industry, crops and livestock
	Risk of wildfire increases with drought and low humidity

Impact	Depletion of the Ogallala Aquifer is increasingly becoming a hazard to the long term sustainability of life and business in Harper County
	During drought, depletion of alluvial groundwater is intensified, reducing the supply of fresh water to municipal wells
	Increased risk of wildfire, with reduced availability of water for fire suppression
	Loss of agricultural production and economic stress can result in reduced tax revenues to support local government
Towns of Buffalo, Laverne, May and Rosston	
Vulnerability	Many people who live local towns are employed in agriculture and therefore are vulnerable to loss of production income that comes with drought
	The population relies on municipal water supply and individual wells; lack of rainfall intensifies depletion of water supply
	Fire danger is intensified during periods of drought
Impact	Quantity and quality of municipal water supply may be reduced
	Drought has negative impacts on agricultural production and jobs, retail trade serving agricultural families, and the personal and business tax base
	Drought brings an increased threat of fire while less surface water is available for fire suppression
Buffalo and Laverne School Districts	
Vulnerability	Schools are dependent on Municipal water supply which is affected by drought
Impact	Quantity and quality of potable water may be reduced
	Increased risk of fire occurs while water supply for fire suppression is at a low point
	Economic stress results in reduced tax revenues for funding schools
	Water rationing may prohibit watering the athletic field increasing the chance of injury to student athletes

More detailed impacts in Harper County and participating jurisdictions:

The impacts of drought are a safety and economic threat to Harper County. In addition to reductions in streamflow, lakes and aquifer levels, which can severely impact domestic and municipal water supplies, drought can reduce significantly the amount of water available to crops and livestock, trigger deadly wildfires, and devastate the environment.

Municipal water supply. During drought, public water systems may fail under the strain of greatly increased customer demand for water. The source of municipal drinking water in Buffalo, May, Laverne is from public wells. In Rosston private wells are the source of supply. RWD #1, located in Selman, which supplies water to much of the rural population in the eastern half of the county, is served by a well in Woodward County.

The following statement regarding municipal water facilities was reproduced from the OWRB Hydrologic Drought Report published in 2012. "Older facilities are especially vulnerable. State and federal funding programs—such as the Oklahoma Water Resources Board's Financial Assistance Program, which (as of 2012) has provided more than $2.7 billion in water sewer infrastructure projects— have done much to increase the drought resistance of Oklahoma's local water treatment and distribution systems." That analysis estimates that Oklahoma faces an $82 billion need in such financing over the next 50 years (OWRB, 2012).

Economic impact. The economy of Harper County, Oklahoma employs 1,650 people. The largest industries in the county are Educational Services (211 people), Agriculture, Forestry, Fishing & Hunting (200 people), and Retail Trade (177 people) (Data, 2020). Because the local economy is heavily based on agricultural production and retail support of a rural lifestyle, the economic impacts of drought can be severe among all jurisdictions.

Jobs, Taxes**.** Reduced agricultural production impacts jobs in the unincorporated part of the County, while retail sales, services, schools, residential life and local government are concentrated in the towns of Buffalo and Laverne. All these are affected by lost agricultural production and the resulting lower tax revenues.

Crops. Agricultural activity is susceptible to the negative effects of drought. Crops at critical stages of development can show a loss of productivity or become a total loss when precipitation is severely limited.

Livestock suffer when drought impacts the quality and availability of vegetation suitable for grazing or hay production. When extreme, drought can affect the quantity and quality of surface water available to livestock. Wells pumped by windmill may be affected, depending on the depth of the well and the groundwater strata with which it intersects.

Fire. Drought conditions pose a significant increased risk of fire danger. Wildfires that start on open range not only destroy rural business, agriculture and residential structures, but these fires can be very difficult to control and may quickly become a threat to towns as well.

Surface waters. Stream gage records in Harper County and upstream on the Cimarron and Beaver Rivers show a trend of reduced annual flow over the last few decades. This may indicate increased vulnerability to drought. Section 5.3 of this report reflects a change in jurisdictional priorities to meet this challenge.

Local and regional drought conditions impact the Ogallala Aquifer

Harper County has a semi-arid climate, with steady winds that hasten evaporation of surface water and precipitation, making groundwater an essential component of the local water supply. The Ogallala Aquifer underlies a massive land area stretching from southern South Dakota to north Texas, including northwest Oklahoma. Throughout the region,

agricultural production is dependent on irrigation from groundwater wells to mitigate the impact of low precipitation levels. Over time, consistent heavy draw on groundwater supplies for agricultural purposes has a significant impact on aquifer levels.

Aquifer depletion between 2001 and 2008, inclusive, was about 32% of the cumulative depletion during the entire 20th century (USGS 2012). Since 2008, the number of irrigated acres has only increased.

During the 1990s, the Ogallala aquifer held some three billion acre-feet of groundwater used for crop irrigation as well as drinking water in urban areas. The aquifer system supplies drinking water to 82% of the 2.6 million people who live within the boundaries of the High Plains study area (USGS 2008). The combined effect of that demand with the agricultural irrigation of thousands of acres of farmland in eight states creates a situation that may become unsustainable at some point.

Groundwater recharge. The rate at which fresh water enters the system is limited by several factors. In many locations, the aquifer is overlain with a shallow layer of caliche that is practically impermeable; this increases runoff and limits the amount of water available to recharge the aquifer. Drought conditions further reduce the amount of water available to recharge the system and increases the demand for groundwater irrigation. When water demand is greater than the recharge rate, an imbalance occurs and aquifer levels drop. The Ogallala Aquifer is roughly illustrated on the map below.

3.4.2 Earthquake

Description. An earthquake occurs when two blocks of the earth suddenly slip past one another. The surface where they slip is called the fault or fault plane. The location below the earth's surface where the earthquake starts is called the hypocenter, and the location directly above it on the surface of the earth is called the epicenter.

Most earthquakes occur as the result of slowly accumulating pressure that causes the ground to slip abruptly along a geological fault plane on or near a plate boundary. The resulting waves of vibration within the earth create ground motion at the surface that vibrates in a very complex manner.

The Oklahoma Geological Survey (OGS) is a state agency for research and public service charged with studying the state's land, water, mineral and energy resources. OGS began earthquake monitoring 40 years ago with its first seismic station that is still in operation near Leonard, Oklahoma. In April 2015, the OGS determined that the majority of recent earthquakes in central and north-central Oklahoma are very likely triggered by the injection of produced water in disposal wells (Earthquakes in Oklahoma, 2019).

Location

All participating jurisdictions are at risk of earthquake. While the risk of earthquake is county-wide, damage from these events is primarily limited to fixed structures, therefore towns and residential clusters, businesses and schools, roads, bridges and other infrastructure such as electrical equipment, water and sewer lines are subject to potential damage. Earthquakes in Harper County do not appear to correlate with known fault lines.

Extent

Harper County uses the Modified Mercalli Scale to classify the magnitude of earthquakes. Earthquakes throughout the planning area have been measured in the range from 2 to 3 magnitude and I, II, and III on the Modified Mercalli scale, but an earthquake of any magnitude on the scale could occur.

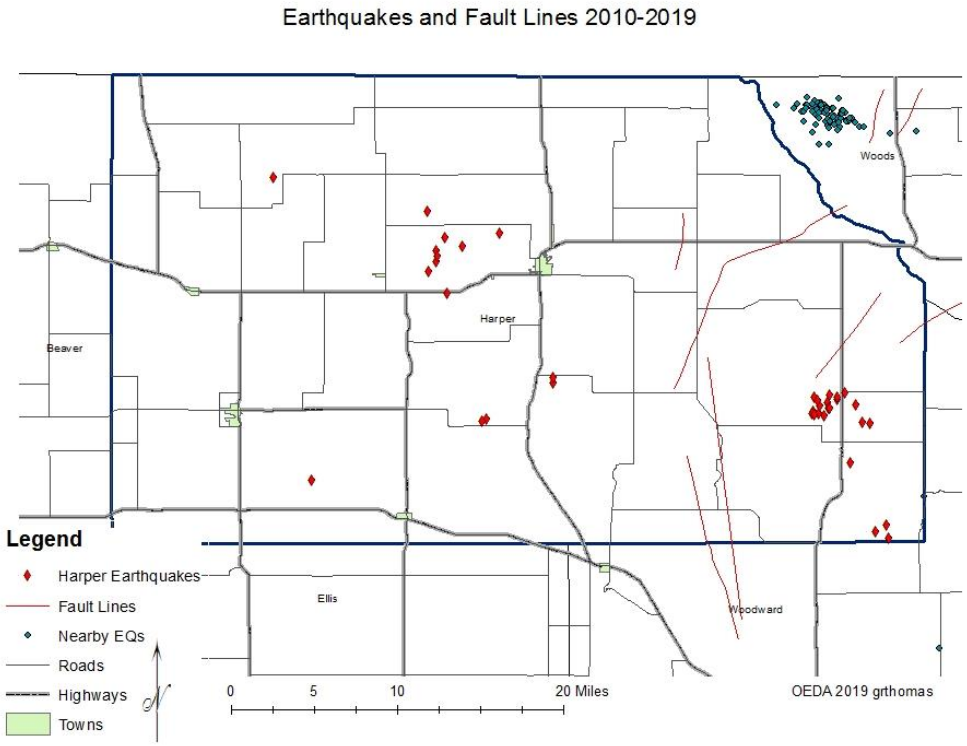
Magnitude	Mercalli	Description	Earthquake Effects
2	I	Instrumental	Not felt except by a very few under especially favorable conditions.
	II	Feeble	Felt only by a few persons at rest, especially on upper floors of buildings.
3	III	Slight	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.

Magnitude	Mercalli	Description	Earthquake Effects
	IV	Moderate	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
4	V	Rather Strong	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
5	VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
	VII	Very Strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
6	VIII	Destructive	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
7	IX	Ruinous	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
	X	Disastrous	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
8	XI	Very Disastrous	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
	XII	Catastrophic	Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Source: http://earthquake.usgs.gov/learn/topics/mercalli.php

Previous Occurrences

Data gleaned from the Oklahoma Geological Survey; University of Oklahoma indicate that over a 10 year period (2010 through 2019), 43 earthquakes occurred in Harper County, virtually all of which were of magnitudes between 2 and 3; only three were of magnitude equal to or greater than 3 *slight to moderate*. These seismic earthquakes are so mild that residents nearby may not even notice them.



Probability of Future Events

The probability of an earthquake is greater than 100%, High. There is a 100% probability that about 4 of these will occur in any given year (43/10 = 4.3).

Vulnerability and Impact

While earthquakes recorded in the planning area to date have not resulted in reports of damage, all participating jurisdictions are vulnerable to potential damaging events.

Structures. In the event of a larger quake, structures can be damaged. Of special concern throughout the planning area is public infrastructure, such as roads, bridges, oil storage sites and utility installations. Local roads and bridges are in a chronic state of deferred maintenance. Only 20% of residential structures were built in the last 40 years (since 1980) (ACS, 2019). Many of the standing agricultural building were constructed from the time of settlement in the early 1900's through the 1970's. Since 1980, many smaller farms and ranches have been absorbed by larger entities, leaving some buildings and

farmsteads in disrepair. These buildings may still be in use as rental properties, or as shelter for crops and livestock, but were not constructed to withstand earthquake.

People. Vulnerable populations include groups of children or elderly people inside schools, hospitals and nursing homes who may be difficult to protect or evacuate at the time of a damaging event. In addition to the danger from damaged building materials, cabinets can spill open, loose objects may fall, or shelves may become dislodged during such an event, posing a risk of injury to anyone in the vicinity.

EARTHQUAKE	
Harper Co	
Vulnerability	Much of the local agriculture is based on ranches and livestock. About 80% of agricultural and residential buildings in the county were built prior to 1980, and were constructed prior to the adoption of building codes
	Fixed structures are vulnerable to earthquake damage, including public utility infrastructure, roads, bridges; most of the roads and bridges throughout the county are aging structures that suffer from chronic deferred maintenance
	Tank batteries for oil storage are scattered throughout the rural landscape. These become corroded due to weather over time
Impact	Due to date of construction and obsolete building practices, older agricultural and residential structures may be more susceptible to damage
	Aging roads and bridges may become cracked or unstable
	Utility infrastructure can be damaged by shaking
	People or livestock indoors or near buildings may be harmed by falling debris, especially buildings not built to modern codes
	Oil storage facilities may be damaged, especially those with corrosion
Town of Buffalo	
Vulnerability	Buffalo has public water and sewer infrastructure, electric utility structures and a concentration of residential and business buildings (91% built before 1980) that could be damaged in the event of an earthquake, including a concrete grain elevator
Impact	Structures may be damaged; people indoors or near buildings may be harmed by falling debris
	Older roads and bridges may be cracked, older infrastructure can be damaged by shaking
	Grain elevators are critically important to the agricultural economy. If damaged, storage and shipment of grains could be impacted

Town of Laverne	
Vulnerability	Laverne has public water, sewer and electric utility infrastructure, and a concentration of older residential and business buildings (80% built before 1980) that could be damaged in the event of an earthquake
Impact	Structures may be damaged; people indoors or near buildings may be harmed by falling debris; roads and bridges may be cracked, infrastructure can be damaged by shaking
Town of May	
Vulnerability	May has municipal water infrastructure, a concrete grain elevator and a concentration of residential buildings that could be damaged in the event of a damaging earthquake
	An abandoned gas station has underground tanks still in place
Impact	Structures may be damaged; people indoors or near buildings may be harmed by falling debris; roads and bridges may be cracked, infrastructure can be damaged by shaking; grain elevators are critically important to the agricultural economy. If damaged, storage and shipment of grains could be impacted
	Underground liquid storage tanks could rupture and leak hazardous fluids
Town of Rosston	
Vulnerability	Rosston has a concentration of older streets and residential buildings that could be damaged in the event of a damaging earthquake; of 28 dwelling units, only 17 are occupied, most built prior to 1980;
	Livestock are corralled in town
Impact	People and animals indoors or near buildings may be harmed by falling debris
	Older buildings may be susceptible to damage; many buildings are vacant and in disrepair
Buffalo and Laverne School Districts	
Vulnerability	School buildings and accessory structures were built between 1932 and 2019. Older structures may be more vulnerable to earthquake damage, staff and children are concentrated in these buildings
	Shelves or cabinets are not adequately secured with tie downs; windows are not coated with shatterproof film
	Students and staff lack education on earthquake safety protocol
Impact	During an earthquake, buildings and other structures can be damaged by shaking; windows may shatter, shelves can collapse or spill contents, posing a risk to health and life.

	Students and staff have not been educated about the potential for earthquake to occur, and the related safety protocol, decreasing their ability to protect themselves adequately in an earthquake event

3.4.3 Extreme Heat

Description.

Summertime temperatures routinely climb above the 100-degree mark, which can create very uncomfortable conditions when combined with high dew point. Temperatures that hover 10 degrees or more above the average high temperature for an area, and last for several days or longer, is one measure of extreme heat. In addition, humid or muggy conditions can persist and air quality can deteriorate during the summer when a dome of high atmospheric pressure creates a temperature inversion that traps a stagnant air mass near the ground.

Location

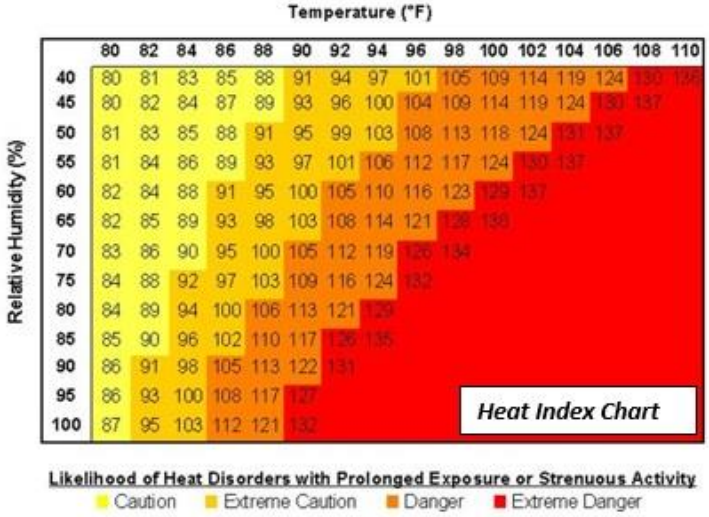
Extreme heat events affect the entire planning area. Urbanized areas with more concrete and asphalt tend to have somewhat higher temperatures than open and vegetated areas, therefore it could be expected that Buffalo and Laverne may see a slightly higher temperature than the unincorporated part of the county.

Extent

The planning area uses the Heat Index Chart to categorize Extreme Heat, and values that fall anywhere on the Index may be expected to occur.

Temperature and Humidity. Extreme heat conditions in Harper County are a function of heat and humidity; illustrated below using a Heat Index Chart. A status of Danger can occur at temperatures as low as 86 degrees Fahrenheit when humidity is at 90% and may be expected to reach Extreme Danger when temperatures reach 90 with high humidity. At temperatures of 98 degrees and above, humidity as low as 40% creates a dangerous situation.

The combined effects of temperatures with rising humidity can present a situation where humans and animals may experience heat disorders which, at extreme levels can be fatal. Oklahoma humidity is typically between 43% and 83% during summer days (Climate, 2019).



Previous Occurrences

One way to describe periods of extreme heat is to simply record the number of days temperatures reached 100 degrees and above. Such temperatures always pose a danger of heat disorders to unsheltered people or animals. Over the most recent 10 year period, temperatures reached 100 degrees on 13% of all summer days.

Temperatures 100 degrees and above (Summer)		
Year	# of Days	Month with Most Occurrences
2010	10	Aug (8 days)
2011	58	July (29 days)
2012	28	July (15 days)
2013	2	July, Aug (1 day each)
2014	8	Aug (5 days)
2015	0	
2016	1	Aug (1)
2017	2	July (2)
2018	3	July (3)
2019	9	Aug (8 days)
	121/920 days	

When the Heat Index Chart is applied, extreme heat can be inferred when the combination of temperature and humidity is charted in the *Danger* zone on the Index. The following table shows extreme heat days by including all summer days when the temperature was over 90 degrees and humidity pushed conditions into the Danger Zone. This daily risk of extreme heat averages about 69% of all summer days in a ten year period (634 days of 920 summer days).

Temperatures 90 and above with humidity in the Danger zone (Summer)		
Year	# of Days	Month with Most Occurrences
2010	71	Aug (31 days)
2011	92	Temp above 90 every day June - Aug
2012	80	July, Aug (31 day each)
2013	52	June, July (16 days each)
2014	53	Aug (26)
2015	56	July (21 days)
2016	70	July (27 days)
2017	52	July (27 days)
2018	61	July (24)
2019	47	Aug (22 days)
	634/920 days	

Probability of Future Events

Using the above data, we can determine that every summer for the last ten years there were occurrences of extreme heat. Additional days when the temperature rises to 90 or above do occur annually in Harper County, especially during May and September. Therefore, the probability of an extreme heat event is about 63.4 days a year over 10 years (634/10 = >100 %), High.

Vulnerability and Impact

Extreme heat events affect all jurisdictions. Humans, crops and livestock suffer injury or death from extreme heat. In extreme heat situations local emergency responders accompany fire departments on calls, in the event they are needed to treat fire fighters for heat disorders. Infrastructure such as roads, bridges and electrical lines are damaged due to expansion and contraction during extreme temperatures. Children and elderly or disabled persons are especially vulnerable to heat stress.

EXTREME HEAT

Harper Co	
Vulnerability	There are no public places of refuge or cooling stations in Harper County. The county is a rural area and there are many low income and elderly individuals. Some people cannot afford to buy or operate air conditioners all summer and sometimes there are breakdowns or power loss. There is no place of refuge for Fire fighters and people who must work outdoors during times of extreme heat
	Such conditions also directly affect agricultural production of crops and livestock by causing severe heat stress
	Harper County has older infrastructure that is more vulnerable to extreme weather conditions
Impact	Lack of a public cooling station increases the danger of heat exhaustion for all people and especially vulnerable low income and elderly who do not have the ability to withstand extreme heat events. Fire fighters and people working outdoors need to be cooled down periodically to avoid heat disorders.
	Loss of production in crops and heat disorders in livestock has a negative economic impact on the county
	Older infrastructure fails when subject to extreme weather
Town of Buffalo	
Vulnerability	Buffalo lacks temperature controlled shelters for residents that either do not have adequate air conditioning, or when they experience power failure
	The Town has older infrastructure which is more vulnerable to a cycle of temperature extremes
	Emergency personnel and people working outdoors must sometimes work in extreme conditions
Impact	The lack of cooling stations impacts economically-challenged residents who do not have the ability to withstand extreme heat events particularly elderly populations, the disabled and families with very young children; pets need shelter and additional access to water
	Extreme heat expansion causes stress on infrastructure
	Extreme temperatures can cause heat disorders in emergency response personnel and people working outdoors
Town of Laverne	
Vulnerability	Laverne lacks a public, temperature controlled shelter for residents that do not have air conditioning, or for refuge during power failures
	The town has older infrastructure that is vulnerable to a cycle of temperature extremes
	The city pool is under reconstruction during 2020-2021 and is not available to mitigate heat stress

	Emergency personnel and people must work outdoors in extreme conditions
Impact	The lack of cooling stations impacts economically-challenged residents who do not have the ability to withstand extreme heat events, particularly elderly populations, the disabled and families with very young children
	Extreme temperatures cause heat disorders in emergency response personnel and people working outdoors
	Heat stress causes damage to infrastructure
Town of May	
Vulnerability	The Town of May lacks temperature controlled shelter for vulnerable residents; many residents have low incomes and cannot always meet their summer air conditioning needs
	The town has older infrastructure that is vulnerable to a cycle of temperature extremes
	There is no city pool for midday relief from heat
	Outdoor workers and emergency personnel may be working in extreme conditions
Impact	Lack of cooling stations increases the danger that people will suffer heat stress when they are without adequate air conditioning
	Extreme temperatures cause heat disorders in emergency response personnel and people working outdoors
	Heat stress causes damage to infrastructure
Town of Rosston	
Vulnerability	Rosston lacks a temperature-controlled place of refuge
	Livestock cannot thrive in extreme conditions
	Older infrastructure is more vulnerable to a cycle of temperature extremes
	There is no city pool for midday relief from heat
	Emergency personnel and people working outdoors may be working in extreme conditions
Impact	Lack of adequate cooling stations increases the danger that people will suffer heat stress if they are without adequate air conditioning.
	Agricultural production is reduced when livestock suffer from extreme conditions
	Extreme temperatures cause heat disorders in emergency response personnel and people working outdoors
	Heat stress causes damage to older infrastructure
Buffalo and Laverne School Districts	
Vulnerability	Children and staff are vulnerable to heat stress. Although most extreme heat events occur during summer months when school is not in session, extreme heat does occur on other school days or during summer activities
	Staff is not trained to oversee extreme heat safety protocols at those times
Impact	Young children can be negatively impacted by extreme heat. Lack of safety protocols and staff training for extreme heat can imperil student health
	Schools may have to close due to excessive heat
	Cooling costs to maintain air-conditioned areas are increased

3.4.4 Flood

Description. River flooding is when a river rises to its flood stage and spills over the banks. The amount of flooding is usually a function of the amount of precipitation in an area, the amount of time it takes for rainfall to accumulate, previous saturation of local soils, and the terrain around the river system. A river located in a broad, flat floodplain will often overflow to create shallow and persistent floodwaters in an area that do not recede for extended periods of time. The excess water can be from snowmelt or rainfall far upstream. Flood effects can be local, impacting a neighborhood or community. They can also be very large, affecting entire river basins and multiple states.

Riverine flooding occurs when a stream becomes so full as to overflow onto adjacent lands. Sheet flooding occurs when excessive rainfall exceeds the design capabilities of drainage facilities and ponding occurs.

NFIP Participation. The Town of Buffalo has been mapped by FEMA, has a floodplain ordinance to regulate building in flood areas and does participate in the National Flood Insurance Program (NFIP). Town Administrator Brian Bowles acts as Floodplain Manager. The remainder of the county has not been mapped by FEMA and other local jurisdictions do not participate in the NFIP (Maps below). Harper County, the Towns of Laverne, May and Rosston do not have floodplain ordinances for issuance of permits to regulate building within flood zones.

Location

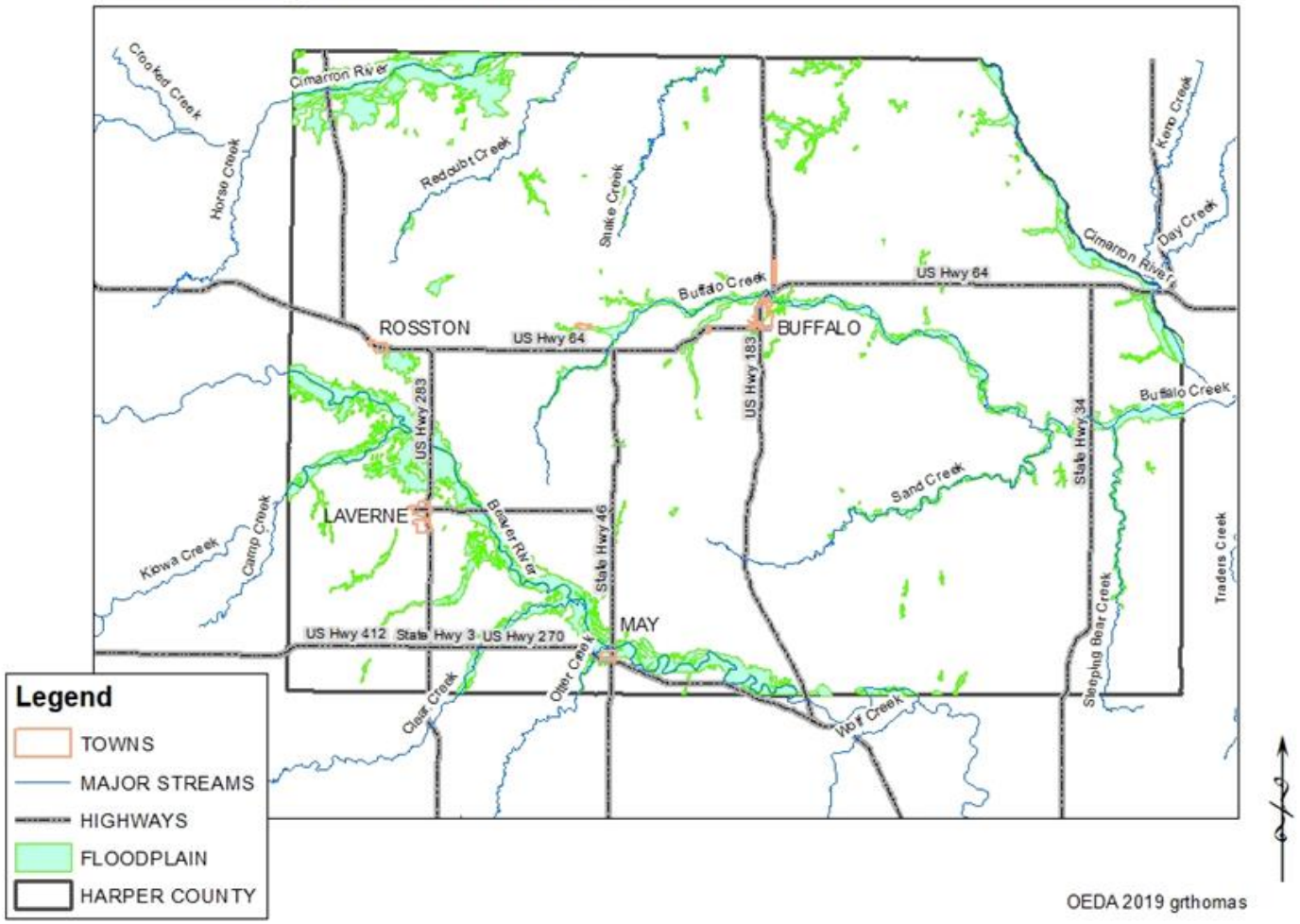
Flood can affect the entire Planning Area. The Town of Buffalo has a FIRM map defining the floodplain that affects residential and commercial areas of town.

Because the floodplain for the remainder of the county has not been delineated by FEMA, data from the Natural Resources Conservation Service (NRCS) was used to determine the flood hazard boundary in those areas. From that data, detailed maps were created for each community and are included below. Maps for May and Rosston are in Appendix B of this document.

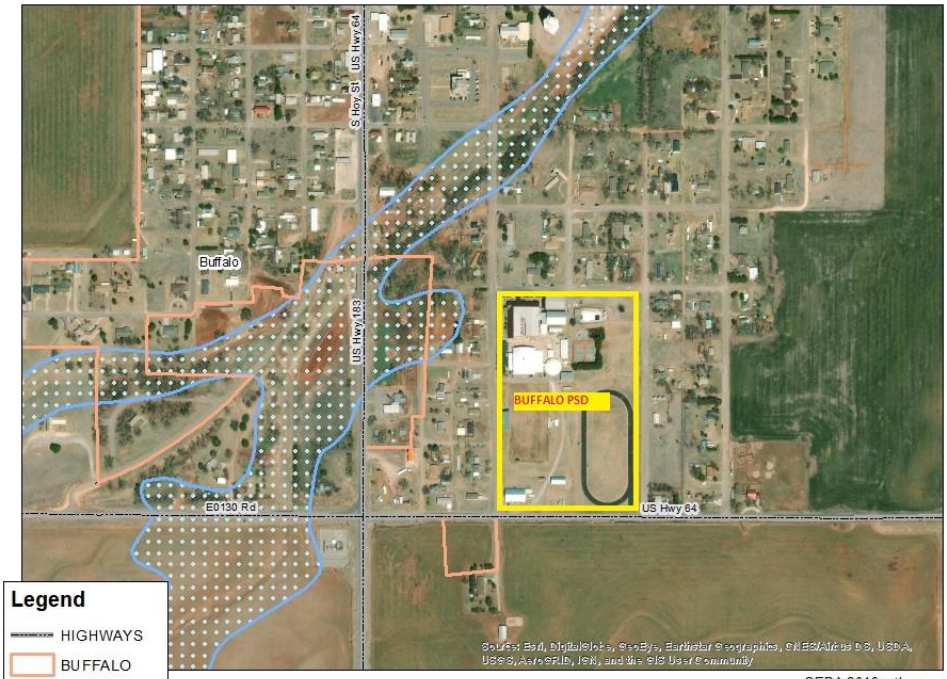
A stream associated with Buffalo Creek flows through Buffalo where it poses a flood hazard. The Town of May is located in a broad, flat floodplain of the Beaver River on the north and Otter Creek to the west. In the Town of Rosston a base flood area overlaps the municipal boundary. There are no Special Flood Hazard Areas in the Town of Laverne, but at times of heavy rain, overland sheet flow does occur and drainage structure capacity can be exceeded. Neither the Buffalo or Laverne School Districts are in a SFHA, but sheet flow that occurs during heavy rain can overwhelm the capacity of drainage structures. This is a relatively rare occurrence since the region tends to suffer chronic drought.

Throughout the County, few structures are located in known flood areas. Residents have either built according to local knowledge of flood areas or flood damaged structures have not been rebuilt. Floodplains as identified and mapped by the Oklahoma Natural Resources Conservation Service (NRCS) are illustrated below:

FLOODPLAIN; HARPER COUNTY OK

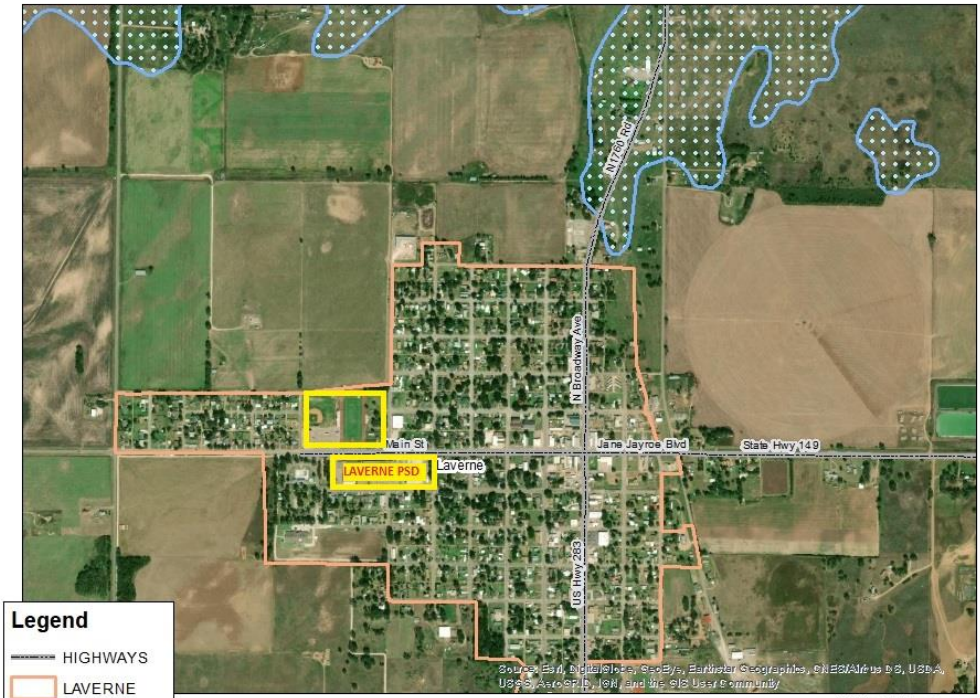


FLOODPLAIN; BUFFALO PUBLIC SCHOOLS



OEDA 2019 grthomas

FLOODPLAIN; LAVERNE PUBLIC SCHOOLS



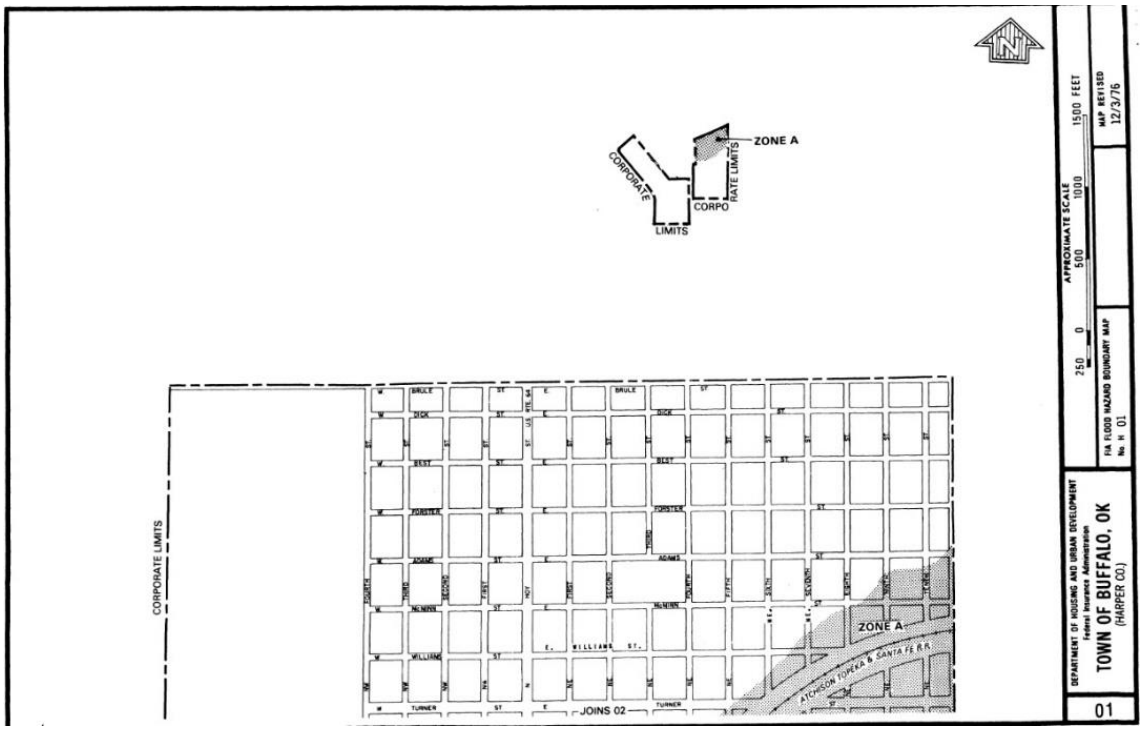
OEDA 2019 grthomas

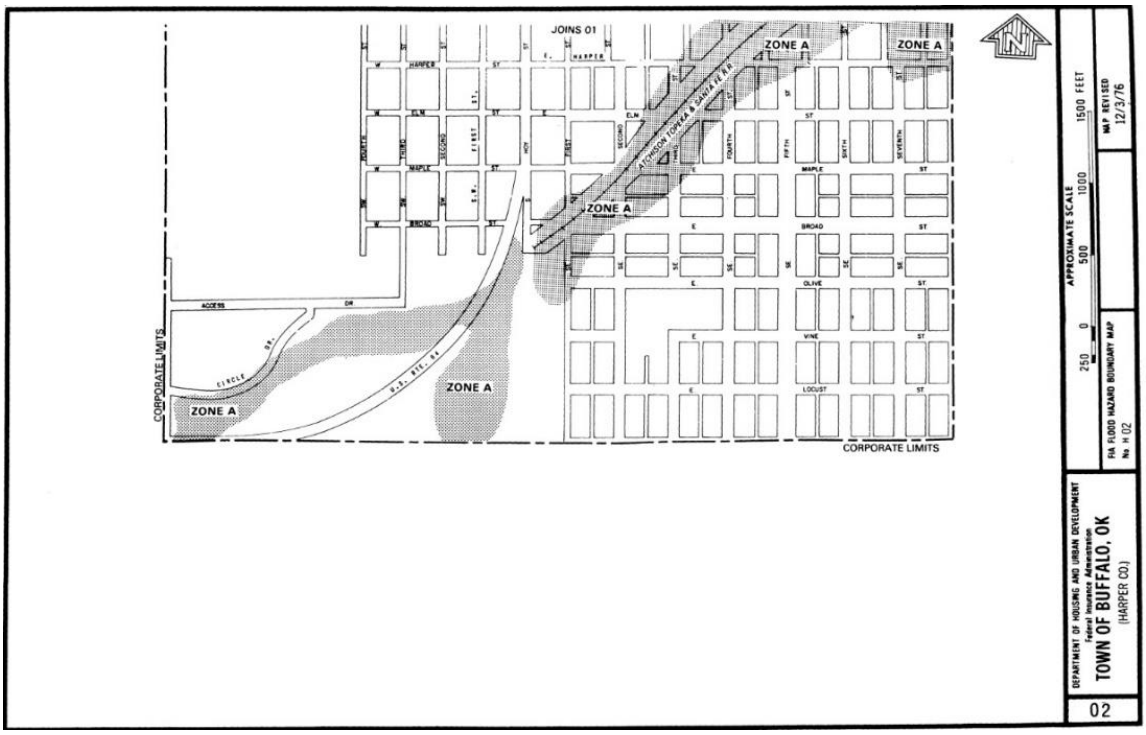
Extent

The areas shown on the Federal Flood Insurance Rate Map FIRM below are estimated to have a 1% annual chance of being inundated during a flood event. Both the NRCS flood data and the older FIRM maps are based on USGS topographical maps. NRCS uses soil type data to further identify flood prone areas (Collier, 2019).

The National Elevation Dataset (NED)1 used by FEMA in 1987 results mainly from the interpolation to a grid cell format of the elevation contours depicted in standard USGS 1:24,000-scale topographic maps. The extent of flooding in the shaded areas of these maps is expected to be 2 feet deep or less (NAP, 2007) { (FEMA, 2002) Section A.3 p.5}. In jurisdictions where sheet flow occurs, sheet flow is expected to be at depths of 0.1 feet over a surface area less than 100 feet (USDA, 2010).

FIRM Maps for the Town of Buffalo. **Firm Panel 400351B effective date 09/01/1987**





Previous Occurrences

Between 01/01/2010 and 12/31/2019 two floods have occurred in Harper County. One was recorded in the NOAA storm database (NOAA, 2020), which occurred on 4/17/2019. The ditches and adjacent floodplain contained most of the excess water. Ponding remained evident for several weeks with a slow rate of infiltration due to the abundance of clay minerals in the soil. A previous flood 2010, was recalled by the local emergency managers.

Probability of Future Events

Flood is a relatively rare occurrence in Harper County. The probability for flood in Harper County is 2 events in 10 years 2/10 = 20% Low probability.

It should be noted that persistent regional drought conditions contribute to low water levels in local rivers. The historic floodplain was formed when there was a much greater annual volume of water than is present today. The Beaver River is partly sourced from the Ogallala Aquifer which, as noted elsewhere in this plan, has evidenced significant depletion over the last several decades, reducing flow.

Vulnerability and Impact

Low density population, a modest economy and corresponding low tax base contributes to a situation where Harper County has many older roads and bridges that were not designed to modern standards and suffer from deferred maintenance. Those structures are more vulnerable to damage from excess water. Town streets in Buffalo and Laverne are designed with a shallow dip at intersections that functions to drain water off the street. Storm drains are rare.

Drainage ditches along county roads and highways are designed with the capacity to capture and hold most of the stormwater from routine storms, but larger storms can overwhelm the system. Parts of Buffalo, May and Rosston are in the floodplain of Buffalo Creek, Otter Creek and the Beaver River. No critical facilities identified in this plan are located within the floodplain.

Ponding, Spring 2019. Roadside ditch and field on the west side of Hwy 283, near the municipal boundary north of Laverne, holds floodwater from the Beaver River.

FLOOD

Harper County	
Vulnerability	Older roads and bridges lack adequate flood capacity.
	Several roads are subject to water over the road at times of flooding, posing a threat to human life
Impact	Ditches have the capacity to hold low level floods but ponding persists where infiltration is slow due to the high concentration of clay in the soils and compaction of soils in ditches
	Erosion due to flood weakens road and bridge infrastructure; excess storm water causes erosion and floods roads when water volume overwhelms the capacity of drainage ditches
	Standing water becomes stagnant over a period of time and poses a health risk from breeding mosquitos and other life.

Town of Buffalo	
Vulnerability	Residential and commercial structures are at risk from overland sheet flow and rising flood water associated with Beaver Creek
	Streets are not designed with storm drains
	Existing drainage and storage structures reach capacity quickly and overflow
	Where ponding occurs, infiltration is slow due to the presence of clay minerals in soils and compaction of soils in ditches
Impact	Overland sheet flow or rising flood water damages residential and commercial structures
	Erosion due to flood weakens street and bridge infrastructure
	Storm water causes erosion and floods the streets when water volume overwhelms the capacity of drainage ditches
	Standing water becomes stagnant over a period of time and poses a health risk from breeding mosquitos and other life
Town of Laverne	
Vulnerability	Residential and commercial structures are at risk from sheet flow, streets are not designed with storm drains
	Existing drainage and storage structures fill quickly
	Infiltration is slow due to the presence of clay minerals in soils and compaction of soils in ditches
Impact	Sheet flow and storm water overwhelm the capacity of drainage systems
	Ponding water infiltrates slowly, providing breeding grounds for mosquitos and other undesirable life
Town of May	
Vulnerability	The Town of May lies at a relatively low elevation in the floodplains of the Beaver River and Otter Creek
	Residential and commercial structures are at risk from sheet flow and floodwater, streets lack adequate drainage and storage capacity
	Ponding occurs and there is a slow rate of infiltration due to clay minerals in the soil
Impact	Storm water overwhelms the capacity of drainage systems
	Water infiltrates slowly, providing breeding grounds for mosquitos and other undesirable life
Town of Rosston	
Vulnerability	Much of the south and east portions of Rosston lie in the floodplain of Beaver Creek
	Streets lack adequate drainage and storage capacity
	Livestock is present in the floodplain
	Sheetflow and ponding occurs; there is a slow rate of infiltration due to clay minerals in the soil.

Impact	Storm water overwhelms the capacity of drainage systems
	Livestock suffer damage to hoofs and feet if dry soil is inundated for an extended period,
	Water infiltrates slowly, providing breeding grounds for mosquitos and other undesirable life
Buffalo and Laverne School Districts	
Vulnerability	While school district structures are not located in Flood hazard areas, there is a risk of damage from overland flow
	Water over roads poses a hazard to bus transportation
Impact	Overland sheet flow damages buildings or parking lots
	Students and school personnel are impacted outside of the school setting
	Transportation to school is disrupted when water floods the roads

3.4.5 Hail

Description. Hail is a form of precipitation that consists of solid lumps of ice, which are individually called hailstones. Hail formation requires an atmospheric environment of strong, upward moving air, called an updraft, within the subfreezing region of a thunderstorm cloud. Large hail stones greater than an inch in diameter (quarter size), can result from a severe thunderstorm and require a very powerful updraft to form. Most large hail is the product of supercell thunderstorms, which have a sustained rotating updraft that moves growing hailstones through the height of the cloud before falling to the ground.

Location

Hail affects the entire planning area.

Extent

The planning area uses the Hail Diameter Description Scale to categorize Hail events. Hailstones of any size described on the chart can be expected to fall in the planning area.

Another factor that affects the amount of damage from hail is the speed at which it falls. Velocity is affected by the height of the falling object due to the constant acceleration of gravity. For small hailstones produced at lower atmospheric heights, the expected fall speed is between 9 and 25 mph. For hailstones that fall in a severe thunderstorm (1-inch to 1.75-inch in diameter), the expected fall speed is between 25 and 40 mph.

In the strongest, upper level supercells which produce some of the largest hail, the expected fall speed can reach between 44 and 72 mph or more. While there is a degree of uncertainty in these estimates due to variability in a hailstone's shape, degree of melting, fall orientation, and environmental conditions such as wind (NOAA, 2020), a 3 inch hailstone falling at 70 mph has the potential to cause serious damage or death.

HAIL DIAMETER	
DESCRIPTION SCALE	
Hail Diameter (Inches)	Description
1/4"	Pea
1/2"	Small Marble
3/4"	Penny or Large Marble
7/8"	Nickel
1"	Quarter
1 1/4"	Half Dollar
1 1/2"	Walnut or Ping Pong Ball
1 3/4"	Golf Ball
2"	Hen's Egg
2 1/2"	Tennis Ball
2 3/4"	Baseball
3"	Teacup Size
4"	Grapefruit
4 1/2"	Softball

The cost of damages to buildings and infrastructure must be borne by owners or insurance companies. Disruption of the economic purpose of affected structures is a cost which may be difficult to quantify and absorb.

Previous Occurrences

There were 35 hail events of ¾ inch and larger recorded by NOAA between 2010 and 2019. These events occurred on 21 individual days. On some days hail was reported by more than one jurisdiction, or different sizes of hail may have been recorded over a period of time during a single storm. Most hail recorded was between ¾ inch and 1¾ inch

diameter. Historic records show that a few storms in previous decades have produced hail of larger than 3 inches diameter (Harper Co Storm Events, 2019).

HAIL EVENTS 2010-2019	
Magnitude (inches)	# Events (35)
0.75	2
0.88	2
1	10
1.25	3
1.5	5
1.75	10
2	3
2.75	2
3	1

Probability of Future Events

Hail falls in the planning area several times each year. The probability of a hail event is greater than 100%. High probability.

Vulnerability and Impact

Injury to people or animals, damage to crops and structures varies with the size and velocity of hailstones and the duration of the event.

HAIL

Harper Co	
Vulnerability	Rural residential and agricultural structures of all vintage and a variety of construction materials are scattered throughout the county. Some of those are more vulnerable due to age of construction, siding materials applied or type and age of the roof
	Due to the relatively mild winters, personal vehicles, farm equipment and larger trucks are often stored outdoors
	Livestock frequently graze open land, away from roofed structures
	Infrastructure such as electrical power lines, transformers and associated equipment is exposed to the weather
Impact	Hail events cause crop losses from minor damage to total loss
	Unsheltered livestock are stressed or injured
	Damage to vehicles ranges from minor dents to total loss of value
	Roofs, siding and windows on residential, business and school buildings are damaged
	Utility equipment such as substations, power lines and transformers are damaged by large hail
Town of Buffalo	
Vulnerability	A population of about 1300 people, with all the associated residential and commercial buildings are concentrated in the Town of Buffalo. Structures date from 1887 to 2019; older roofs are more vulnerable to damage from hail. About 12% of the people are below the poverty line; 44% are low to moderate income and may not be able to maintain structures in good repair or purchase better quality materials. Poor quality roofing and siding is more easily damaged
	Due to the relatively mild winters, personal vehicles, equipment and trucks are often stored outdoors
	Municipal utility services such as electric power and communication systems vulnerable to hail are also sited in or near Buffalo
Impact	Damage to structures and vehicles ranges from minor cosmetic damage to total loss of value
	Roofs, siding, windows and appurtenances on residential and commercial structures suffer damage from hail events

	Damage to electrical infrastructure such as power lines and substations causes loss of power
Town of Laverne	
Vulnerability	A population of about 1370 people, with associated residential and commercial buildings are concentrated in the Town of Laverne. Structures date from 1887 to 2019; older roofs are more vulnerable to damage from hail. About 13% of the people are below the poverty line; 46% are low to moderate income and may not be able to keep structures in good repair or purchase better quality materials. Poor quality roofing and siding is more easily damaged. The population of Laverne reached a peak of 1,937 in 1930 falling to 1,370 today. This drop in population has left many abandoned residential and commercial structures which are in a poor state of repair.
	Due to the relatively mild winters, personal vehicles, equipment and trucks are often stored outdoors
	Municipal utility services such as electric power and communication systems vulnerable to hail are also sited in or near Laverne.
Impact	Damage to structures and vehicles ranges from minor cosmetic damage to total loss of value
	Roofs, siding, windows and appurtenances on residential and commercial structures suffer damage from hail events
	Damage to electrical infrastructure such as power lines and substations causes loss of power
Town of May	
Vulnerability	A population of about 41 people, with residential structures and a few commercial buildings. Seventeen percent (17%) are in poverty. Most structures were built prior to 1980; older roofs are more vulnerable to damage from hail. Of 37 housing units in the Town, 20 are occupied and 17 are vacant. Ten (10) are mobile homes. Older mobile homes are constructed with metal roofs and metal or plastic siding that makes them more vulnerable to hail damage than conventional residential homes with siding of wood or brick. Of 17 owner-occupied homes, 10 are valued at less than $50,000.
Impact	Roofs, siding, windows and outside structures such as antennas are damaged by hail events, especially on mobile homes and older conventional houses. Low value residential structures with deferred maintenance will be damaged more extensively than a well-built modern home.
Town of Rosston	
Vulnerability	Rosston has a population of 31 people and 28 housing units, 17 of which are occupied. Only 3 houses were built since 1980; older roofs are more vulnerable to damage from hail. Population peaked at 185 in 1930. Since then, many structures have crumbled and fallen into disrepair.
	Due to temperate climate, many residential structures do not include a garage for indoor storage of vehicles
Impact	Hail damages roofs, siding, windows and vehicles parked outside
	Old and abandoned residential structures with deferred maintenance are more likely to be damaged by hail events

Buffalo and Laverne School Districts	
Vulnerability	Buildings, buses and other vehicles, outdoor structures are exposed to the weather.
	The main school buildings all have flat roofs which allows hail to impact the surface as a direct hit, rather than a sloped or curved surface which could deflect hailstones
Impact	Hail damages roofs, siding, windows and appurtenances, vehicles stored outside, sports complex. People who are outdoors are injured.

3.4.6 High Winds

Description. High winds can result from thunderstorms, strong cold front passages, or gradient winds between high and low pressure. Damaging winds are often called "straight-line" winds to differentiate the damage they cause from tornado damage. Downdraft winds are a small-scale column of air that rapidly sinks toward the ground, usually accompanied by precipitation as in a shower or thunderstorm. A downburst is the result of a strong downdraft associated with a thunderstorm that causes damaging winds near the ground.

Location

High winds affect the entire planning area.

Extent

Wind speeds are classified according to the Beaufort Wind Chart shown below. The planning area can experience any wind speed on the Beaufort Wind Chart.

Beaufort Wind Chart – Estimating Winds Speeds

Beaufort Number	MPH Range	MPH Average	Terminology	Description
0	0	0	Calm	Calm. Smoke rises vertically.
1	1-3	2	Light air	Wind motion visible in smoke.
2	4-7	6	Light breeze	Wind felt on exposed skin. Leaves rustle.
3	8-12	11	Gentle breeze	Leaves and smaller twigs in constant motion.
4	13-18	15	Moderate breeze	Dust and loose paper is raised. Small branches begin to move.
5	19-24	22	Fresh breeze	Smaller trees sway.
6	25-31	27	Strong breeze	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult.
7	32-38	35	Near gale	Whole trees in motion. Some difficulty when walking into the wind.
8	39-46	42	Gale	Twigs broken from trees. Cars veer on road.
9	47-54	50	Severe gale	**Light structure damage.**
10	55-63	60	Storm	**Trees uprooted. Considerable structural damage.**
11	64-73	70	Violent storm	**Widespread structural damage.**
12	74-95	90	Hurricane	**Considerable and widespread damage to structures.**

Webpage: http://www.weather.gov/iwx
Twitter: @nwsiwx
Facebook: NWSNorthernIndiana

Previous Events

During the period between 2010 through 2019, 35 high wind events were recorded in the NOAA database. Over that period, the highest wind speed recorded in the planning area was 75 mph on July 6, 2004.

Probability of Future Events

The probability of a high wind event is High; 35/10 = > 100% probability. Three or four high wind events happen each year.

Vulnerability and Impact

The quality and age of building materials affect the resilience of structures during high wind events. Many structures in Harper County suffer from deferred maintenance, with loose material that increases the vulnerability of those structures to wind damage.

Wind turbines are located south of Buffalo and in south central Harper County. They are designed to shut down at a given speed to protect the equipment from damage.

High Wind

Harper Co	
Vulnerability	Buildings, especially roofs are vulnerable to the effect of high wind. Depending on wind speed, debris of various material and weight is carried aloft.
	Emergency communication systems are partly dependent on land lines. The 911 system has not yet been completed. There are coverage gaps in cell phone service
	Utility infrastructure lines and poles are vulnerable to high wind events
	Trees are uprooted or broken, limbs take down utility lines
	Wind increases the danger that fire will spread
	Many semi-trucks travel local highways to facilitate economic activity
	Because there are many jobs in natural resources and construction that require crews to be able move from one location to another for relatively short periods of time, there are many high-profile, lightweight RV's and campers utilized as living space in the county
Impact	Structures and infrastructure are directly damaged, while power outages from broken electrical lines may cause secondary (indirect) impacts such as loss of emergency communications, and can endanger the health of people who may be dependent on power for medical devices
	When downed electrical lines are present, it may be necessary to close roads until power companies can ensure public safety
	Eye injuries occur from dust or debris in the air
	Sustained winds of 30 mph or gusts of 45 mph will make it difficult to drive high profile vehicles such as semi trucks and RVs (NWS, 2020) Parked vehicles can be overturned at higher wind speeds depending on the weight of the load

Town of Buffalo	
Vulnerability	Residential, commercial and governmental buildings and utility infrastructure are exposed to damaging wind events.
	Electric lines and poles are vulnerable to damage in high wind events
	Trees are uprooted or broken
	Wind increases the danger that fire will spread
	There are 3 RV parks in Buffalo and campers are stored outdoors in residential areas
	Many homes have satellite antennas or other appurtenences attached to walls or roofs
Impact	Roofs are damaged by loss of shingles or other roofing material
	Wind driven projectiles cause injury to people or animals, destroy windows and result in other property damage
	Interruptions in communications due to damaged equipment can slow emergency response
	Wind delivers additional oxygen to fires, increasing fire intensity and spread
	RV's and campers are blown over
	Uprooted or broken trees pull down power lines and block streets
Town of Laverne	
Vulnerability	Residential, commercial and governmental buildings and utility infrastructure are exposed to extreme weather events
	Several residential properties have an excess of loose junk
	There are two RV Parks in Laverne and many campers are stored outdoors in residential neighborhoods. These vehicles are parked and not anchored to the ground
	Lightweight steel carports are popular storage structures in residential neighborhoods
	Winds increase the possibility that fires will spread
Impact	Roofs are damaged by loss of shingles or other roofing material
	Flying debris causes injury to people or animals, destroys windows and results in other property damage
	Interruptions in communications can slow emergency response
	Carports are carried aloft. RV's and campers are blown over
	Uprooted or broken trees pull down power lines and block streets
	Wind delivers additional oxygen to fires, increasing fire intensity and spread
Town of May	
Vulnerability	There are several mobile homes in May, some are older and in poor condition
	Loose junk and debris is present in some areas
	Many homes have satellite antennas or other appurtenances attached to walls or roofs
Impact	Roofs are damaged by loss of shingles or other roofing material. Mobile home skirting may be torn away
	Flying debris causes injury to people or animals, destroys windows and results in other property damage

	Eye injuries occur from dust or debris in the air
	Power outages from broken electrical lines may cause secondary impacts such as loss of emergency communications, and can endanger the health of people who may be dependent on power for medical devices
Town of Rosston	
Vulnerability	Buildings, especially roofs are vulnerable to the effect of high wind
	Depending on wind speed, debris of various material and weight is carried aloft
	Above ground electrical infrastructure lines and poles are vulnerable to high wind events
	Old and abandoned structures are present in the town. Structures that suffer from deferred maintenance are more susceptible to wind damage
Impact	Trees are uprooted or broken, limbs take down utility lines
	Residences and trees in a poor state of maintenance can be more easily damaged by high winds
	Debris and loose fragments become projectiles
	Many homes have satellite antennas or other appurtenances attached to walls or roofs
Buffalo and Laverne School Districts	
Vulnerability	None of the school building windows have shatterproof film on them to protect them from flying debris during a high wind event
	The schools are dependent on the municipal power system. These systems use above-ground power lines, which are very susceptible to high wind damage
	Debris of various weight and material is carried aloft
	High winds can move high profile vehicles such as school buses
Impact	Students and staff are at higher risk of injury should flying debris impact classroom windows
	Power outages interrupt school operations and result in a loss of school days
	Wind-blown debris causes injury and property damage. Windows are broken
	High winds create dangerous conditions for transport of students.

3.4.7 Lightning

Description. Lightning is a discharge of intense atmospheric electricity, accompanied by a vivid flash of light, from one cloud to another or from a cloud to the ground. Lightning is formed by the separation of positive and negative charges that occur when ice crystals collide high up in a thunderstorm cloud. As lightning passes through the atmosphere the air immediately surrounding it is heated, causing the air to expand rapidly. The resulting sound wave produces thunder.

Location

All jurisdictions in the planning area are subject to Lightning Hazard.

Extent

According to the NASA Global Hydrology Research Center, cloud-to-ground (CG) lightning is the most damaging and dangerous form of lightning. Most flashes originate near the lower-negative charge center and deliver negative charge to Earth. However, an appreciable minority of flashes carry positive charge to Earth. These positive flashes often occur during the dissipating stage of a thunderstorm's life. Positive flashes are also more common as a percentage of total ground strikes during the winter months.

Evaluating lightning density rather than lightning count gives a more accurate picture of how much lightning occurs in different sized states or counties. Density is stated as cloud-to-ground (CTG) strikes per square km. In 2019, Oklahoma ranked second of 50 states in density of CTG lightning strikes per square km per year, and 2nd in total lightning, which includes in-cloud lightning with 14,772,145 flashes and cloud to ground strikes recorded (Vaisalia, 2019).

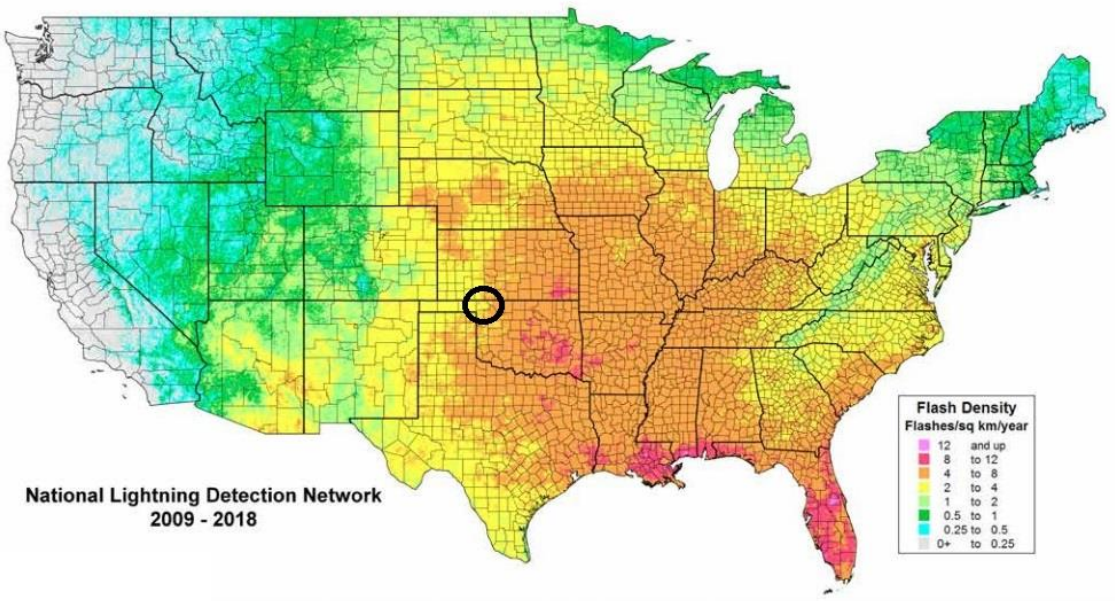
Lightning occurs frequently throughout the entire planning area each year. The Annual Vaisala Lightning Report is used to categorize Lightning Extent. The 2009-2018 and the 2019 Vaisala Cloud-to-Ground Flash Density Maps below show that 2-4 flashes per square km/per year is typical. The planning area can expect lightning flash density values from 2 to 12 on the Vaisala maps scale to occur each year. See maps below.**Previous Occurrences**

TOP TEN TOTAL LIGHTNING COUNTS BY STATE IN 2019		
1	Texas	47,397,975
2	Oklahoma	14,772,145
3	Kansas	13,804,461
4	Missouri	13,415,285
5	Florida	13,049,687
6	Illinois	8,138,020
7	Louisiana	8,102,341
8	Nebraska	7,950,231
9	Arkansas	7,442,101
10	Mississippi	5,879,270

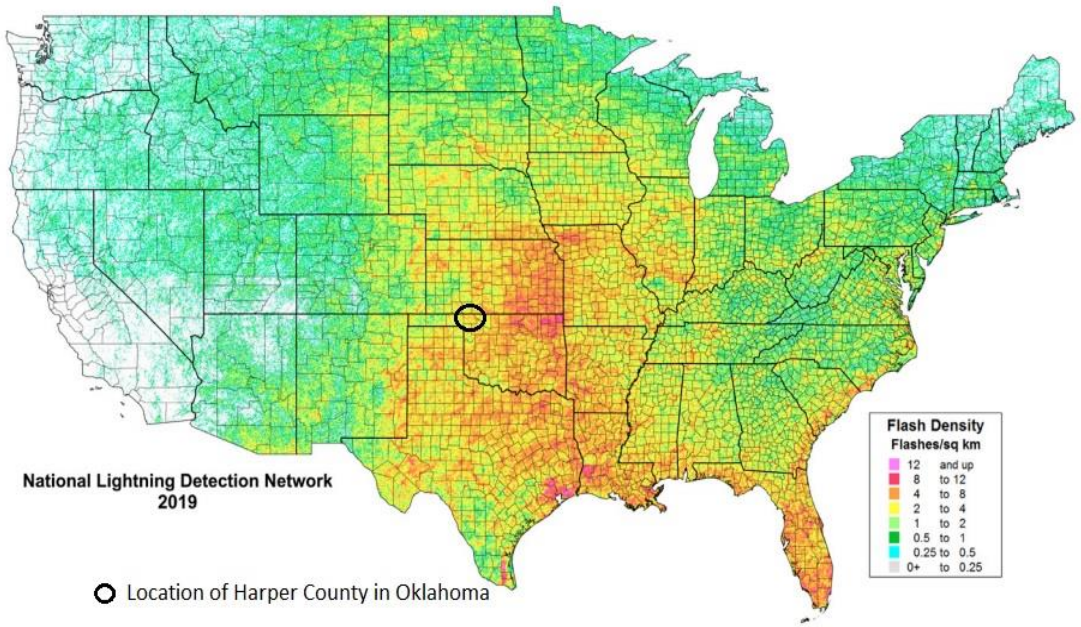
The illustrations below show annual counts for cloud-to-ground lightning strike density in Harper County 2009 through 2018 indicate an average frequency of about 2-4 flashes per square/km per year. These strikes occurred with somewhat greater than average frequency in 2018 and 2019 when there were an estimated 4-8 flashes per sq/km per year (Vaisalia, 2019).

During the last decade, lightning events have frequently damaged electrical infrastructure and caused loss of power, but no financial impact has been reported.

U.S. Cloud-to-Ground Flash Density Map, 2009–2018



U.S. Cloud-to-Ground Flash Density in 2019



Lightning of major severity was recorded twice in the NOAA storm records for Harper County for the period between 2010 through 2019 (Harper Co Storm Events, 2019). Additional damaging events have occurred that were not formally recorded.

Harper County; Lightning events recorded in the NOAA database:

LOCATION	DATE	EVENT TYPE	SOURCE	EVENT NARRATIVE
HARPER Co	8/4/2012	Lightning/ Wildfire	Emergency Manager	A grass fire was ignited by lightning along Highway 34 just south of the Oklahoma Kansas state line. The fire was extinguished by rain. No damage was reported. The exact time the fire ended is unknown.
HARPER Co	5/13/2016	Lightning	Emergency Manager	A tank battery caught on fire due to a lightning strike.

Probability of Future Events

The storm data records that were evaluated covered 10 years; 2010 through 2019. Lightning occurs at a frequency of 2-4 cloud to ground strikes per square kilometer per year. That results in a probability of greater than 100% that lightning will occur in a given year; High probability.

Vulnerability and Impacts

Throughout the planning area, life and health are impacted negatively by lightning strike events, from both direct and indirect impacts. Direct effects are those which result from physical proximity to a lightning strike, such as damaged communication equipment. Indirect impacts are those which occur as a secondary effect of a strike, when a breakdown in communication disrupts the emergency response to a health crisis, crime, or accident.

Tank Battery Hit Near Laverne YouTube 5/13/2016 FireAlley

In rural areas, tank batteries are hit with some regularity. A tank battery is a group of containers used to store crude oil, located near sites where oil is produced. When hit by lightning they can release a significant amount of hazardous material. Tank batteries are protected with lightning suppression devices, but according to some oil industry safety companies, existing industry standards have not kept pace with the advances in oil field technology. As a result, lightning & static related issues will continue to plague the industry. A contributing factor is the age of the tank battery installation, when corrosion reduces the protective effects of grounding devices over time (PetroG, 2015).

Lightning

Harper Co	
Vulnerability	Due to low population density and corresponding budget shortfalls, lightning suppression devices in Harper County do not meet a “best practices” standard
	Harper County is an agricultural community where people commonly work with machinery outdoors and animals graze on open land. Both are at risk for bodily injury or loss of life due to lightning strikes. Many privately owned agricultural buildings are not equipped with lightning suppression devices
	Most utility infrastructure is above ground and exposed to weather events which causes frequent loss of power. Emergency communications equipment that requires electric power or outdoor antenna systems cannot be totally protected from lightning damage
	Several companies engage in natural resource extraction in Harper County. Oil storage tanks are sited on rural parcels around the county. Known as "tank batteries," these groups of storage containers are vulnerable to lightning strikes
Impact	People or animals struck by lightning need immediate lifesaving medical attention. Communication systems that are disrupted by lightning strike will cause reduced emergency response capability
	Power outages put health and life at risk for people who are dependent on electrical power to operate medical devices
	When tank batteries are hit by lightning, they burst into flame, destroying property, releasing hazardous material & contributing to the incidence of wildfire
	Lightning strikes start other fires especially during frequent drought conditions when any spark can ignite ready tinder
Town of Buffalo	
Vulnerability	People working outdoors or using outdoor recreation areas such as the municipal golf course at Doby Springs, the swimming pool and local parks are exposed to risk from lightning; lightning detection devices and lightning protection systems are not installed
	Emergency communication systems are partially dependent on above-ground land lines
	Utility infrastructure is exposed to weather and components are vulnerable to lightning damage, particularly electrical transformers or substations. There is a substation near Buffalo
Impact	Staff at Doby Springs golf course and the municipal pool must rely on anecdotal information and personal experience to determine when facility visitors should seek shelter from lightning
	People who are struck by lightning need immediate medical attention. Electronics inside buildings are destroyed by the power surge of a lightning strike passing through the electrical grid, which can disable critical communication systems
	Loss of power puts the health of individuals at risk when they depend on electricity to operate medical equipment. Fires are initiated by lightning strikes that hit flammable materials, especially after periods of dry weather
Town of Laverne	
Vulnerability	People working outdoors or using outdoor recreation areas such as the Laverne Golf Course, the municipal swimming pool and local parks are exposed to risk from lightning; lightning detection and protective devices are not installed

	Emergency communication systems are partially dependent on above-ground land lines. The 911 system is not fully operational. Cell phone service is inconsistent
	Utility infrastructure such as electrical transformers or substations are exposed to weather
	Tank batteries are located near the town of Laverne, which puts the Town at greater risk from wildfires when storage containers are damaged by lightning strike
Impact	Golf course staff and lifeguards must rely on weather reports and personal judgement to determine when facility visitors must seek shelter
	Electronics inside buildings are destroyed by the power surge of a lightning strike passing through the electrical grid, which disables critical communication systems
	People who are struck by lightning need immediate medical attention. Communication breakdowns endanger life and health when emergency response is delayed
	Loss of power puts the health of individuals at risk when they depend on electricity to operate medical equipment
	Fires are initiated by lightning strikes that hit flammable materials, especially after periods of dry weather
Town of May	
Vulnerability	Buildings and other structures are at risk, people working or engaging in outdoor recreation are vulnerable. The Town of May is 15 to 25 miles from the nearest medical clinic or hospital. Emergency communication systems are partially dependent on above-ground land lines
	There are 17 vacant dwellings and other abandoned properties, which have trees for which maintenance is long deferred. According to arborist Davey.com, trees such as Oaks, Elm and Cottonwood are more likely to attract lightning. When these trees grow near buildings (where copper wiring or plumbing is present) or near power lines, the danger of lightning strike is increased (Trees, 2020). Tree damage leads to downed power lines
Impact	Response time of emergency personnel is slowed by disruptions to the emergency communication system. Electronics inside buildings are destroyed by the power surge of a lightning strike passing through the electrical grid, which can disable critical communication systems, putting people at risk
	Loss of power puts the health of individuals at risk when they depend on electricity to operate medical equipment
	Abandoned residential structures are more often hit by lightning strikes when trees grow up near the structure and trees are not properly maintained
Town of Rosston	
Vulnerability	Most residential and agricultural structures in Rosston are not equipped with lightning detection or grounding devices
	People working outdoors or engaging in outdoor recreation are vulnerable. Rosston is 10 to 20 miles from the nearest medical clinic or hospital
	Emergency communication systems are partially dependent on above-ground land lines. When power loss occurs, emergency response is delayed

	Due to a reduction in population over decades, there are many vacant lots and neglected properties in Rosston. These sites are more likely to have trees for which maintenance has been deferred. According to Davey Tree Expert, trees such as Oaks, Elm and Cottonwood are more likely to attract lightning due to a high starch content. These are present on most lots. When these trees grow near buildings (where copper wiring or plumbing is also present) or near power lines, the danger of lightning strike is increased (Trees, 2020)
Impact	People who are struck by lightning need immediate medical attention while response time of emergency personnel is slowed by disruptions to the emergency communication system
	Loss of power puts the health of individuals at risk when they depend on electricity to operate medical equipment
	Abandoned residential structures are more often hit by lightning strikes when trees grow up near the structure. Tree damage leads to downed power lines
Buffalo and Laverne School District	
Vulnerability	Lightning protocols are not specifically addressed in the Emergency Operations Plan
	School play yards and sports stadiums are among areas where lightning can be a danger. Electronic equipment is susceptible to damage
	Staff, parents and students don't have a clearly articulated plan for handling lightning emergencies
Impact	Protocols are needed because people who are struck by lightning need immediate medical attention while response time of emergency personnel is slowed by disruptions to the emergency communication system.
	Electronic scoreboards and metal bleachers exposed to weather place people at additional risk
	Misunderstandings occur among parties when lightning strike protocols for the safety of children are unclear

3.4.8 Tornado

Description. Tornados are violently rotating columns of air that reach from the bottom of a cumulonimbus cloud to the ground. Tornados are found in severe thunderstorms, but not all severe thunderstorms produce tornados. While all tornados touch both the ground and the bottom of a cloud, it is possible for only part of the tornado to be visible.

A tornado may be on the ground for only a few seconds, or last for over an hour. They can appear in a variety of shapes and sizes, ranging from thin, rope-like circulations to large, wedge-shapes greater than one mile in width. However, a tornado's size is not necessarily related to its wind speed. The strongest tornados can have wind speeds in excess of 200mph. In Oklahoma, most tornados occur between 3PM and 9PM, during the months of March through May, but may occur anytime the necessary atmospheric conditions of wind shear, lift, instability, and moisture are present.

Harper County and most of Oklahoma lies in an area often referred to as Tornado Alley, characterized by interaction between cold, dry air from Canada, warm to hot, dry air from Mexico and the Southwestern U.S., and warm, moist air from the Gulf of Mexico. Meteorologically, the region is ideally situated for the formation of supercell thunderstorms, often the producers of violent (EF-2 or greater) tornadoes (NOAA 2019)

The interactions among these three contrasting air currents produces severe weather with a frequency virtually unseen anywhere else on our planet. An average 62 tornadoes strike the state each year – one of the highest rates in the world by square mile of land area. (US Tornado Climatology, 2010).

Location

Harper County has a history of tornado activity. Tornados affect the entire planning area.

Extent

The scale of intensity for tornados in Harper County is measured by the Enhanced Fujita Scale as illustrated below. The Planning area can expect tornados of any magnitude on the scale to occur.

The classification of tornados in this county should be viewed with the caveat that tornados are usually rated by calculating the amount of damage to structures directly in the path. In this low-density rural area where few structures are present, a severe storm may bypass most homes, barns or buildings. Therefore, the intensity of some tornados may not be accurately evaluated if they have passed mostly through open range.

Enhanced F Scale for Tornado Damage

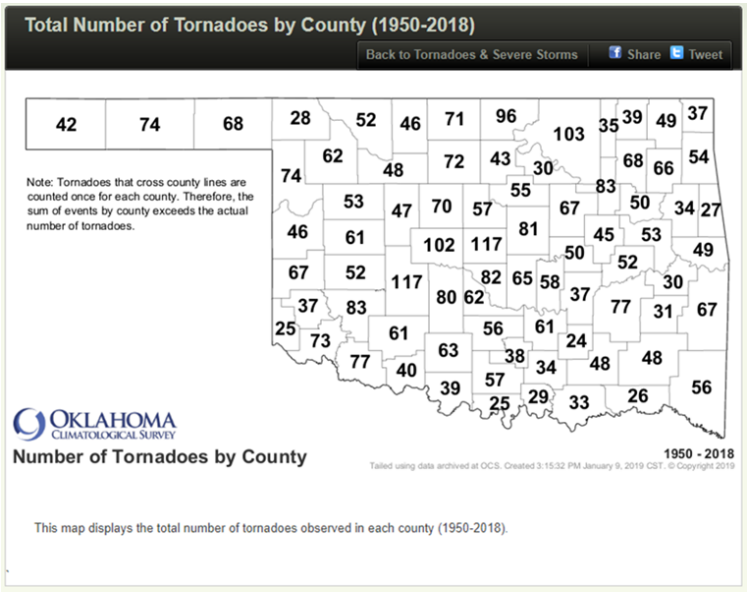
FUJITA SCALE			DERIVED EF SCALE		**OPERATIONAL EF SCALE**	
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)	**EF Number**	**3 Second Gust (mph)**
0	40-72	45-78	0	65-85	**0**	**65-85**
1	73-112	79-117	1	86-109	**1**	**86-110**
2	113-157	118-161	2	110-137	**2**	**111-135**
3	158-207	162-209	3	138-167	**3**	**136-165**
4	208-260	210-261	4	168-199	**4**	**166-200**
5	261-318	262-317	5	200-234	**5**	**Over 200**

http://www.spc.noaa.gov/faq/tornado/ef-scale.html

Previous Occurrences

Between 1950 and 2018, 28 tornados were recorded in Harper County, with many more occurring in adjacent counties. It should be noted that tornados often cross county lines, so are counted as an event in each county.

NOAA storm records from 2010 through 2019 below, show seven Tornado events in Harper County Ok.



NOAA Storm data 2010-2019

LOCATION	DATE	"F" SCALE	SOURCE	NARRATIVE
Unincorporated Harper County (SELMAN)	4/14/2012	EF1	Emergency Manager	This tornado moved into Harper County from Woodward County, producing barn damage near the county line.
MAY	11/16/2015	EF2	Emergency Manager	This tornado moved from Ellis County into Harper County to the west of Fort Supply. Four electrical transmission poles were broken as well as several trees 4 miles west of Fort Supply. Outbuildings were heavily damaged north of Fort Supply as the tornado continued northeast, and more power poles were broken east of Buffalo near the end of the tornado's path.
SELMAN	5/23/2016	EF unknown	Trained Spotter	Research meteorologists observed a tornado in southeast Harper County to the south-southeast of Selman.
LAVERNE	5/23/2019	EF2	NWS Storm Survey	This tornado broke numerous power poles and damaged trees as it moved northeast, crossing US Highway 412/State Highway 3, and dissipated about one mile north of the highway to the southwest of Laverne.
BUFFALO	5/23/2019	EF unknown	Broadcast Media	An Oklahoma City television storm chaser observed a tornado estimated to be about 5 miles west of Buffalo. No damage was reported.
LAVERNE	5/23/2019	EF unknown	Trained Spotter	Spotters observed a tornado from a second storm southwest of Laverne. No damage was noted that could be distinguished as independent from the initial tornado in the area, therefore the location of this tornado was estimated.
Unincorporated Harper County (SELMAN)	5/24/2019	EF1	Emergency Manager	A storm chaser observed a tornado from 10:42 to 10:47 pm CDT in far northeastern Harper County. An outbuilding was destroyed and numerous trees were downed on a ranch. The tornado dissipated before reaching the state line.

Probability of Future Events

Over the period 2010-2019, 7 tornados were recorded in Harper County, resulting in a probability of 70% chance of a tornado in any year, Medium probability.

Vulnerability and Impact

The entire planning area is vulnerable to tornado damage. Damage is caused by a combination of wind speed and debris carried by the wind. People, animals and every type of structure, farm, business and residential buildings are vulnerable to tornado damage, as well as utility infrastructure, schools, recreation areas, vehicles, crops, livestock and trees. High profile vehicles, campers, carports and mobile homes that are not properly anchored to the ground become unstable at wind speeds over 40 mph. Anchored mobile homes can be seriously damaged when tornadic winds gust over 80 mph.

Indirect effects. While structural damage is common, secondary impacts of tornado events can be equally serious, particularly the loss of power. Communication equipment can be damaged, making the delivery of emergency services more difficult. Cellphone and radio towers are exposed to wind, rain and flying debris. Power outages can take time to repair, putting health at risk for individuals dependent on critical medical devices. Food storage or even buying a gallon of gas becomes a challenge during loss of electrical power. Post-storm impacts include the loss of the economic use of damaged buildings or equipment and the cost to repair.

One study showed that 50 percent of tornado-related injuries are suffered during rescue attempts, cleanup, and other post-tornado activities. Nearly a third of injuries resulted from stepping on nails. Because tornadoes often damage power lines, gas lines, or electrical systems, there is always a risk of fire, electrocution, or an explosion (CDC, 2012).

TORNADO

Harper Co	
Vulnerability	Harper County lacks a public shelter or place of refuge sufficient to withstand tornados. People, animals and every type of structure, farm, business and residential buildings are vulnerable to tornado damage
	Electric utility infrastructure is above ground. The 911 system is not yet fully operational
	Tree damage is common especially when trees are not properly maintained
Impact	People are forced to seek shelter in structures that were not designed to withstand tornados
	Harper County emergency communication equipment is partly dependent on above ground land lines and therefore, more readily damaged by high winds, disrupting the delivery of emergency services. Cellphone and radio towers are exposed to wind, rain and flying debris

Town of Buffalo	
Vulnerability	Some warning sirens are older models that do not meet current specifications. The regional 911 system is not yet fully operational
	There is no public tornado shelter in Buffalo
	There are three RV parks in Buffalo; campers and mobile homes are lightweight and subject to damage from wind and debris. No shelters are in place or required
	Nursing homes and medical facilities in Buffalo are especially vulnerable due to the unpredictability of a tornado route and the difficulty of evacuating patients and staff that may be in the path of danger
Impact	People are forced to seek shelter in structures that were not designed to withstand tornados
	Unanchored RV's or mobile homes suffer damage at wind speeds over 40 mph; anchored mobile homes can be seriously damaged when tornadic winds gust over 80 mph (F0)
	Post-storm impacts include the loss of the economic use of damaged buildings or equipment and the cost to repair. Nursing homes, hospitals and businesses are at economic risk as well as physical safety
Town of Laverne	
Vulnerability	Some warning sirens are older models that do not meet current specifications. The regional 911 system is not yet fully operational
	There is no public tornado shelter in Laverne; people and animals are vulnerable to injury. There are two RV parks; RV's and mobile homes are lightweight and subject to wind damage and there is no designated storm shelter for occupants
	There are many campers and RV's stored under carports or on open lots in residential neighborhoods
	Steel carports are common in Laverne and are very lightweight storage structures that readily catch wind
	Older residential structures in the central areas of town are in various states of disrepair. Some properties in town have a concentration of loose scrap metal and assorted junk that can become projectiles when borne aloft by high speed tornadic winds
	Nursing homes and medical facilities in Laverne are especially vulnerable due to the unpredictability of a tornado route and the difficulty of evacuating patients and staff that may be in the path of danger
Impact	People are forced to seek shelter in structures that were not designed to withstand tornados
	RV's or mobile homes that are not anchored become unstable at wind speeds over 40 mph; anchored mobile homes can be seriously damaged when tornadic winds gust over 80 mph (F0)
	Carports are readily carried aloft
	Patient health is compromised when storms cause power loss, or evacuation is required

Towns of May and Rosston	
Vulnerability	There is no public tornado shelter in the Towns of May or Rosston. People, animals and every type of structure are vulnerable to tornado damage
	In the Town of May, 27% of residential structures are mobile homes. Rosston has the next largest proportion of mobile home at 25% (USCensus 2020). Mobile homes are lightweight structures and even when anchored are especially vulnerable to tornadic winds
	Older residential structures in the town are in various states of disrepair
	Trees suffer from deferred maintenance
Impact	People are forced to seek shelter in structures that were not designed to withstand tornados
	Unanchored RV's or mobile homes suffer damage at wind speeds over 40 mph; anchored mobile homes can be seriously damaged when tornadic winds gust over 80 mph (F0)
	Structures in poor repair are less able to resist the effects of tornadic winds. Trees that are not properly cared for will lose branches or be uprooted more quickly than a well maintained tree
Buffalo and Laverne School Districts	
Vulnerability	There is no tornado shelter available at Buffalo or Laverne Public Schools. School buildings and sports facilities in Buffalo are vulnerable due to the unpredictability of a tornado path and the difficulty of evacuating students and staff
	Children are separated from their families while at school
Impact	Students are at risk during the school day from the results of a tornado activity without proper sheltering at their facilities
	Staff caring for children separated from family face challenges of safe reunification and authorization for medical care

3.4.9 Wildfire

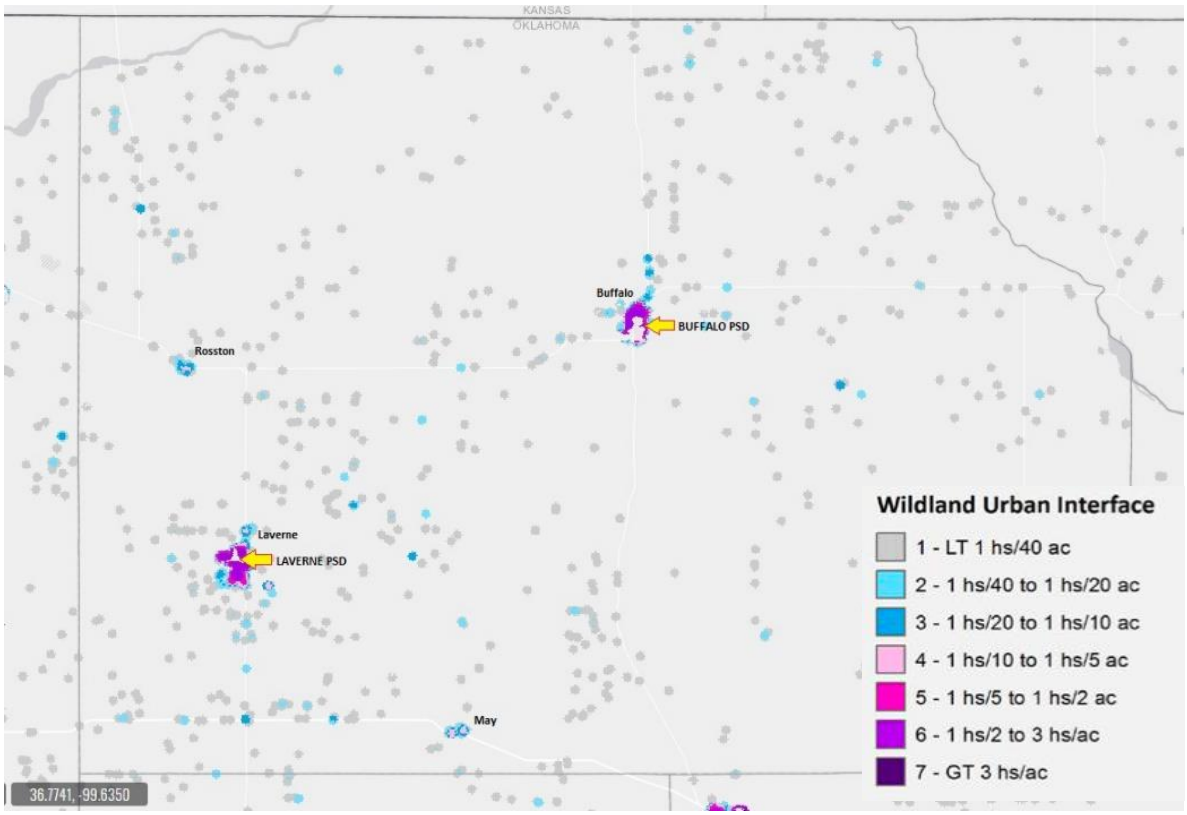
Description. Wildfire is an uncontrolled fire in a rural or wilderness area. The majority of wildfires occur when precipitation is low. A wildfire often begins unnoticed and can spread quickly, lighting brush, trees, and structures. There are three different classes of wildfires. A surface fire is common in grasslands, or areas with open vegetation, and can spread quickly. A ground fire is a dense, very hot fire that has a thick fuel source and significantly damages the soil health where it occurs. Crown fires are those that move by jumping along the tops of trees. Wildfires often begin unnoticed, but are usually signaled by dense smoke that fills the area for miles around.

Location

All participating jurisdictions are at risk from the danger of wildfire. Agricultural crops and rangeland are present throughout the planning area, and surround all jurisdictions. Areas with highly flammable Red Cedar trees are especially vulnerable. Masses of tumbleweeds and other dry, windblown plant materials build up in fence rows, brushy places and abandoned farmsteads, creating a tinderbox for sparks.

Extent

Spreading fires in brush, crops or grass are considered to be wildfires. A fire that starts as a rural wildfire can quickly become a threat to rural structures and towns. The Wildland/Urban interface is illustrated in the map below (WUI, 2020).



Relative humidity has an effect on the potential for wildfire events. During times of high humidity, prescribed burns can be used safely to control vegetation and improve pasture. When humidity is low, the danger of wildfire increases rapidly. The Keetch-Byram Drought Index and the Fire Danger Rating System are used to classify the danger of wildfires, based on the amount of soil moisture and humidity present at a given time. The planning area can expect any value on both scales to occur. See charts, below.

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

Fire Danger Rating System		
Rating	Basic Description	Detailed Description
CLASS 1: Low Danger (L) COLOR CODE: 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.

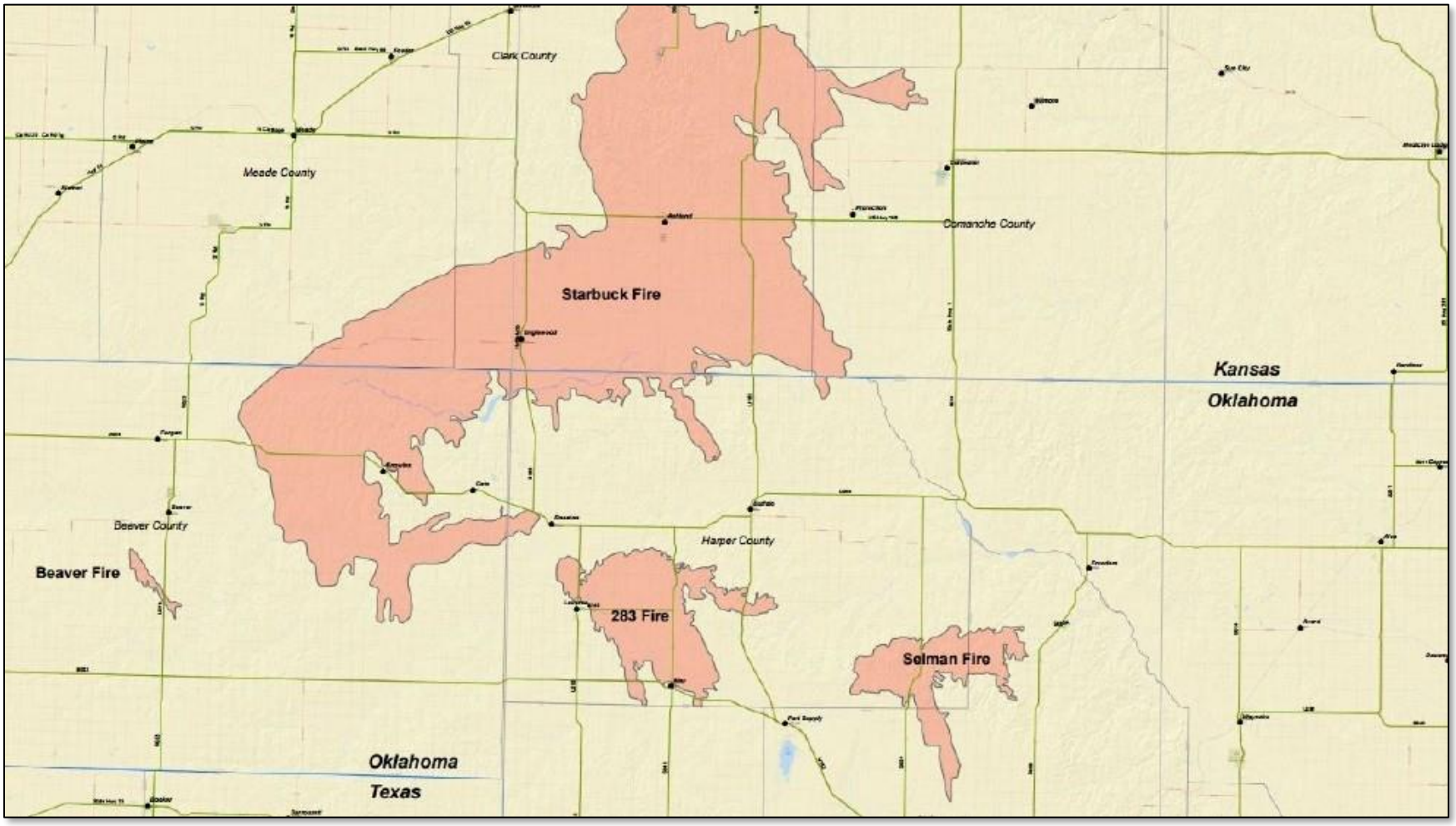
CLASS 3: High Danger (H) COLOR CODE: Yellow	fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning 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 very fast rate	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.
CLASS 5: Extreme (E) COLOR CODE: 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: http://www.wfas.net/content/view/34/51/		

Previous Occurrences. Incidents of fire response are recorded by the Oklahoma Department of Forestry. Smaller, localized wildfires are logged together with all fire calls. The Oklahoma Department of Forestry does identify larger fires that require a coordinated State response. Harper County has had four such fires in the last ten years.

WILDFIRES 2010 – 2020

COUNTY	DATE	TIME	EVENT	NAME
HARPER	8/4/2012	22:30	Wildfire	UNNAMED FIRE
HARPER	2/18/2016	12:00	Wildfire	BUFFALO
HARPER	3/6/2017	12:00	Wildfire	STARBUCK COMPLEX
HARPER	3/14/2018	12:00	Wildfire	CIMARRON FIRE

March 6, 2017 NWOK Complex; Starbuck, Beaver, 283 and Selman Fires



Probability of Future Events

Over the last ten years (2010 – 2019) there have been four severe wild fires, the Starbuck complex in 2017 being the most destructive. Numerous smaller wildfires occur every year and the probability that a wildfire will occur during any year is greater than 100%; High.

Vulnerability and Impact

The entire planning area is vulnerable to Wildfires, especially during times of low precipitation. Periods of drought and low humidity together with ever-present winds create extremely volatile conditions where any spark is blown to life.

Virtually all firefighters in the region are volunteers. Any fire can become a wildfire when response teams are too far away. Therefore, it is necessary to support the many small but well trained volunteer Fire Departments to mitigate this hazard, improve response capability and reduce the potential for injury, loss of life and property.

Eastern Red Cedar is a highly flammable and invasive tree species that occurs throughout Harper County. While some Red Cedar trees were native to NW Oklahoma, they were controlled by regular prairie fires. After 1900, the land was converted to agriculture and fire was suppressed. During the Oklahoma Dust Bowl in the 1930's many more of these trees were planted to form windbreaks. Today, Red Cedar is a noxious weed that spreads readily and takes root in old shelterbelts, fence lines, and abandoned farmsteads.

The tumbleweed *(Russian thistle)* is another prolific noxious weed. Mature plants break off at ground level, creating windblown tumbleweeds that collect in fencerows or any brushy area, providing very dry tinder.

After the threat to humans, impacts of wildfires on livestock are especially tragic. Cattle moving away from a fire become trapped in fencing. After the 2017 Starbuck Fire, many hundreds of animals had to be shot to end their suffering. Bulldozers must be employed to remove and bury the carcasses.

WILDFIRE

Harper County	
Vulnerability	Highly flammable and invasive Red Cedar grows in shelterbelts, abandoned farmsteads, fencerows and on fallow land. Average wind speed in Harper County is almost 16 mph; due to the nearly constant and vigorous wind, fencerows and abandoned farmsteads become clogged with Red Cedar and dry brush. Tumbleweeds are prolific and collect in masses along fences and fill abandoned farmyards.
	Drought with low humidity increases the danger. Extended periods of drought are common in the planning area.
	Above ground utility infrastructure is located throughout the county and electric powerlines run along fencerows.
Impact	The environmental conditions create a situation where any spark can ignite dry grass or tinder and quickly become a wildfire. For example, spot welding of fences is one example of a common cause of wildfire in Harper County

	Loss of life and property damage is the impact of wildfire. One severe result is when livestock becomes trapped by fencing and cannot escape the fire. People must be safely evacuated leaving livestock behind
	The loss of crops, livestock, agricultural buildings and residential structures carries a tremendous economic cost both in terms of initial losses and continuing until items can be rebuilt or replaced
	Power lines are burned or left hanging when the poles burn off at ground level
Towns of Buffalo, Laverne, May and Rosston	
Vulnerability	Existing communication systems are inadequate to transmit information among Public Safety personnel, Fire and Emergency volunteers and the general public. The 911 system is not fully established and even emergency radio communication can be unreliable. Cell phone service has gaps in coverage areas
	Buffalo and Laverne both have nursing homes and hospitals with ill and older patients under care. These people are more difficult to evacuate
Impact	Larger fires can encircle a town; citizens do not always know which direction they should travel to evacuate safely.
	Fire causes loss of life and property; residents and business owners may be forced to abandon valuable property and are sometimes reluctant to move to safety
	People with limited mobility such as hospital or nursing home patients suffer added stressors to health during evacuation
Buffalo and Laverne School Districts	
Vulnerability	Both the Buffalo and Laverne PS Districts lack protocols for Wildfire response. In the Public School Emergency Operation Plans, the protocol for fire is focused on evacuation from structural fires, while protocols for evacuation during wildfires are not specifically addressed
	The existing communication systems of Buffalo and Laverne are inadequate to transmit public safety information to emergency personnel, school staff and the public. The 911 system is not fully operational, and cell phone service has gaps in its coverage. This hampers the ability of school staff to communicate with emergency personnel and parents
Impact	When children must be evacuated from town during school days or school events, while they are separated from their families, the lack of emergency protocols increases the likelihood for confusion about evacuation destinations and procedures.
	Inadequate communication systems inhibit school staff from receiving timely information, and it reduces their ability to adequately communicate with parents. Misunderstandings and communication failures can occur among administration, staff, students, and parents when children are evacuated from a school facility. This miscommunication will increase if family members are forced to evacuate separately from students

3.4.10 Winter Storm

Description. Winter Storm can refer to a combination of winter precipitation, including snow, sleet and freezing rain. A severe winter storm can range from freezing rain or sleet to moderate snow over a few hours, or to blizzard conditions and extremely cold temperatures that last several days.

Blowing snow is wind-driven snow that reduces visibility and causes significant drifting. Blizzards occur when falling and blowing snow combine with winds of 35 mph or greater, reducing visibility to near zero.

Freezing rain is precipitation that falls, as liquid, into a layer of freezing air near the surface. When the precipitation makes contact with the surface, it forms into a coating or glaze of ice and even a small accumulation can cause a significant hazard.

Sleet is frozen precipitation that has melted by falling through a warm layer of the atmosphere and then refreezes into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and can accumulate like snow and become a hazard to motorists.

Ice storms are extended freezing rain events, lasting from several hours to days, when the freezing rain accumulates on surfaces and damages trees, utility lines, and roads. Ice loads on overhead power lines, combined with windy conditions, may cause the lines to "gallop." This forceful motion often causes the lines to break away from the connectors and poles, resulting in widespread power failure.

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

Location

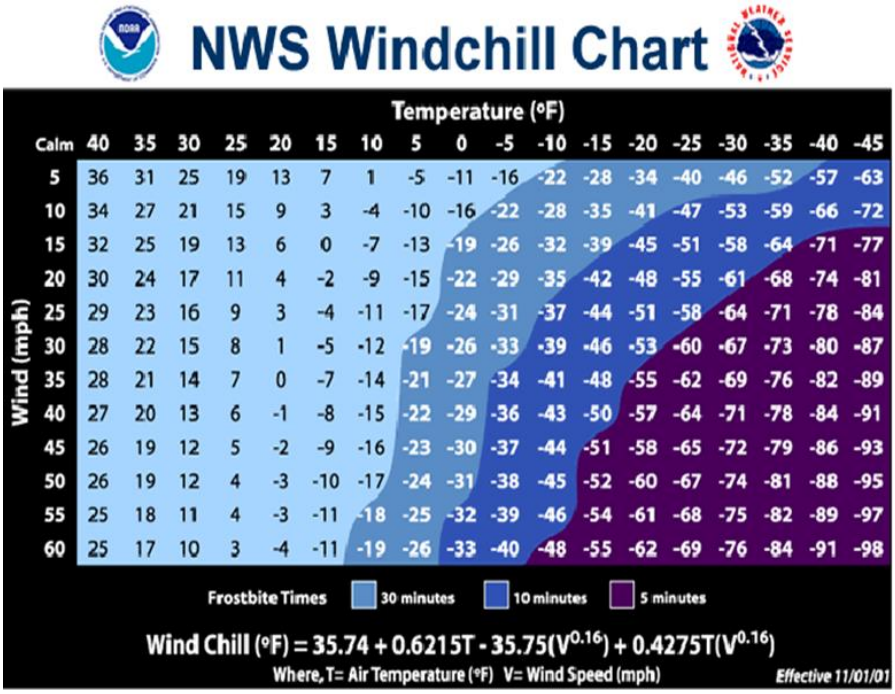
The entire planning area is at risk from winter storms several times each year. Ice and freezing rain, snowfall, cold temperatures and wind create a hazard to all residents and structures.

Extent

The Sperry-Piltz Ice Accumulation Index is used to categorize ice damage, as shown in the table below. Ice accumulation can be expected to occur at any level on the Sperry-Pilz Index.

The planning area also uses the National Weather Service (NWS) Windchill Chart to evaluate the potential for injury or loss of life due to low temperatures. Due to the unpredictable nature of winter storms, the planning area can experience a wide variety of temperatures referenced on the Windchill Chart (below). However, it is expected that temperatures of -20 or warmer can occur, with potential wind speeds at any level on the NWS chart, below.

While serious winter weather events are not unusual, most storms in Harper County are short-lived. It is unusual for snowfall to remain on the ground more than a few days (OKHMP, 2019).



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

ICE DAMAGE INDEX	DAMAGE AND IMPACT DESCRIPTIONS
0	Minimal risk of damage to exposed utility systems; no alerts or advisories needed for crews, few outages.
1	Some isolated or localized utility interruptions are possible, typically lasting only a few hours. Roads and bridges may become slick and hazardous.
2	Scattered utility interruptions expected, typically lasting 12 to 24 hours. Roads and travel conditions may be extremely hazardous due to ice accumulation.
3	Numerous utility interruptions with some damage to main feeder lines and equipment expected. Tree limb damage is excessive. Outages lasting 1 – 5 days.
4	Prolonged & widespread utility interruptions with extensive damage to main distribution feeder lines & some high voltage transmission lines/structures. Outages lasting 5 – 10 days.
5	Catastrophic damage to entire exposed utility systems, including both distribution and transmission networks. Outages could last several weeks in some areas. Shelters needed.

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

Previous Occurrences

Between the years 2010 and 2019, twenty-seven winter storms are recorded in the NOAA data.

Winter Storm/Winter Weather Events from 2010-2019

From NOAA Storm Events Database
https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=40,OKLAHOMA

WINTER STORMS

BEGIN DATE	EVENT TYPE	EVENT NARRATIVE
1/28/2010	Winter Storm	Minor accumulations of glaze occurred during the morning hours, before changing over to sleet and then snow for the afternoon. The precipitation intensity decreased during the late afternoon and early evening, before redeveloping for much of the night. Three to five inches of snow accumulated on top of the glaze by sunrise.

3/19/2010	Winter Storm	Three to four inches of snow accumulated across the county, including four inches in Buffalo. Numerous wind gusts of 35 to 40 mph reduced visibilities to below one mile at times.
1/31/2011	Winter Storm	Light snow began, with wind gusts increasing to 40 mph by midnight. The majority of the storm occurred on 2/1.
2/1/2011	Winter Storm	Around 2 inches of snow was measured two mile south-southwest of Buffalo. Wind gusts over 40 mph also created considerable blowing and drifting of the snowfall across the county. The event began during the evening hours of 1/31.
2/8/2011	Winter Storm	The observer measured 6.4 inches in Laverne. Frequent gusts of 30 to 40 mph greatly reduced visibilities and caused considerable blowing and drifting of the snow.
12/12/2003	Winter Weather	A winter storm caused problems across northwest Oklahoma and portions of southwest and central Oklahoma. Northwest Oklahoma received only snow. Snowfall amounts ranged from 1 to 3 inches at most locations in the area.
1/25/2004	Winter Weather	A strong cold front moved across the area causing precipitation that initially fell as rain or drizzle to freeze on roads and other surfaces. One to three inches of snow also fell across the area. Strong winds gusting above 40 mph caused visibility problems from the blowing snow. Temperatures behind the front continued to fall throughout the day eventually reaching single digits in some areas. With falling temperatures, strong north winds, and snow, numerous traffic accidents occurred across the area due to slick and hazardous roads.
2/4/2004	Winter Weather	A mix of rain, sleet, and snow fell across the area. Snowfall totals of 1 to 3 inches were reported across most of the area, with a few locations receiving almost 4 inches. Numerous traffic accidents were reported due to the mixed precipitation causing slick and hazardous road conditions.
11/30/2006	Winter Weather	Snowfall totals of 1 to 3 inches were reported across Harper County
11/23/2007	Winter Weather	Up to 2 inches of snow was reported in Laverne.
12/22/2007	Winter Weather	Up to four inches of snow fell near Buffalo and Laverne. Blowing and drifting snow was a problem with 20 to 30 mph winds reported. Snow drifts as high as two feet resulted in some areas. US HWY 64 between Alva (Woods County) and Buffalo had to be closed due to reduced visibilities. Six vehicles were involved in separate accidents as a result.
1/31/2008	Winter Weather	One inch of snow was measured in Laverne.
12/9/2008	Winter Weather	Two inches of snow accumulated in Buffalo and surrounding areas.

1/26/2009	Winter Weather	Up to a half of an inch of ice glaze and sleet accumulated near Buffalo.
1/9/2011	Winter Weather	Three inches of snow accumulated in Buffalo.
1/19/2011	Winter Weather	Around 3 inches of snow accumulated at Buffalo.
1/19/2011	Winter Weather	Two inches of snow accumulated at Laverne.
2/12/2013	Heavy Snow	Two inches of snow accumulated at Buffalo.
12/21/2013	Heavy Snow	Two inches of snow accumulated at Laverne.
1/4/2014	Winter Weather	Snow began light on the 4th and lingered into the morning of the 5th. By the time the snow ended, Laverne reported 2 inches of snow.
2/4/2014	Heavy Snow	Two inches of snow accumulated at Laverne.
3/2/2014	Heavy Snow	Around 3 inches of snow accumulated at Buffalo.
11/16/2014	Winter Weather	Snow began during the early morning hours and tapered off by noon. Once snow had ended, up to 3 inches of snow had fallen in Buffalo, with higher amounts to the northwest.
11/16/2014	Heavy Snow	Up to four inches of snow fell near Buffalo and Laverne.
2/27/2015	Winter Weather	Snow began early on the 27th and lasted through the early morning hours of the 28th. By the time snow had ended, around two inches of snow 14 miles south of Buffalo.
1/14/2017	Ice Storm	A mix of sleet and freezing rain fell across the area. Ice up to an inch thick brought down trees limbs and power lines across the county.
11/12/2018	Heavy Snow	Two inches of snow accumulated at Laverne.

Probability of Future Events

Twenty-seven winter storms recorded in a 10 year period indicates a probability of 2 or 3 such storms each year; >100% = High probability.

Vulnerability and Impact

Winter storms were one of the top three concerns expressed by the public in Harper County. Above ground electric utility infrastructure is vulnerable to ice, wind and snow, leading to loss of power. During winter storms, road conditions deteriorate, creating dangerous exposure scenarios. Emergency response vehicles and personnel can be delayed due to road conditions or communication breakdowns. Power loss during times of extreme temperatures can create a dangerous situation, especially for those who rely on electricity for medical support equipment.

WINTER STORM

Harper Co	
Vulnerability	Due to the temperate climate Harper County does not need heavy plows and trucks to remove snow on a routine basis. Therefore, the County is less equipped to deal with a severe winter storm event than a similar municipality at a more northerly latitude. There may be an extended time period before secondary roads are fully cleared
	Many people in Harper County work outdoors engaged in agriculture, natural resource extraction or construction. Humans, crops and livestock are vulnerable to extreme temperatures, making these outdoor activities more dangerous
	Due to older and above-ground electrical utilities, power outages frequently occur when there is ice accumulation and wind.
	There is no public shelter or place of refuge in Harper County
	Few households have backup power generator systems in place
	The emergency response system is partly dependent on electric power
Impact	Vehicle accidents due to heavy snow or icy roads and bridges put humans at risk of exposure to extreme temperatures while cell phone communication is unreliable in rural areas
	Farm workers, utility crews and rescue personnel are exposed to extreme conditions, risking injury and loss of life.
	Utility infrastructure is damaged by ice accumulation and wind. Power disruptions can slow emergency response
	Utility crews encounter difficulty reaching downed power lines in remote locations when roads are impassable
	When power fails and roads cannot immediately be cleared, people can be isolated at home without access to supplies or medical care
	People are exposed to dangerously low temperatures in their own homes and may resort to unsafe use of carbon monoxide producing heat sources
Towns of Buffalo, Laverne, May and Rosston	
Vulnerability	Power outages frequently occur due to ice accumulation and high winds
	There is no public shelter or place of refuge in Buffalo, Laverne, May or Rosston
	Travel conditions deteriorate, putting people at risk of exposure in case of breakdown or accidents
	No groceries or medical services are available within walking distance in the towns of May or Rosston; the nearest supplies are more than 10 miles away
Impact	People are exposed to dangerously low temperatures in their own homes and may resort to unsafe use of carbon monoxide producing heat sources
	Access to essential supplies and medical services is disrupted

Buffalo and Laverne School Districts	
Vulnerability	The community does not have many heavy trucks or snow plows; secondary roads cannot be cleared immediately
	Above ground electric utilities are exposed to weather; power outages frequently occur
Impact	While poor road conditions persist, schools are subject to cancellation or delay
	When there is a loss of power, school must be cancelled
	School staff, children and caregivers must travel in hazardous conditions to reach school or home

CHAPTER FOUR: MITIGATION STRATEGY

4.1 Capabilities Assessment

The ability of a community to respond and recover from disasters is a function of the capabilities and resources available. Some of these capabilities include the skills of staff and employees; others are met by contracting for services on an as-needed basis.

In addition to staff skills, abilities and services, each incorporated municipality has the authority to impose regulations on land development, manage floodplains, and may be a provider of critical utilities or functions such as water, sewer, and electric services and waste collection.

For a good portion of each year, schools are responsible for nearly every child in a community and employ many other local people. Schools, therefore have a special interest in ensuring public safety from hazardous events. Other educational opportunities offered to a community can enhance the efficacy of pre-disaster planning and post-disaster management.

The tables below provide a summary of the administrative and technical capabilities currently in place in each participating jurisdiction. A mark (X) indicates that the jurisdiction was reported to have the authority to implement the specified regulatory tool and that the tool is currently in place.

4.1.1 Existing Institutions, Plans, and Ordinances

EXISTING PLANS AND ORDINANCES

JURISDICTION	BUILDING CODE	ZONING ORD	SUBDIVISION ORD	SPECIAL PURPOSE ORD	GROWTH MGNT ORD	SITE PLAN REVIEW	COMPREHENSIVE PLAN	CAPITAL IMP PLAN	ECON DEV PLAN	EM RESPONSE PLAN	POST DISASTER PLAN
HARPER COUNTY										X	X
TOWN OF BUFFALO	X							X		X	X
TOWN OF LAVERNE	X							X		X	X
TOWN OF MAY										X	X
TOWN OF ROSSTON										X	X
Notes: Post Disaster Plan: The County plan covers all municipalities.											

4.1.2 Administrative and Technical Capability

LOCATION	ENGINEER AVAILABLE	FLOODPLAIN MNGR	SURVEYORS	STAFF WITH EM EXP	STAFF W GIS OR HAZUS	SCIENTISTS (GEO, BIO, AG)	EM MANAGER	GRANT WRITERS
HARPER COUNTY	X		X	X	X		X	X
TOWN OF BUFFALO	X	X	X	X			X	X
TOWN OF LAVERNE	X		X	X			X	X
TOWN OF MAY	X		X					X
TOWN OF ROSSTON	X		X					X
NOTES:	Hired by project		Hired by project		OEDA	Hired as needed		by Contract or OEDA

4.1.3 Financial Capabilities

JURISDICTION	CAPITAL IMP PROJ FUNDING	TAX AUTHORITY	UTILITY SERVICE FEES	DEVELOPMENT FEES	GEN OB FUNDS & BONDS	CDBG/REAP	FEDERAL FUNDS	STATE FUNDING
HARPER COUNTY	X	X			X	X	X	X
TOWN OF BUFFALO	X	X	X		X	X	X	X
TOWN OF LAVERNE	X	X	X		X	X	X	X
TOWN OF MAY	X	X	Trash		X	X	X	X
TOWN OF ROSSTON	X	X			X	X	X	X

4.1.4 Education and Outreach Capabilities

JURISDICTION	LOCAL CITIZEN GROUPS INVOLVED	NON-PROFITS	ONGOING ED & INFO PROGRAMS	NATURAL DISASTER/SAFETY PROGRAMS	STORM-READY CERTIFICATION	FIREWISE COMMUNITY	PUB/PRIVATE PARTNERSHIPS FOR DISASTER ISSUES
HARPER COUNTY	X	X	X	X			X
TOWN OF BUFFALO	X	X	X	X			X
TOWN OF LAVERNE	X	X	X	X			X
TOWN OF MAY	X	X		X			X
TOWN OF ROSSTON	X	X		X			X
NOTES:		AM RED CROSS					

4.1.5 School District Capability Assessment

SCHOOL DISTRICT ASSESSMENT	BUFFALO	LAVERNE
1. HAS YOUR SCHOOL DISTRICT HAD POSITIVE RESPONSES TO BOND ISSUES?	YES	YES
2. BASED ON POPULATION IS YOUR SCHOOL DIST GROWING OR DECLINING?	GROW	GROW
3. HAS THE DISTRCT TAKEN MEASURES TO PROTECT STUDENTS FROM HAZARD EVENTS?	YES	YES
4. LIST ANY HAZARD EVENTS THAT DAMAGED YOUR SCHOOLS IN THE LAST 10 YRS:	NONE	NONE

OTHER SCHOOL DISTRICT CAPABILITY	**BUFFALO PSD**	**LAVERNE PSD**
CAPITAL IMPROVEMENT PLAN		
EMERGENCY MANAGEMENT PLAN; HAZARD RESPONSE	X	X
BUDGET TO RAISE FUNDS FOR MITIGATION (BONDS)	X	X
PUBLIC/PRIVATE PARTNERSHIPS, CORPORATE DONATIONS	X	X
DESIGNATED EMERGENCY MANAGER	X	X
PTO/PTA	X	X
LIGHTNING EVALUATION TRAINING FOR TEACHERS/COACHES		
POST DISASTER RECOVERY PLAN		

4.1.6 Capability improvements

Because it is a rural county with low population density, Harper County municipalities do not have the tax base to support many planning or construction projects. Therefore, each jurisdiction must be assertive in pursuit of grant funds and low-cost strategies for long range planning activities and to complete hazard mitigation projects. It is important for each municipality and school district to have a designated staff person to act as a point of contact for grant administration. The local Council of Governments (COG) can work with staff to facilitate access to many of these funding opportunities.

Public funding is available for strategies listed in the table below, such as Capital Improvement Planning (CIP) and Comprehensive Planning which are funded up to 100% of total project cost by Community Development Block Grants (CDBG-CIP) through the Oklahoma Department of Commerce. Other low-cost, high-impact strategies include the *Firewise* communities program sponsored by the Oklahoma Department of Forestry and *StormReady*, which is sponsored by the United States National Weather Service.

There are several good programs at the Oklahoma Department of Emergency Management that support small communities in becoming more resilient, such as Safe Schools 101, which provides an assessment of existing structures at no cost to the local community and provides recommendations for improvement. Schools may use the assessment to consider realistic options for hardening and/or installation of safe rooms in the structure as well as identify the strongest areas of construction that may be used as areas of refuge already present in the school. The school district will have the opportunity to choose which actions if any it would like to take based on the results of the assessment.

The following improvements would improve capability for the participating jurisdictions:

JURISDICTION	IMPROVEMENT
Harper County	Develop and adopt a Comprehensive plan
	Become a Firewise Community
	Become a Storm-ready Community
Town of Buffalo	Develop and adopt a Comprehensive plan
	Become a Firewise Community
	Become a Storm-ready Community
Town of Laverne	Develop and adopt a Comprehensive plan
	Become a Firewise Community
	Become a Storm-ready Community
Town of May	Conduct and adopt a Capital Improvement Plan
	Become a Firewise Community
	Become a Storm-ready Community
	Participate in the NFIP
Town of Rosston	Conduct and adopt a Capital Improvement Plan
	Become a Firewise Community
	Become a Storm-ready Community
	Participate in the NFIP

Buffalo PSD	Develop and adopt a Capital Improvement Plan
	Participate in Safe Schools 101
	Include Lightning Evaluation Training for staff
	Develop and adopt a Post-disaster Recovery Plan
Laverne PSD	Develop and adopt a Capital Improvement Plan
	Participate in Safe Schools 101
	Include Lightning Evaluation Training for staff
	Develop and adopt a Post-disaster Recovery Plan

Harper County Towns do not have as many regulatory ordinances as one might find in a city of larger size. While there is existing regulation of noxious weeds as identified by the State, some improvement could be made through the adoption of local policies to control Red Cedar and tumbleweeds in towns as well as rural areas, and more aggressive reporting and enforcement of Oklahoma Noxious Weed laws.

In regard to technical capability, Staff is available for most local services, but people with special technical skills such as Grant Writers, Engineers, Surveyors and GIS Technicians are typically hired from the Regional COG or from nearby cities on an individual project basis. Capability could be enhanced with more frequent use of existing resources.

Other critical capabilities. Hospitals, Medical Clinics and Residential Care facilities are located at Buffalo and Laverne. Volunteer Fire Departments and EMS are active in each community. These volunteer units are supported by a variety of local resources such as Department of Forestry programs and grants, Rural Economic Action Plan (REAP) grants, local fund-raising efforts and others.

There is another, informal asset that is a benefit to this region, and that is the high cultural value placed on being of service to one's neighbors. There is remarkably strong local response (both physical and financial) in the event of fire or any other disaster that strikes.

4.2 NFIP Participation

The Town of Buffalo participates in the National Flood Insurance Program (NFIP). Harper Co, Laverne, May, and Rosston do not participate in the NFIP. FEMA has not completed a study to determine other flood hazard locations in Harper County; therefore, FIRM maps for the remainder of the county have not been published at this time. Local knowledge, including NRCS data is the primary source of other flood data available. No repetitive loss structures have been identified in the planning area.

Buffalo will continue to comply with NFIP floodplain management regulations by controlling development in Special Flood Hazard Areas (SFHAs). Capability in the planning area would be enhanced by increased participation in the NFIP. The Towns of Rosston and May would benefit from NFIP participation.

4.3 Mitigation Goals

The planning team was guided by the following four principles during the development of goals and action steps for this update.

1. To protect life
2. To protect property
3. To protect the environment
4. To increase public preparedness for disasters (OKHMP, 2019)

GOALS	
Goal 1	To increase communication and coordination to improve response times and efficiency when disaster strikes
Goal 2	To educate the general public on the importance of hazard mitigation
Goal 3	To determine and reduce areas that are considered in high risk areas or suffer repetitive losses associated with natural disasters
Goal 4	To develop and educate responders and health care providers about mitigation strategies and measures for varying hazards
Goal 5	To enhance and strengthen existing pre-disaster and prevention activities

4.4 Action Items

An overall goal of the mitigation actions is to reduce risk to existing buildings and infrastructure, as well as limit any risk to new development and redevelopment.

There are five Mitigation Action Types:

Local Plans and Regulations: Using authorities, policies, and codes to influence development.
Structure/ Infrastructure Projects: Modifying or removing infrastructure to mitigate hazard.
Natural System Protection: Minimizing damage by preserving natural system functions.
Education and Awareness Programs: Informing citizens on how to mitigate hazards.
5% Projects: Actions not quantifiable by a Benefit Cost Analysis, (i.e., sirens, generators, etc.).
One effective criteria for prioritizing mitigation actions is to analyze each action by the Social, Technical, Administrative, Political, Legal, Economic, and Environmental criteria. The (STAPLEE) Method was applied to prioritize the mitigation actions selected by the community. That evaluation is recorded in the Action Tables below and labeled “Mitigation Action Evaluation.”

STAPLEE Mitigation Action Evaluation

Category	Evaluation
Social	Community acceptance, Effect on segments of the population, educational
Technical	Technical feasibility, Long term solution, Secondary impacts
Administrative	Staffing, Funding available, Maintenance & operations
Political	Political support, Local leadership support, Public support
Legal	Jurisdictional authority, potential legal challenge
Economic	Benefits outweigh costs, contributes to economic goals, outside funding required
Environmental	Effect on land, water, species, consistent with sound environmental goals

Each of these categories were considered when setting priorities. Perceived benefits according to the STAPLEE evaluation include the determination that benefits must outweigh costs for each action step recommended. The priorities of the community as stated during public meetings and by survey were compared with the STAPLEE categories of potential benefit as a means of measuring the qualitative benefit to the community.

Preference was then given to the hazards viewed by the public as presenting the most frequent problems and the most severe consequences. For example, planning committee discussions and community survey comments indicated that the most frequent problem was extended power outages as a result of extreme weather, and the top priority was to develop a community shelter as a place of refuge, equipped with generators and emergency supplies at the County fairgrounds in Buffalo. That project would utilize an existing building and provide a temperature-controlled place of refuge during power outages. Such a project meets criteria of the first seven categories of the STAPLEE chart, with only environmental benefits being less directly evident.

Public meetings, surveys and public comments indicated that the top four hazards of concern in the community are Drought, Wildfires, Winter storms and Tornados, in that order. The hazard of greatest concern was drought because of its effect on other critical issues such as long term water supply and the increased danger of wildfires. Therefore, Action items 2 through 5 aim to mitigate those hazards by regulating water usage during drought and decreasing the associated fire danger.

Other specific actions developed to support mitigation goals are outlined below.

Action Item 1	**Establish a community place of refuge**
Hazard(s) Addressed	Extreme Heat, Tornado, Winter Storms
Mitigation Action Type	Structure, infrastructure improvements
Jurisdiction	Harper County, Towns of Buffalo, Laverne, May and Rosston
Action Description	Establish place of refuge at the County Fairgrounds to include power generators for power outages to serve citizens of Harper County
Responsible Party	Harper Co Emergency Manager
Potential Implementation Timeline	2 years
Estimated Cost	$5000 - $10,000
Potential Funding Sources	FEMA grants, local fund raising activities
Mitigation Action Evaluation	Social, technical, administrative, political, legal, economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	No
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 2	**Regulate water usage; preserve resources**
Hazard(s) Addressed	Drought
Mitigation Action Type	Local Plans & Regulations
Jurisdiction	Harper County, Buffalo, Laverne, May, Rosston; Buffalo & Laverne PSD
Action Description	Adopt ordinances or practices that regulate water usage during times of drought to improve preservation of water resources
Responsible Party	Harper Co Public works, Buffalo Public Works, Laverne Public Works Dept, School Superintendent
Potential Implementation Timeline	6 months
Estimated Cost	Negligible
Potential Funding Sources	Local
Mitigation Action Evaluation	Social, administrative, political, legal, economic, environmental
Will this action protect lives and/or prevent injury?	Yes. Water conservation practices will protect people from the health & economic consequences of water shortages as a result of drought
Will the action eliminate or reduce damage to infrastructure?	No
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 3	Become a Firewise Community
Hazard(s) Addressed	Wildfires
Mitigation Action Type	Education & awareness
Jurisdiction	Harper County, Buffalo, Laverne, May, Rosston
Action Description	Take required steps and apply to become a Firewise community
Responsible Party	Harper County Emergency manager, Buffalo Emergency Manager, Laverne Emergency Manager, May Fire Chief, Rosston Fire Chief
Potential Implementation Timeline	One year
Estimated Cost	Negligible; Staff time
Potential Funding Sources	Local
Mitigation Action Evaluation	Social, technical, administrative, economic, environmental
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	Yes
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 4	Adopt regulations to require defensible space
Hazard(s) Addressed	Wildfire
Mitigation Action Type	Local Plans & Regulations
Jurisdiction	Harper County, Buffalo, Laverne, May, Rosston; Buffalo PSD, Laverne PSD
Action Description	Adopt ordinances or policies to increase defensible space around structures in the Wild land/Urban Interface area for existing and new buildings
Responsible Party	Harper County Emergency Manager, Town managers of Buffalo, Laverne, May, Rosston; Buffalo and Laverne School Superintendents
Potential Implementation Timeline	6 to 12 months
Estimated Cost	Negligible
Potential Funding Sources	Local
Mitigation Action Evaluation	Social, administrative, political, legal, economic, environmental
Will this action protect lives and/or prevent injury?	Increased defensible space will protect people from the threat of wildfire
Will the action eliminate or reduce damage to infrastructure?	Yes. Additional defensible space will reduce the demand on municipal water supplies in the event of fire and reduce fire damage to infrastructure
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 5	**Increased Elimination of Red Cedar**
Hazard(s) Addressed	Wildfire
Mitigation Action Type	Local Plans & Regs, Education & Awareness
Jurisdiction	Harper County, Towns of Buffalo, Laverne, May, Rosston
Action Description	Adopt policies that reduce risk through land use planning by promoting conservation of open space and WUI boundary zones. Provide public education to encourage compliance with state noxious weed laws
Responsible Party	Harper County Commissioners District 1, 2 and 3; Buffalo and Laverne Code Enforcement officers
Potential Implementation Timeline	Initiate in one year, on-going implementation
Estimated Cost	Negligible cost
Potential Funding Sources	Local fees, NRCS
Mitigation Action Evaluation	Social, administrative, political, legal, economic, environmental
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	Yes
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 6	**Increase Public Warning Capability by Becoming a StormReady community**
Hazard(s) Addressed	Tornado, Hail, High winds, Winter storm
Mitigation Action Type	5% projects
Jurisdiction	Harper Co, Towns of Buffalo, Laverne, May, Rosston
Action Description	Participate in StormReady Program in order to enhance the town's ability to provide increased warning to citizens, and mitigate the threats to public safety during a hazardous weather event.
Responsible Party	Harper County Emergency Manager, Town Emergency managers, Town Boards of May and Rosston
Potential Implementation Timeline	One year
Estimated Cost	Negligible
Potential Funding Sources	Local, State EM
Mitigation Action Evaluation	Social, technical, administrative, political, economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	Yes
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 7	**Install additional outdoor warning sirens**
Hazard(s) Addressed	Tornado, Hail, Lightning
Mitigation Action Type	5% project
Jurisdiction	Buffalo, Laverne, May, Rosston
Action Description	Apply for grants for sirens, purchase and install
Responsible Party	Buffalo and Laverne Emergency Managers
Potential Implementation Timeline	1 - 5 years
Estimated Cost	To be determined
Potential Funding Sources	FEMA, OEM grants, REAP
Mitigation Action Evaluation	Social, Technical, Political, Economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	No
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 8	**Conduct Safety Inspections of Building Safety and Implement recommended mitigation strategies**
Hazard(s) Addressed	Earthquake, High winds, Tornado, Hail
Mitigation Action Type	Local plans & regs, Structure/ Infrastructure Projects
Jurisdiction	Harper Co, Towns of Buffalo, Laverne, May, Rosston; Buffalo PSD, Laverne PSD
Action Description	Harper Co, Towns of Buffalo, Laverne, May, Rosston; Structural and non-structural hazard risks in and around critical facilities will be assessed by design professionals and recommendations will be implemented by all jurisdictions. Buffalo PSD and Laverne PSD Partner with Safe Schools 101 Program to assess hazard risks of existing structures, and to evaluate the potential for the hardening of existing structures to withstand hazards. Recommendations will be implemented.
Responsible Party	Harper Co EM, Towns of Buffalo and Laverne EMs; School Superintendents, Buffalo and Laverne PSD EMs
Potential Implementation Timeline	1 - 5 years
Estimated Cost	Free assistance
Potential Funding Sources	Local, State assistance grant
Mitigation Action Evaluation	Social, Technical, Administrative, Economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	Yes
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 9	**Design and install safe rooms at local schools**
Hazard(s) Addressed	High winds, Tornado, Hail
Mitigation Action Type	Structure, Infrastructure Project
Jurisdiction	Buffalo PSD, Laverne PSD
Action Description	Work with OEM to evaluate structures and apply for grants to install safe rooms consistent with Safe School 101
Responsible Party	Buffalo and Laverne School Superintendents, PSD Emergency Managers
Potential Implementation Timeline	1 - 5 years
Estimated Cost	Local Match funds may be required
Potential Funding Sources	Local, OEM/FEMA
Mitigation Action Evaluation	Social, Technical, Administrative, Economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	Yes
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 10	**Install Community Safe Rooms**
Hazard(s) Addressed	Tornado, High winds, Hail
Mitigation Action Type	Structure, Infrastructure projects
Jurisdiction	Harper Co, Towns of Buffalo, Laverne, May, Rosston
Action Description	Work with OEM to facilitate a Community safe room program for towns and unincorporated areas.
Responsible Party	Harper County EM and Town of Buffalo & Laverne EMs; Harper County EM will assist the Towns of May and Rosston
Potential Implementation Timeline	2-5 years
Estimated Cost	Local match may be required
Potential Funding Sources	Local, FEMA
Mitigation Action Evaluation	Social, technical, political, economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	Yes
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 11	Facilitate Residential Safe Room program
Hazard(s) Addressed	High winds, Tornado, Hail
Mitigation Action Type	Structure, Infrastructure projects
Jurisdiction	Harper County, Buffalo, Laverne, May, Rosston
Action Description	Work with OEM to facilitate a residential safe room grant program for homeowners
Responsible Party	Harper County Emergency Manager, Buffalo and Laverne EMs, Property owners
Potential Implementation Timeline	2-5 years
Estimated Cost	Private funds
Potential Funding Sources	Local, OEM/FEMA
Mitigation Action Evaluation	Social, technical, administrative, political, economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	Yes
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 12	Increase Severe Weather Risk Awareness
Hazard(s) Addressed	Extreme Heat, Hail, Tornado, Winter storms
Mitigation Action Type	Education & Awareness
Jurisdiction	Harper County, Buffalo, Laverne, May, Rosston
Action Description	Inform residents of shelter locations and places of refuge that are available for community safety purposes during hazardous weather.
Responsible Party	Harper County EM; Town Managers Buffalo, Laverne, May and Rosston
Potential Implementation Timeline	Initiate within 1 year, then on-going updates
Estimated Cost	$100
Potential Funding Sources	Local funds, COG GIS support
Mitigation Action Evaluation	Social, administrative, political, economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	No
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 13	Bury utility lines for critical facilities
Hazard(s) Addressed	Hail, High Wind, Lightning, Tornados, Winter storms, Wildfire
Mitigation Action Type	Local Plans & regulations
Jurisdiction	Harper Co, Towns of Buffalo, Laverne, May, Rosston
Action Description	When making repairs, bury lines when possible
Responsible Party	Harper County Commissioners District 1,2 & 3; Utility Administrators for Buffalo, Laverne, NW Electric COOP for May & Rosston
Potential Implementation Timeline	Initiate, then on-going
Estimated Cost	Done in conjunction with repairs to reduce cost
Potential Funding Sources	Utility fees
Mitigation Action Evaluation	Technical, administrative, economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	Yes
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 14	Continue to install rip-rap to control erosion
Hazard(s) Addressed	Flood
Mitigation Action Type	Natural System protection
Jurisdiction	Harper County, Towns of Buffalo, Laverne, May, Rosston
Action Description	Continue to install rip-rap to prevent erosion in known erosion and washout areas to protect roads
Responsible Party	County Commissioners for Districts 1, 2 and 3; Buffalo Public Works Director, Laverne Public Works Director
Potential Implementation Timeline	Ongoing
Estimated Cost	No new cost
Potential Funding Sources	Local funds
Mitigation Action Evaluation	Technical, administrative, economic, environmental
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	Yes
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 15	Equip schools, shelters and public places of refuge with NOAA weather radios
Hazard(s) Addressed	Extreme heat, Flood, Hail, High Winds, Lightning, Tornado, Winter storms
Mitigation Action Type	5% Projects
Jurisdiction	Harper County, Buffalo, Laverne, May, Rosston; Buffalo PSD, Laverne PSD
Action Description	Acquire and distribute NOAA Weather radios to local shelters, schools and public places of refuge; frequent testing of this equipment
Responsible Party	Harper County Emergency manager
Potential Implementation Timeline	Initiate within 6 months, then on-going as needed
Estimated Cost	Negligible
Potential Funding Sources	OEM grants
Mitigation Action Evaluation	Social, technical, political, economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	No
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 16	Increase Public Accessibility to Flood Insurance Rate Maps and NRCS flood data
Hazard(s) Addressed	Flood
Mitigation Action Type	Local Plans and Regulations
Jurisdiction	Harper County, Towns of Buffalo, Laverne, May, Rosston; Buffalo PSD, Laverne PSD
Action Description	Establish and publicize a user-friendly, publicly accessible repository for Flood Insurance Rate Maps
Responsible Party	Harper County Emergency Manager
Potential Implementation Timeline	6 months
Estimated Cost	<$100
Potential Funding Sources	Local, COG support
Mitigation Action Evaluation	Social, technical, administrative, environmental
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	No
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 17	Design and Publish an Educational Booklet
Hazard(s) Addressed	Drought, Earthquake, Flood, Extreme heat, Hail, High winds, Lightning, Tornado, Wildfire, Winter storms
Mitigation Action Type	Education & Awareness
Jurisdiction	Harper County, Towns of Buffalo, Laverne, May, Rosston, Buffalo PSD, Laverne PSD
Action Description	Distribute a booklet throughout schools and public buildings on mitigation techniques and protocols for all hazards.
Responsible Party	Harper County Emergency manager
Potential Implementation Timeline	Initiate within 6 months, then on-going as needed
Estimated Cost	Negligible
Potential Funding Sources	Donated
Mitigation Action Evaluation	Social, technical, administrative, economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	No
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 18	Educate Schools on Evacuation Routes
Hazard(s) Addressed	Wildfire
Mitigation Action Type	Education and Awareness
Jurisdiction	Buffalo PSD, Laverne PSD
Action Description	Inform school staff on proper wildfire evacuation procedures, so they can create evacuation protocols in their emergency operations plans.
Responsible Party	Buffalo and Laverne School Superintendents
Potential Implementation Timeline	Initiate within 6 months
Estimated Cost	Negligible
Potential Funding Sources	Staff time
Mitigation Action Evaluation	Social, technical, administrative, economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	No
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

4.5 Integration of Data, Goals, and Action Items

Each jurisdiction in Harper County will receive a copy of the 2021 Hazard Mitigation Plan Update so that the data, information, and hazard mitigation goals and actions may be incorporated into other planning mechanisms. Regulations may be adopted to facilitate implementation of Hazard Mitigation strategies. Hazard mitigation information and actions identified in this update will be incorporated into other plans when adopted or reviewed as follows:

Jurisdiction	Plan	When
Harper County; Towns of Buffalo, Laverne, May and Rosston	Comprehensive Plans (if adopted)	Annual review, 20 year update
	Harper County Emergency Management Plan	Annual review, annual update
	Harper County Post-Disaster Recovery Plan	Annual review, annual update
Towns of Buffalo, Laverne	Capital Improvement Plans	Annual review, 5 year update
Buffalo and Laverne Public School Districts	Emergency Operations Plans	Annual review, annual update
	Post disaster recovery plans (if adopted)	Annual review, annual update

The Harper County Emergency Management Plan and the Post-Disaster Recovery Plan cover all jurisdictions and are reviewed by the Emergency Management Director and each department director on an annual basis.

The Emergency Management Directors for Harper County, Buffalo and Laverne, all Town managers and public works directors review priorities for capital improvements as part of fiscal planning on an annual basis. The action items project list from the Hazard Mitigation Plan will be reviewed during the budget planning process to document progress and ensure on-going prevention, preparedness, response, recovery, and mitigation of identified hazards.

The Buffalo and Laverne Capital Improvement Plans (CIPs) are reviewed on an annual basis by the Town Boards, Town EMs, and Public Works Directors. The Towns of May and Rosston are eligible to apply for CIPs, and it is recommended that they do so to improve capability and hazard resilience.

The Buffalo and Laverne School Districts each have a School Board and a designated Emergency Manager who are responsible for review and update of Emergency Operations Plans every year. The action items list from the Hazard Mitigation Plan will be reviewed during these plan updates to ensure the school district continues to seek opportunities to accomplish mitigation action items. Each Public School Board has the authority to distribute school funds and issue bonds as they pertain to proposed mitigation action projects. The public votes on bond issues to approve or deny funding for projects.

Incorporation of previous HMP. The Oklahoma State Hazard Mitigation Plan incorporates local plans, including the Harper County HMP, but local Capital Improvement Plans and School Emergency Operation Plans have been developed independently, and data or goals from the previous Harper County HMP were not incorporated into those plans during the last 5 years.

4.6 Future Planning efforts Drought resilience

The citizens of Harper County are concerned about the effects of drought and aquifer depletion over the next fifty years. In recent decades, the Oklahoma Water Resources Board's Financial Assistance Program has provided billions of dollars in assistance to local water and sewer infrastructure projects, which has increased the drought resistance of local water treatment and distribution systems in towns and cities across the state. Harper County is eligible to apply for assistance through that program.

An analysis conducted for the 2012 Update of the Oklahoma Comprehensive Water Plan (OCWP) estimated that Oklahoma faced an $82 billion need in such financing over the next 50 years (OWRB, 2012). This is an indication that the State recognizes the risk and is motivated to assist communities in mitigation of that long term hazard.

CHAPTER FIVE: PLAN UPDATE PRIORITIZATION AND REVIEW

5.1 Changes in Jurisdictional Development

Two modest changes in development have occurred in Harper County since the publication of the previous HMP. Those are: an increase in the number of Tank Batteries which are used as storage for petroleum products, and an increase in the number of wind turbines that have been built. Neither has made a significant change in the potential for or severity of hazard events in the county; both were addressed in this update as a component of utility infrastructure. No other changes in development have impacted the jurisdiction's overall vulnerability. Housing and industry are both relatively stable.

5.2 Status of Previous Mitigation Action Items

The table below illustrates the status of hazard mitigation actions in the previous plan by identifying those that have been completed and those that have not been completed.

Recommended projects from previous plan Green = Completed; Red = Not yet complete; Yellow = Continue			
1	Installation of NOAA Weather Radio Transmitter	Action: Purchase and install a transmitter after securing tower space	NOAA radio is now available from Woodward (WWG46)
2	Install Safe Rooms in county schools	Action: Installation of large safe rooms at Laverne and Buffalo Public Schools	Not met. Still relevant and included in plan update
3	Increase public awareness	Action: In Harper County, the county needs more outreach to the residents to increase community involvement, to inform the public about hazards	On-going need. Included in plan update
4	Install a storm siren in the unincorporated communities of May and Rosston	Action: In District #1, the unincorporated community of May, there is a need for a storm siren. The siren would serve the residents of May. The siren could be set off by County Emergency Management or County Sheriff remotely, or by an appointed May resident. Rosston is in District #2 and also has a need for this mitigation action.	Not met. Still relevant and included in the plan update
5	Install a Communications Repeater	Action: Securing a license and installing a Communications Repeater to service the Emergency Radio Network in Harper County	Complete
6	Obtain Reserve Power Supplies for County	Action: The Harper County Hospital is in need of an emergency power source to maintain operational status during power outages. Mitigation would entail the purchase and installation of a generator.	Complete
7	Establish county-wide E-911	Action: The residents of Harper County do not have enhanced 911 capabilities. A 911 system would help mitigate loss of life and property by reducing response times	This project is underway

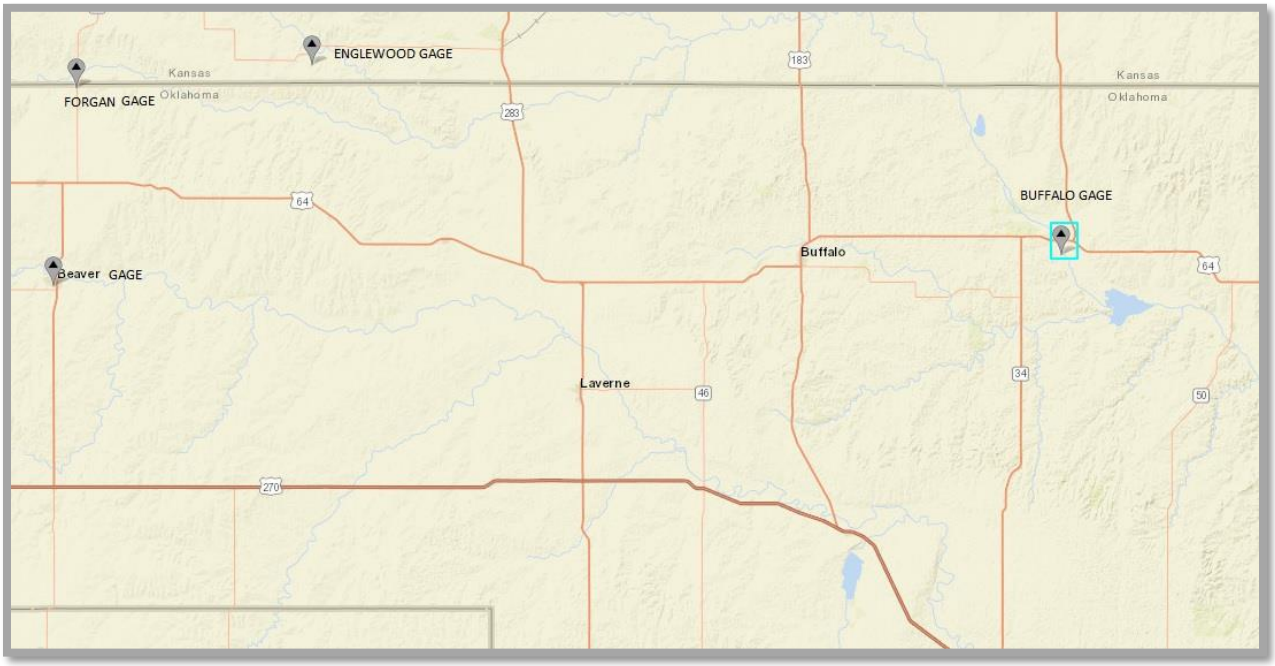
5.3 Changes in Jurisdictional Priorities

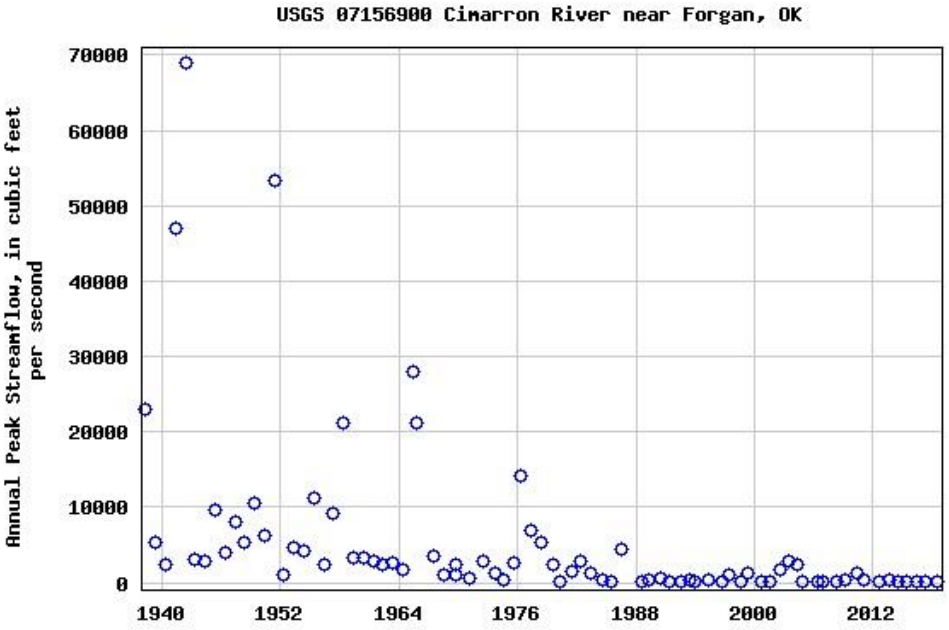
Drought has become a hazard of increased concern to local officials and residents of Harper County. Drought not only affects the annual availability of fresh water throughout the county, it contributes to increased danger of wildfires and intensifies aquifer depletion.

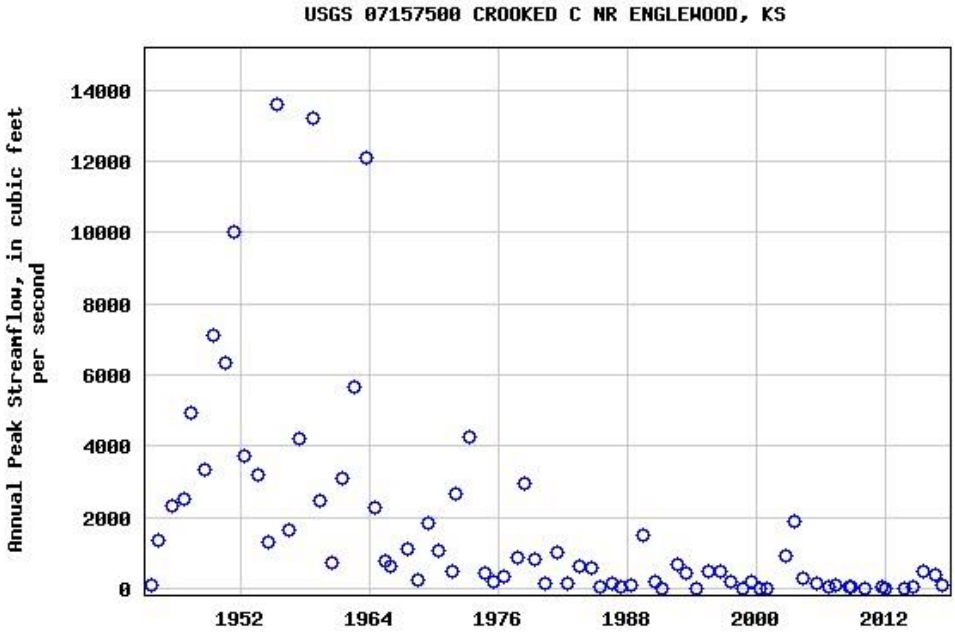
- ***Wildfires.*** The danger of Wildfire is a hazard that may become an increasing threat if drought becomes more frequent or severe
- ***Aquifer depletion.*** The planning team took special note that the problem of aquifer depletion could become severe at some time in the next few decades

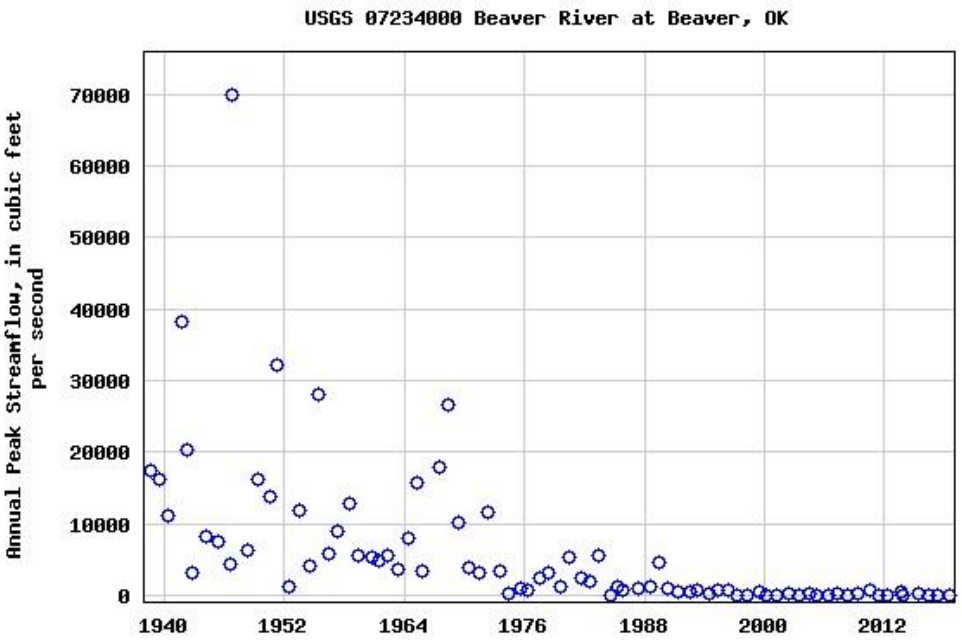
The map below illustrates the location of four stream gages. Four graphs on the following pages show the trend towards depletion of available surface water at those stream gages upstream from and in Harper County. Surface water volume has clearly shifted downward since 1990 and has remained consistently low.

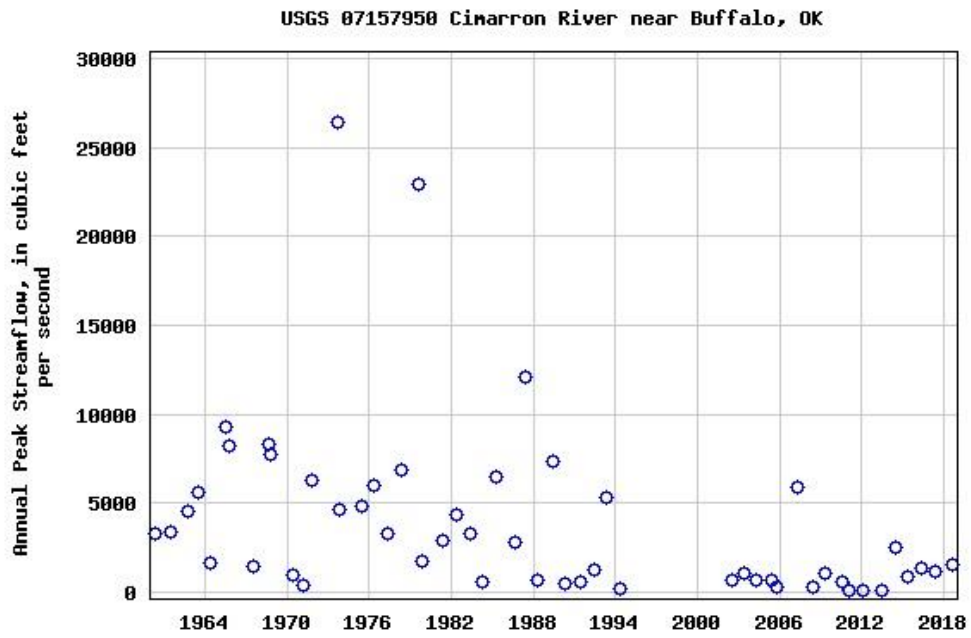
LOCATION OF STREAM GAGES NEAR FORGAN OK, ENGLEWOOD KS, BEAVER OK AND BUFFALO OK




USGS 07156900 Cimarron River near Forgan, OK
Annual Peak Streamflow, in cubic feet per second
70000
60000
50000
40000
30000
20000
10000
0
1940
1952
1964
1976
1988
2000
2012


USGS 07157500 CROOKED C NR ENGLEWOOD, KS
Annual Peak Streamflow, in cubic feet per second
14000
12000
10000
8000
6000
4000
2000
0
1952
1964
1976
1988
2000
2012





5.4 Conclusion

The Goals and Action Items detailed in this 2021 Hazard Mitigation Plan update are intended to be a guide to officials and residents of Harper County as they continue to make progress towards becoming a safer community. As new information and new technology become available, this plan will be updated accordingly.

APPENDIX A References

References

ACS. (2019, December 31). *Harper County OK Selected Housing Characteristics*. Retrieved from USCensus American Community Survey: https://data.census.gov/

CDC. (2012, 6 12). *Tornado*. Retrieved from Center for Disease Control: https://www.cdc.gov/disasters/tornadoes/after.html

Climate. (2019). *Harper County Climate Facts*. Retrieved from Oklahoma Climatological Survey: https://climate.ok.gov/index.php/climate/county_climate_by_county/harper

Collier, T. (2019, September 23). Resource Soil Scientist. (G. R. Thomas, Interviewer)

Data. (2020, April 30). *Harper County, OK*. Retrieved from Data USA: https://datausa.io/profile/geo/harper-county-ok

Disaster Declarations by State & County. (2019, June 19). Retrieved from FEMA.gov: https://www.fema.gov/data-visualization-disaster-declarations-states-and-counties

Drought in OK. (2019, October 7). Retrieved from Drought.gov: https://www.drought.gov/drought/states/oklahoma

Earthquakes in Oklahoma. (2019, June 18). Retrieved from Oklahoma Secretary of Energy & Environment: https://earthquakes.ok.gov/what-we-are-doing/oklahoma-geological-survey/

FEMA. (2002). *Guidelines and Specs for Flood Hazard Mapping*. Retrieved from fema.gov: https://www.fema.gov/media-library-data/1387568629763-85712b7052d5e0ec91e395ce975370c1/Guidelines+and+Specifications+for+Flood+Hazard+Mapping+Partners+Appendix+A-Guidance+for+Aerial+Mapping+and+Surveying+(Feb+2002).pdf

Harper County Ok. (2019). Retrieved from Oklahoma Climatological Society: https://climate.ok.gov/index.php/climate/county_climate_by_county/harper

NAP. (2007). *Elevation Data for Floodplain Mapping* . Retrieved from The National Academies Press: https://www.nap.edu/read/11829/chapter/2#4

NOAA. (2020, January 27). *Hail Basics*. Retrieved from NOAA: https://www.nssl.noaa.gov/education/svrwx101/hail/

NOAA. (2020, June 4). *Storm Events Database*. Retrieved from NOAA: https://www.ncdc.noaa.gov/stormevents

OKHMP. (2019). *State Mitigation Plan*. Retrieved from Oklahoma Department of Emergency Management: https://www.ok.gov/OEM/Programs_&_Services/Mitigation/State_Mitigation_Plan.html

OWRB. (2012, December 15). *Oklahoma Comprehensive Water Plan*. Retrieved from Oklahoma Water Resources Board: http://www.owrb.ok.gov/supply/ocwp/pdf_ocwp/WaterPlanUpdate/WaterDemandForecastReport.pdf.

SCIPP. (2018). *Simple Planning Tool for Oklahoma*. Retrieved from Southern Climate Impacts Planning Program: http://www.southernclimate.org/documents/OK_SPT

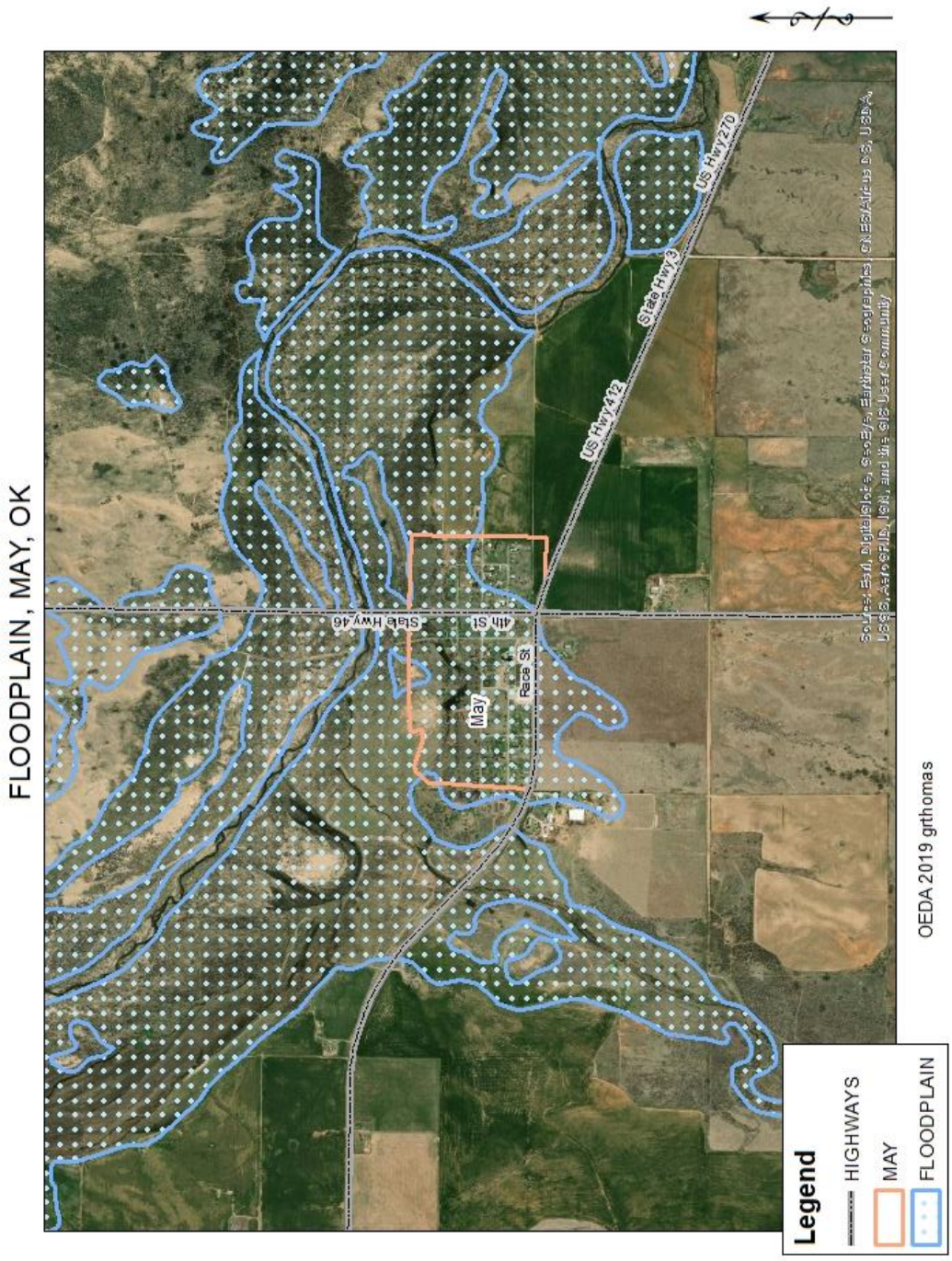
US Tornado Climatology. (2010). Retrieved from National Oceanographic and Atmospheric Association: https://www.ncdc.noaa.gov/climate-information/extreme-events/us-tornado-climatology

Vaisalia. (2019). *2019 Annual Lightning Report*. Retrieved from Vaisalia: https://www.vaisala.com/sites/default/files/documents/2019%20Annual%20Lightning%20Report_1.pdf

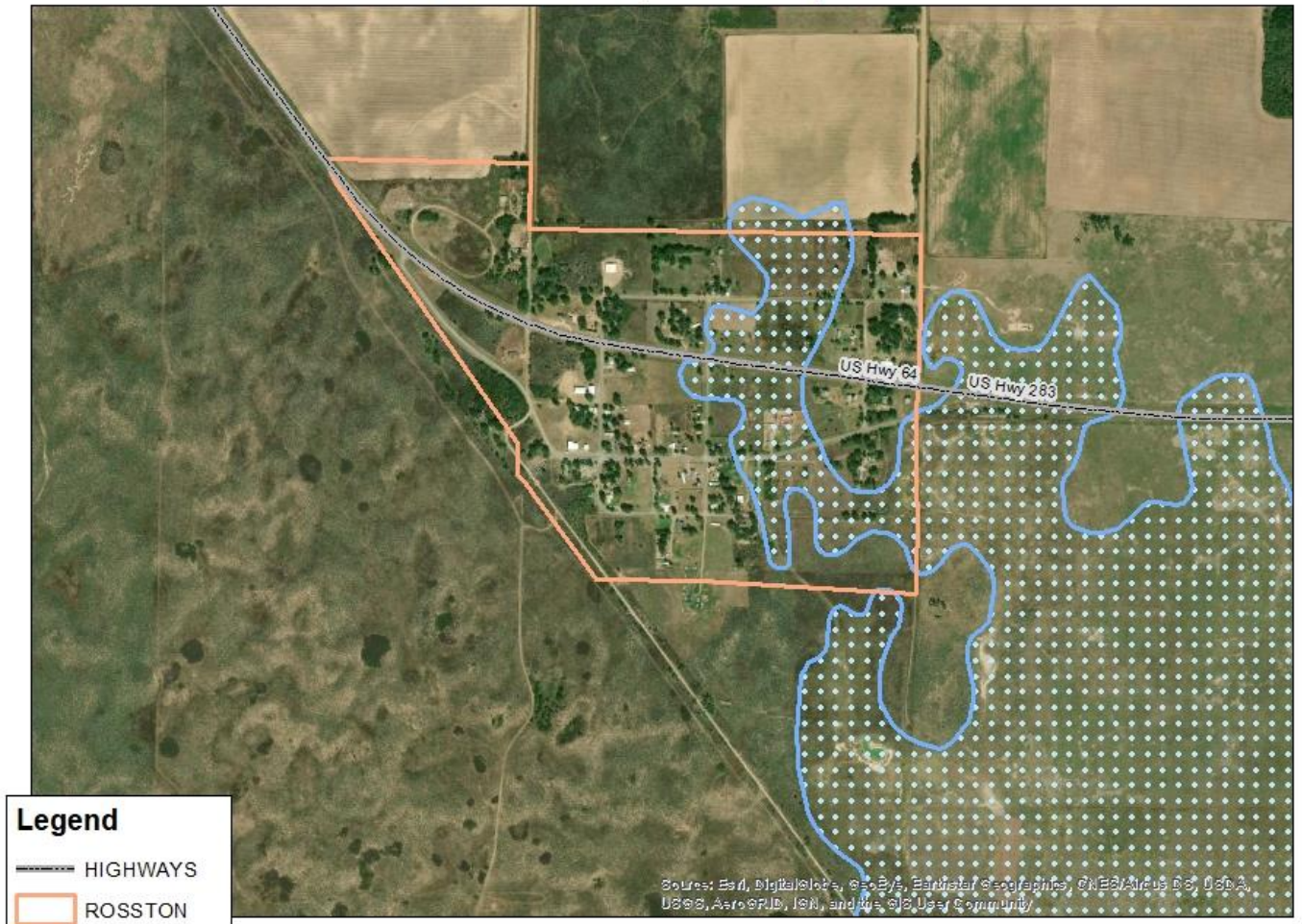
WUI. (2020). *Southern Wildfire Risk Assessment*. Retrieved from Southern Foresters: https://www.southernwildfirerisk.com/

APPENDIX B Additional information

B.1 Flood area detail: Towns of May, Rosston



FLOODPLAIN, ROSSTON, OK



OEDA 2019 grthomas