2024

Keokuk County Hazard Mitigation Plan

6/17/2024

Keokuk County Iowa

A Multi-jurisdictional

Hazard Mitigation Plan

The purpose of Hazard Mitigation Planning is to improve the health, safety and welfare of the citizens of Keokuk County through development of effective strategies that can be implemented to mitigate the negative effects of known hazards.

This Plan was produced by the combined efforts of the Federal Emergency Management Agency (FEMA), the Iowa Department of Homeland Security and Emergency Management (HSEMD), working together with GRThomas Plans, the Citizens of Keokuk County, Keokuk County Emergency Management, the Keokuk County Supervisors, Cities of Delta, Gibson, Harper, Haysville, Hedrick, Keota, Keswick, Kinross, Martinsburg, Ollie, Richland, Sigourney, South English, Thornburg, Webster and What Cheer. Participating academic institutions include the Keota, Sigourney, and Tri-County School Districts.

Staff from GRThomas Plans is responsible for the production of this document and for any errors or omissions that may exist.

Thank you to all who participated.

US Census Facts:

For Planning purposes, we rely on two types of data produced by the US Census Bureau.

The standard for Total Population is the Decennial Census, taken at ten year intervals, such as years 2000, 2010 and 2020.

The second type of Census data we use is the American Community Survey (ACS), which is a more detailed count for a variety of subjects and is produced at 1 and 5 year intervals.

Most statistics relevant to planning topics were transferred to the ACS in 2005, when it replaced the decennial census long form (US CensusB, 2022). This creates a situation where numbers do not always match the official 2020 Decennial population.

At the time of this writing, ACS statistics for 2023 are not fully available. Therefore, we use 2022 ACS 5-year estimates for consistency within this document.

The 2020 Decennial count is included in a table in Section G for clarification.

For questions about this or other sources of information used in this plan, please refer to the bibliography or call Gail Thomas at the planning office:
(641) 233-8942.

Cover Photo:
Keokuk County Courthouse
Built 1945-1959

Table of Contents

Hazard Mitigation Planning 1
Keokuk County Map 2
Introduction 3
Plan Structure 3
Keokuk County Geography 3
Brief history 5
Keokuk County Statistics 6
Transportation 11
Section A The Planning Process 16
A1. How the plan was prepared 16
A2. Other Stakeholders 20
A3. Public Participation and Feedback 20
A4. Other plans and references 22
Section B: Risk Assessment 23
B1. Identified Hazards 23
Disaster History 25
Hazard Probability Rating 25
B1-a-f Profiled Hazards 27
Drought 27
Expansive soils 35
Extreme Heat 43
Flood 47
Hail 63
High wind 67
Lightning 71
Sinkholes 76
Tornado 82
Wildfire 89
Winter Weather 96
Other hazards 104
Dam Failure 104
Animal, Crop, Plant Disease 111

Human Epidemic or Pandemic 118
Hazardous Materials Incident 123
Section C: Mitigation Strategy 131
Section D: Plan Maintenance 157
D2-b 157
Section E: Plan Update 160
Section F: Plan adoption 164
Section G: Community profiles 165
References 183
Appendices 188
Appendix A – Hazards profiled for Iowa 188
Appendix B – Animal Plant Crop Disease Costs 189
Appendix C – Flood Index, Communities in Keokuk County 191
Stormwater management 193
Appendix D – Compliance, Mitigation Actions 194
Appendix E – Public Survey comments 197
Appendix F – Plan Review Worksheets 198
Appendix G – Adoption Resolutions 203
Appendix G – Summary Action Plan 204

Hazard Mitigation Planning

What is Hazard Mitigation Planning?

A hazard is a situation that poses a threat to the life, health, prosperity, or the environment of a community. Hazard Mitigation is any sustained action taken to eliminate or reduce the long-term risk to human life and property from natural and technological hazards. This plan is intended to identify hazards that pose the greatest risk to Keokuk County and recommend action to mitigate future risk.

Disaster Mitigation Act of 2000

According to the Disaster Mitigation Act of 2000, local governments must prepare, adopt, and update a Hazard Mitigation Plan to be eligible for post-disaster FEMA assistance. This plan works to assess risk, decrease impact, and prevent future damage. The organization and contents of this plan are driven by the requirements of the FEMA and input of Keokuk County residents.

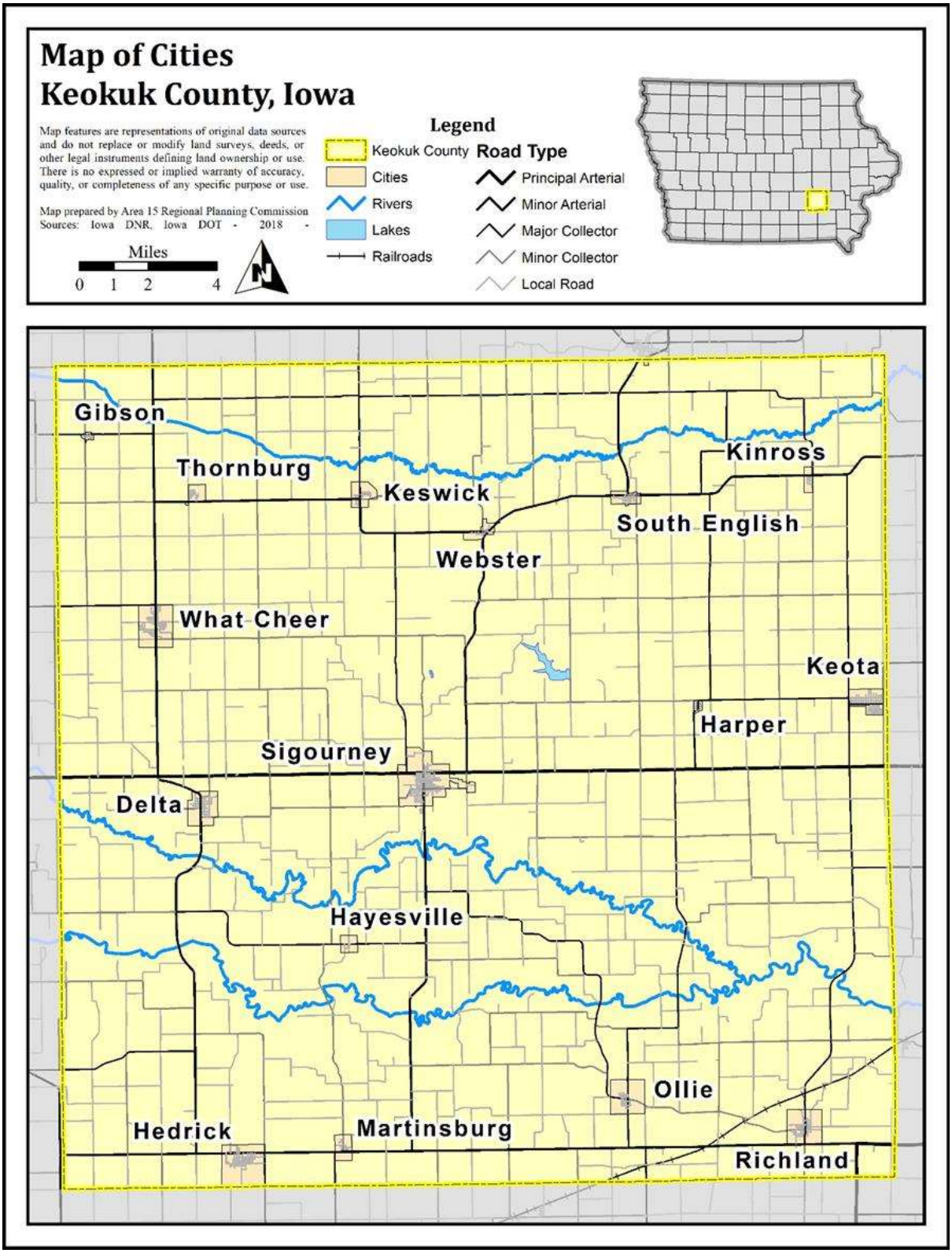
The development and update of the Keokuk County Hazard Mitigation Plan is a response to the passage of the Disaster Mitigation Act of 2000 (DMA), which was signed into law on October 30, 2000, with the goal of reducing losses and future public and private expenditures and improving response and recovery from disasters. This act, Public Law 106-390, amended the Robert T. Stafford Relief and Emergency Assistance Act. The following is a summary of the portions of the DMA that relate to local governments:

- ✓ Local governments and tribal organizations must prepare a multi-hazard mitigation plan to be eligible for funding from the FEMA Pre-Disaster Mitigation Assistance Program and Hazard Mitigation Program.
- ✓ Natural hazards need to be addressed in a risk assessment and vulnerability analysis sections of the multi-hazard mitigation plan. Assessment of human-caused hazards such as hazardous waste spills is encouraged but not required.
- ✓ Authorizes up to seven percent of Hazard Mitigation Grant Program funds available to a state following a federal disaster declaration to be used for development of state, local, and tribal organization multi-hazard mitigation plans.
- ✓ Without an up-to-date multi-hazard mitigation plan, local governments and tribal organizations cannot obtain funds from the Pre-Disaster Mitigation Grant Program

To comply with Section 322 of the Disaster Mitigation Act of 2000 and qualify for future hazard mitigation grant awards, Keokuk County must develop a county-wide hazard mitigation plan. The following grant programs require an approved and adopted hazard mitigation plan:

- Hazard Mitigation Grant Program (HMGP)
- Public Assistance Grant Program (PA)
- Building Resilient Infrastructure and Communities (BRIC)
- Pre-Disaster Mitigation Grant Program (PDM)
- Fire Management Assistance Grant Program (FMAG)
- Safeguarding Tomorrow Revolving Loan Fund Program
- Rehabilitation of High Hazard Potential Dam Grant Program (HHPD) (Stafford, 2023)

Keokuk County Map



Introduction

Plan Structure

This Multijurisdictional Hazard Mitigation Plan is designed to reflect first, conditions in the County as a whole, then address specific differences that may be present in each community. Issues specific to each community are highlighted in the Vulnerability and Impact section of each Hazard Profile in Section B. A comprehensive summary for each community is included in Section G.

Keokuk County Geography

Keokuk County is located in southeastern Iowa. It is bordered by Poweshiek and Iowa Counties on the north, Washington County on the east, Mahaska County on the west and Wapello and Jefferson Counties on the south.

The county is located in a geographic area known as the Southern Iowa Drift Plain. The land surface is characterized by steep rolling hills, level alluvial lowlands and table-like upland divides. Keokuk County's landscape is continually changing from continuous erosion and weathering. It has excellent soil that is derived from a deep deposit of glacial drift and is excellent for agricultural uses such as grains, grass, fruits and vegetables.

There are five main land use categories in Keokuk County: agricultural, commercial, industrial, residential and public uses of the land. The land use in most of the county is agricultural.

The county does not contain any large natural lakes, and the majority of water bodies are primarily soil conservation structures, farm ponds, reservoirs, wetlands, and old quarries. The largest body of water is Lake Belva Deer, located about three miles northeast of Sigourney. Three rivers meander through the Keokuk County countryside. The North and South Skunk Rivers flow through the southern portion of the county and the English River runs through the north.

The North Skunk is the smaller of the two forks and has many tributaries from the north. It rises and falls rapidly with the spring melt and rainfall. The South Skunk is much larger than the North. Its southern tributaries are fewer in number. This fork does not rise and fall as rapidly or as often. The two forks meet three miles inside the southeast county line.

Keokuk County is home to a variety of State, County, and City recreation areas:

- Checauqua River Access—Sigourney
- Coffman Woods Preserve - South English
- Lake Belva Deer Park – Sigourney
- Legion Park – Sigourney
- Griffin Park – What Cheer
- Manhattan Bridge Access—Ollie
- South Skunk River State Wildlife Area – Hayesville/Richland
- Pool Wildlife Area – Richland
- Yenruogis County Park – Sigourney

Map of Rivers, Streams, & Elevation
Keokuk County, Iowa

Map features are representations of original data sources and do not replace or modify land surveys, deeds, or other legal instruments defining land ownership or use. There is no expressed or implied warranty of accuracy, quality, or completeness of any specific purpose or use.

Map prepared by Area 15 Regional Planning Commission
Sources: Iowa DNR & Iowa DOT - 2018 -

Miles
0 1 2 4

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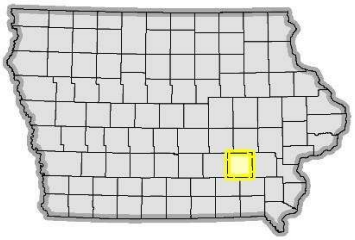
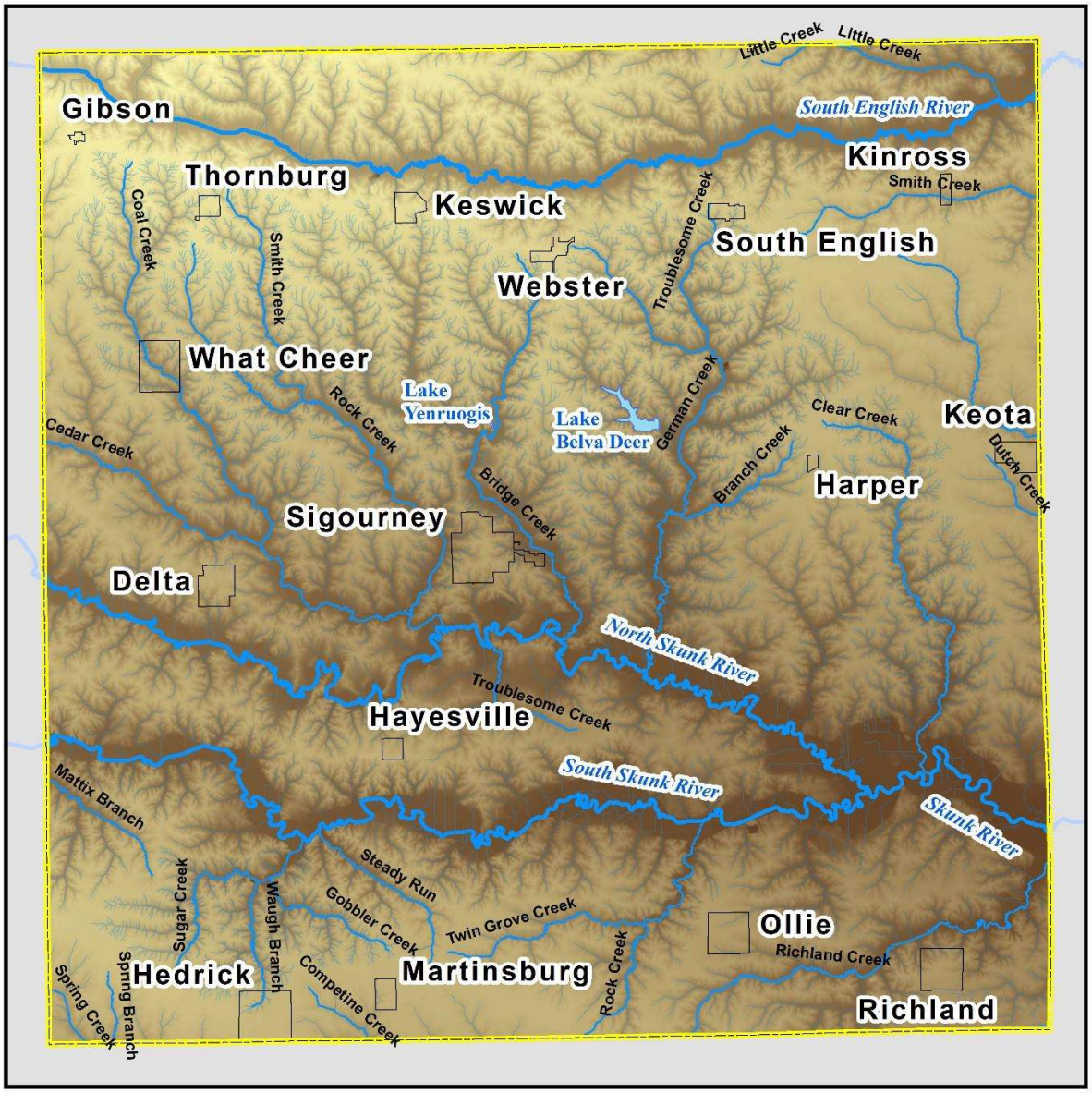
Legend
- Keokuk County
- Cities
- Rivers
- Creeks
- Lakes

Elevation
Feet
909
525





Brief history

A portion of Keokuk County became the property of the government by a treaty with the Sac and Fox Indians on February 21, 1838. This treaty stated that new settlers came into possession of all the territory lying east of Red Rock, which is now Marion County. The first pioneers of Keokuk County settled in present-day Richland in 1838. The balance of the territory in Keokuk County was eventually opened to settlement in 1843.

The boundary and name of Keokuk County were defined by an act of the Territorial Legislature, which was approved in 1844. The courthouse was built in Sigourney in January of 1845. The building was later enlarged, and the present courthouse was completed in 1859. The square that the courthouse stands on was decorated with a border of forest trees in 1860.

Coal deposits were discovered near What Cheer on the west side of the county before 1870. By the late 1880s, significant production was underway reaching 463,000 tons in 1881, and nearly 671,000 tons in 1887. Decline followed and only averaged about 17,500 tons annually until mining ceased in the 1960s.

From the Keokuk County Website:

> Keokuk is named after a famous Sac Indian Chief. Chief Keokuk advocated peace with the white settlers. Indians that dwelt in this area were the Sac and Fox tribes.
>
> Keokuk County was opened up for settlement in May 1843 and the organization of Keokuk County began in 1844. Before this time the county was attached to Washington County. The location of the county seat of justice was a source of controversy. The southeastern portion of the county was the first to be settled so the people there felt that the county seat should be located in the center of the population distribution rather than in the geographical center. After lengthy discussions the commissioners moved the official location of the county seat to the town of Sigourney.
>
> Sigourney was named after the author and poet Lydia Huntley Sigourney. She showed her appreciation by providing the trees which were planted on the courthouse grounds and presenting fifty volumes to the town library.
>
> The first school of the county was taught in a schoolhouse constructed of logs, about 3 1/2 miles northeast of Richland. It was built in 1842 and was taught by James McKinney. Richland Township also boasts of having possessed the only successful academy of the county. It was located in the town of Richland and was attended by pupils from all parts of the county. At one time it had in attendance over 200.

There are 10 historic properties and districts listed on the National Register in the county.

Property Name	Use	Location
Bruce Goldfish Fisheries	Agricultural	Thornburg
Delta Covered Bridge	Transportation	Delta
Keokuk County Courthouse	Civic	Sigourney
Lancaster School	Not in Use	Sigourney
Public Square Historic District	District	Sigourney
Saints Peter & Paul Roman Catholic Church	Religious	Harper
Sigourney Public Library	Civic	Sigourney
C.F. and Mary Singmaster House	Residential	Keota
What Cheer City Hall	Civic	What Cheer
What Cheer Opera House	Entertainment	What Cheer

Keokuk County Statistics

Population

According to the U.S. Census Bureau, the 1850 population of Keokuk County was 4,822. The county grew steadily until 1900, when it had a peak population of 24,979. It has gradually declined since that time. The 2010 decennial census estimated the countywide population at 10,511, which represented a 7.8% decrease from its 2000 population.

As of the 2020 Decennial US Census, the estimated population of Keokuk County was 10,033, a decrease of about 4.5%.

Demographics	
Population	10,033
Race	
White	96.6%
Black or African American	0.6%
American Indian, Alaska Native	0.1%
Asian	0.1%
Some Other Race	1.0%
Two or more races	1.7%
Hispanic or Latino	2.2%

In 2022, median household income for Keokuk County was 15% lower than the state median, and 12% of residents were living below the poverty level.

Keokuk County Iowa		
US Census Bureau Decennial Census Historical population		
Census	Pop.	% Change
1850	4,822	—
1860	13,271	175.2%
1870	19,434	46.4%
1880	21,258	9.4%
1890	23,862	12.2%
1900	24,979	4.7%
1910	21,160	−15.3%
1920	20,983	−0.8%
1930	19,148	−8.7%
1940	18,406	−3.9%
1950	16,797	−8.7%
1960	15,492	−7.8%
1970	13,943	−10.0%
1980	12,921	−7.3%
1990	11,624	−10.0%
2000	11,400	−1.9%
2010	10,511	−7.8%
2020	10,033	−4.5%

ACS 2022	Median household income	Poverty level
State of Iowa	$ 70,571	11%
Keokuk County	$ 60,016	12%

Housing

Total Housing Units	4,668	% Keokuk County	% State of Iowa
Occupied	4,085	88%	91%
Vacant	583	13%	9%
Owner Occupied	3,206	79%	72%
Renter Occupied	879	22%	28%

Keokuk County

Demographics	
Total Population	10,033
Median Age	42.7
65 Years and Over	22%
Workforce	
Population over age 16	8,032
In Labor Force	4,806 (60%)
Not in Labor force	3,226 (40%)
Commute to Work	25 Mins
Households	
Median Household Income	$60,016
Per Capita Income	$32,747
Percent Poverty	12%
Average Household Size	2.3
Zero-vehicle households	91
Housing	
Total Housing Units	4,668
Occupied Housing Units	4,085 (88%)
Vacant Housing Units	583 (13%)
Mobile Homes	165 (3.5%)
Median home value	$105,500
Year built	
Since 2000	10%
1970-1999	26%
1940-1969	19%
1939 or earlier	45%

Workforce

About 60% of the population over age 16 is actively engaged in the workforce. That compares to about 67% in the State of Iowa as a whole. The average commute time to work is about 25 minutes.

Resources

Poverty is 12%. Ninety-one households (209 people) do not have a personal vehicle available. That represents 2.2% of the population, about half that in the rest of the State.

Housing

Owner-occupied homes account for 79% of the total occupied housing units in Keokuk County, and 22% are renter-occupied homes. US Census data (ACS 2022) indicates that Keokuk County has a somewhat larger proportion of vacant housing units (13%) compared to Iowa (9%). Mobile homes represent a similar share of housing in Keokuk County as in the State as a whole (3.5%).

Year built

The table at left shows the percent of housing built in Keokuk County and in Iowa by era. Of the estimated 4,668 housing units in the county, 45% were built before 1940, more than 80 years ago. About 10% were built in the last two decades.

Home Values

The age of housing influences the average cost of home ownership. Housing in Keokuk County is more affordable than in much of the nation. The median value of owner-occupied homes is $105,500 in Keokuk County, about 47% lower than the statewide average of $181,600, and about 38% the national average cost of homes.

Owner-occupied home values	Median home value	% below $100,000	% between $100,000 & $200,000	% over $200,000
Keokuk County	$105,500	47%	29%	24%
Iowa	$181,600	17%	34%	44%
USA	$281,900	14%	24%	67%

Economy

Since its founding, manufacturing has been an important source of employment for residents of Keokuk County. Major occupations in the county today include education (22%), manufacturing (15%), agriculture, forestry, fishing, hunting, and mining (12%), and retail trade (10%). Another 8% are in the construction industry. More details are included in the Tables below.

US Census ACS 2022 5-yr tables)

Workforce	
Population 16 years and over	8,032
In the Labor Force	4,806 = 60%
Percent Unemployment	3.6%
Mean travel time to work	25 mins

Occupation	Number	Percent
Agriculture, forestry, fishing and hunting, and mining	545	11.8%
Construction	364	7.9%
Manufacturing	679	14.7%
Wholesale trade	167	3.6%
Retail trade	469	10.1%
Transportation and warehousing, and utilities	318	6.9%
Information	24	0.5%
Finance and insurance, real estate, rental, leasing	134	2.9%
Professional, scientific, management, admin & waste management	274	5.9%
Educational services, and health care and social assistance	1,024	22.1%
Arts, entertainment, recreation, accommodation, food services	253	5.5%
Public administration	160	3.5%
Other services	220	4.8%

New Development

In recent decades, Keokuk County new housing construction has lagged behind state and national averages. According to Census data, the total number of housing units increased by 10% since 2000, compared to 22% for the State.

Business development: Fertilizer plant expansion at Gibson.

Critical facilities

Critical facilities are structures and institutions necessary for a community's response to and recovery from emergencies. These are assets that are vital to protection of public health and safety before, during and after a hazard event.

FEMA defines a critical facility as follows: Facilities and infrastructure that are critical to the health and welfare of the population and that are especially important following hazard events. Shelters, communications, emergency operation centers, hospitals, public health, public drinking water and wastewater facilities are examples of critical facilities.

Communications. The State of Iowa has 128 public safety answering points (PSAPs) that are the first line of response to a 911 call, with at least one PSAP in each county. All 99 Iowa counties have the capability of accepting wireless enhanced 9-1-1 Phase II service, which provides the person at the public safety answering point with latitude and longitude coordinates so they can more readily locate the person who has placed the 9-1-1 call.

The Communications Network (ICN) is a state agency that administers a statewide fiber optic network. The capacity of the Network enables authorized users such hospitals, state and federal government, public defense armories, libraries, schools and higher education institutions to communicate via high quality, full-motion video; high-speed internet connections; and telephones.

Radio and Print Media. Media plays an important role in keeping the public informed before, during and after an emergency. The table below lists local media coverage providers serving Keokuk County. Other radio stations, television stations and/or print originating from outside the area are not listed.

Telecommunications Infrastructure. Telephone and internet service are supplied to Keokuk County through Cloudburst 9, Farmers Telephone, Iowa Telecom, LISCO, Mediacom, Modern Cooperative Telephone Company, Natel, Rise Broadband, Wellman Cooperative Telephone Association, Windstream and Farmers and Merchants Mutual Telephone Company.

The table below lists local and/or regional television, radio and newspaper sources serving Keokuk County Residents.

Local Media Serving Keokuk County, Iowa		
Radio	KCII 1380 AM	Washington
	KCII-FM 106.1 FM	Washington
	KBIZ 1240 AM	Ottumwa
	KLEE 1480 AM	Ottumwa
	KOTM-FM 99.7 FM	Ottumwa
	KTWA 92.7 FM	Ottumwa
	KHOE 90.5 FM	Fairfield
	KKFD-FM 95.9 FM	Fairfield
	KMCD 1570 AM	Fairfield
Print	The News-Review	Sigourney
	SE Iowa Union, Washington Evening Journal	Washington
	The News	Kalona
	Ottumwa Courier	Ottumwa
	The Oskaloosa Herald	Oskaloosa
	SE Iowa Union, Fairfield Ledger	Fairfield
	The Clarion Plainsman	Packwood
	Press-Citizen	Iowa City
	The Daily Iowan	Iowa City
Local TV Stations	KYOU FOX	Ottumwa

	KTVO ABC	Kirksville, MO
	KIIN PBS	Iowa City
	KWKB CW	Iowa City
	KFXAFOX	Cedar Rapids
Providers	Windstream	IPTV & Fiber TV
	Mediacom	Cable TV
	Modern Cooperative Telephone Company	IPTV
	Wellman Cooperative Telephone Association	Fiber TV

Infrastructure. Critical infrastructure must continue to operate during and following a disaster to reduce the severity of impacts and accelerate recovery, such as water and sewer infrastructure, communications and public safety operations. Losses of these functions have the ability to further threaten a community and can significantly add to the economic impacts a particular hazard can cause.

Structural values and loss. Financial losses from hazards start with the value of the structure itself, however, data limitations prevent the total loss values from being estimated. The value of items within a particular facility that have the potential to be damaged or destroyed, loss of function, along with the cost to clean up, repair or replace can vary widely and significantly increase the cost of damages. Additional expenditures to mobilize workers, and engineering or inspection services are other drivers of post-disaster costs.

Critical services. Members of each community were asked to identify critical facilities within their jurisdiction. These facilities, if impacted by a hazard, could have significant adverse effects on the county and its communities.

Community Facilities by Jurisdiction and number of structures

Delta	8	Richland	23
Gibson	0	Sigourney	10
Harper	2	South English	7
Hayesville	1	Thornburg	1
Hedrick	22	Webster	5
Keota	14	What Cheer	12
Keswick	12	Sigourney CSD	10
Kinross	1	Keota CSD	11
Martinsburg	3	Tri-County CSD	4
Ollie	8	**TOTAL**	**147**

Sites of special concern

People and places that may be especially vulnerable when disaster strikes include:

- Preschool and Daycare centers
- Retirement or Nursing Homes
- Apartment Complexes
- RV Parks

Transportation

Roads

Highways. As the map on Page 13 illustrates, transportation is almost entirely based on vehicle travel. The Iowa Department of Transportation oversees maintenance for State and U.S. Highways.

Streets. All cities maintain the streets within their municipal boundaries.

County Roads. Keokuk County Secondary Roads maintains about 913 miles of roads and 170 bridges in the unincorporated areas of the county.

County Roads Maintained	913 miles
Hard surface	100 Miles
Gravel surface	715 miles
Dirt surface	98 miles
Bridges	170

Major highways, Keokuk County

- 1 Iowa Highway 1
- 21 Iowa Highway 21
- 22 Iowa Highway 22
- 78 Iowa Highway 78
- 92 Iowa Highway 92
- 149 Iowa Highway 149

County Routes

Keokuk County V44
Keokuk County G13
Keokuk County V5G
Keokuk County W15
Keokuk County V67
Keokuk County V45
Keokuk County V29
Keokuk County G48

Public Transportation

Public transportation is available through 10-15 Transit, a federally funded public transportation system that provides on-demand service to any citizen of Keokuk County and nine other southeast Iowa counties. Trips must be scheduled by the previous business day and are subject to driver and vehicle availability.

Airports

There are no public airports in Keokuk County. Two major airports are about an hour away, the DSM International Airport in Des Moines and the regional Eastern Iowa Airport in Cedar Rapids (CID), where non-stop flights are available to 14 US destinations. International airports in the Quad Cities and Peoria Illinois are within a two hour drive. Another commercial air service is the Southeast Iowa Regional Airport in Burlington, about 1.5 hours southeast of Sigourney.

Rail

Freight. Keokuk County has one railroad that passes through the southeast corner of the county. The Dakota Minnesota and Eastern Railroad services commercial entities and does not make any stops in the County. The nearest city that the railroad passes by is the city of Richland in southeast Keokuk County.

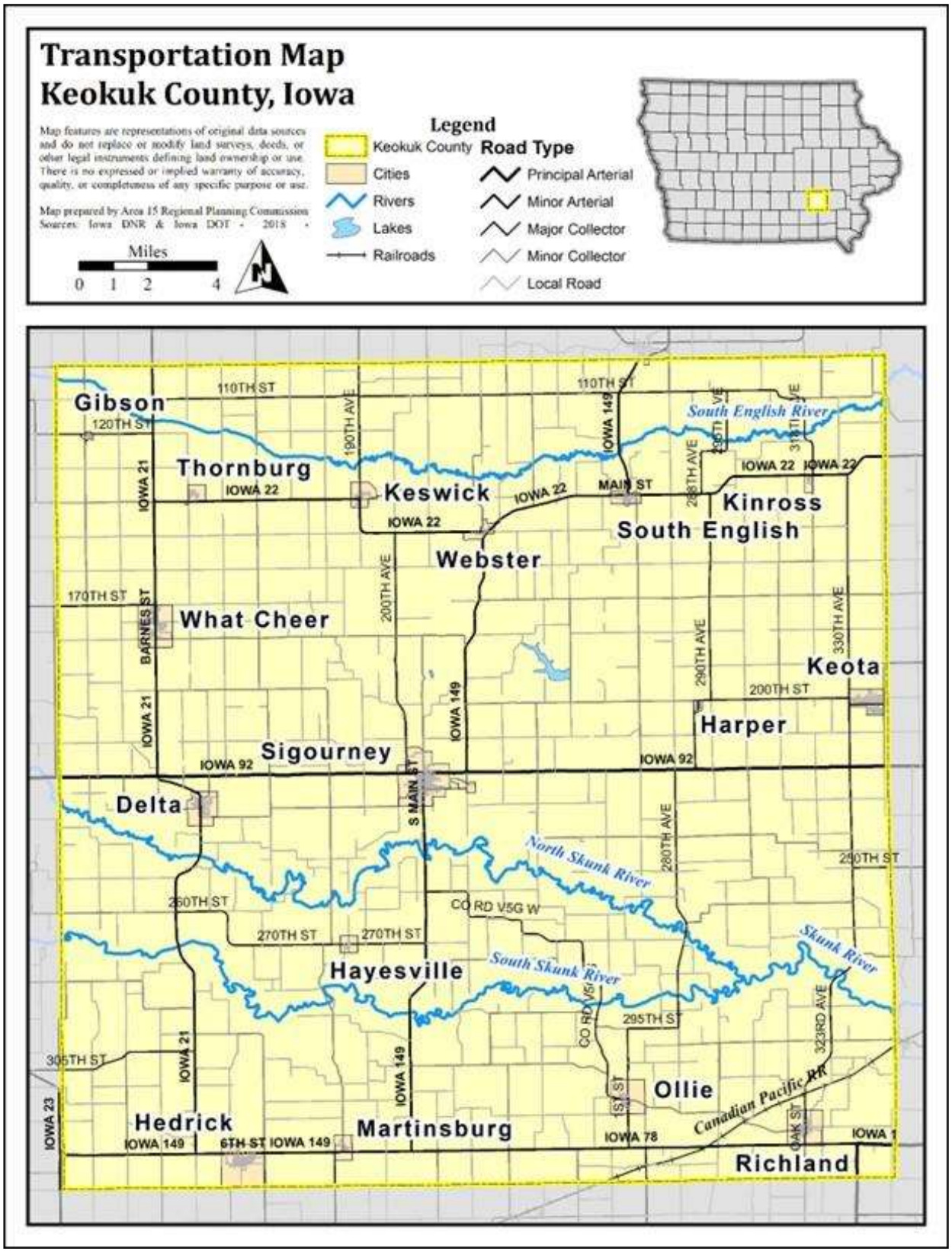
Passenger Rail. There is an Amtrak station in Ottumwa, about 25 miles southwest of Sigourney. The Amtrak California Zephyr runs daily in both directions between Chicago, Illinois and the San Francisco Bay Area serving local and regional destinations along the way. This passenger train carried nearly 300,000 passengers in 2022.

Amtrak 2022	Ridership
California Zephyr	290,423

(FY22, 2023)

Rail in SEKeokuk County Iowa

https://iowadot.maps.arcgis.com/apps/MapSeries/index


Transportation Map
Keokuk County, Iowa
Map features are representations of original data sources and do not replace or modify land surveys, deeds, or other legal instruments defining land ownership or use. There is no expressed or implied warranty of accuracy, quality, or completeness of any specific purpose or use.
Map prepared by Area 15 Regional Planning Commission
Sources: Iowa DNR & Iowa DOT - 2018 -
Miles
0 1 2 4
N
Legend
Keokuk County
Cities
Rivers
Lakes
Railroads
Road Type
Principal Arterial
Minor Arterial
Major Collector
Minor Collector
Local Road
Gibson
Thornburg
Keswick
Kinross
South English
Webster
What Cheer
Keota
Harper
Sigourney
Delta
Hayesville
Ollie
Hedrick
Martinsburg
Richland
South English River
North Skunk River
South Skunk River
Skunk River
Canadian Pacific RR
110TH ST
120TH ST
170TH ST
200TH ST
250TH ST
270TH ST
295TH ST
305TH ST
IOWA 21
IOWA 22
IOWA 92
IOWA 149
IOWA 78
IOWA 23
IOWA 1
MAIN ST
S MAIN ST
BARNES ST
6TH ST
1ST ST
OAK ST
CO RD V5G W
CO RD V5
190TH AVE
200TH AVE
280TH AVE
288TH AVE
290TH AVE
310TH AVE
323RD AVE
330TH AVE

Sidewalks & Bicycle Trails

All communities in Keokuk County would benefit from improved sidewalks and additional trails, both for recreational uses and enhanced transportation options.

Lake Belva Deer has hiking, biking, and horseback riding trails through the park.

The Kewash Nature Trail, connecting the communities of Keota and Washington is an excellent example of an alternative transportation project. Constructed as a recreational trail, such pathways can be of vital importance if a catastrophic event were to disrupt typical modes of transportation. See sidebar.

Water Transportation

Water transportation in Keokuk County is limited to recreational uses.

KEWASH NATURE TRAIL

The Kewash Nature Trail is a 14 mile former railroad right of way that connects the towns of Washington and Keota.

It traverses through a variety of landscapes from rich woodland areas to brilliant native prairie openings which offer a scenic view of the surrounding rolling countryside. Wildlife and wildflowers are abundant along this natural corridor.

Location

Begins at Sunset Park, or D Avenue near 5th Street in Washington.

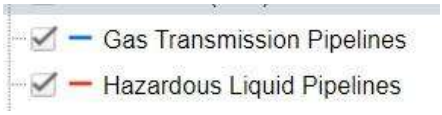
Trail Amenities

The trail has a crushed limestone surface and is open to hikers, bicyclists, and cross-country skiers from 4:30 a.m. - 10:30 p.m. Parking, restrooms, water, and playground facilities are available in Sunset Park in Washington which is connected to the Kewash by Sesquicentennial Park. Parking, restrooms, and water are also available midway along the trail in the town of West Chester and at the trail's west end in Keota.

Hunting, trapping, horses, and unauthorized vehicles are forbidden on the Kewash Nature Trail (KNT, 2024).

Pipelines

Pipelines are another form of transportation in the county. According to the National Pipeline Mapping Service (NPMS) there are about 167 miles of active gas transmission and hazardous liquid pipelines operated by eligible parties.



KEOKUK COUNTY PIPELINES

Section A The Planning Process

A1. How the plan was prepared

All the following activities are outlined in the tables below.

The Keokuk County HMP was developed through a cooperative effort. Planning staff conducted research on hazard data, documented the needs and goals of the community and organized the material into this report. The Keokuk County Hazard Mitigation Planning Committee (HMPC) was formed to provide guidance and oversight during the preparation of this Plan.

Members of the HMPC includes all those that attended meetings. Each participating community was represented by community members at one or more planning meetings. Individuals who participated in the development of this plan come from a wide range of backgrounds including local officials, community and business leaders, educators, nonprofits, the interested public, emergency management professionals and volunteers, firefighters and law enforcement.

All meetings were held in accordance with Iowa Open Meeting law. Local public participation provided valuable insight on the challenges and needs of individual jurisdictions. Other Public engagement strategies applied during the planning process served to identify the goals and aspirations of the community and to guide the development of actions that should be taken to mitigate known hazards. Public opinion surveys and personal conversations were used to solicit comments throughout the planning process.

Staff conducted research on potential mitigation activities by reviewing the previous Keokuk County HMP, FEMA approved mitigation actions, the State of Iowa Hazard Mitigation Plan and other planning documents. Capability and Risk assessments for local governments were completed.

This work resulted in meetings that offered the opportunity for each jurisdiction to discuss the items that had been included in the previous plan, which items had been completed and which should be carried forward to the 2024 plan. Options for other mitigation activities were presented by planning staff. Public suggestions were considered and incorporated. Local preferences for mitigation actions were compared to FEMA guidelines and participants discussed, selected and prioritized the preferred action items for each community.

When the Draft Plan Update was complete, we offered the draft to each jurisdiction for a final review during a 15-day public comment period. Additional digital copies were sent by email to adjacent jurisdictions and other individuals. A press release was published, and the draft was posted on the Keokuk County website.

Comments were received and incorporated into the document. Recommended action steps were refined. The HMP was submitted to the Iowa Department of Homeland Security and Emergency Management (HSEMD) for review, who then referred it to FEMA.

Schedule, time frame and activities

Timeline	
Nov 2023 - Jan 2024	
Prep work	Review previous local planning documents
	Review HM Plans adjacent Counties and State
	Draft document template for new FEMA guidelines
	Fill in generic info and online information
	Data collection, begin draft of hazard profiles
Feb 2024	Draft first two sections of the document
Planning Process	Meet with JCEM, set meeting schedule
	Data collection, draft hazard profiles
Mar 2024	Individual community profiles
	Data collection, draft hazard profiles
Risk Assessment	Meeting 1 Capability assessment, Risk assessment
Hazard vulnerability	Identify critical infrastructure
	Individual jurisdictions assess Vulnerability and Impact
April 2024	Complete the Plan Maintenance & update sections
	Document editing, checklist for compliance
May 2024	Public meetings, Public Survey
	Draft Vulnerability and Impact sections
	Develop potential mitigation strategies for Jurisdiction review
Mitigation Strategy	Meeting 2 Mitigation Strategy Development and Review
	Changes in Jurisdictional development and priorities
	Review previous goals, objectives and actions to carry forward
June 2024	Draft Action Steps, cross check for compliance
Jurisdiction review	Provide Final Draft Action Steps to Jurisdictions, seek comments
	Proofread entire draft, edit
	Provide final draft to stakeholders Initiate a 15-day Public Comment period
	Incorporate final comments into the Plan
	Submit Plan to Iowa HSEMD
July 2024	Final details
	Submit Plan to FEMA

A1-b Participating Jurisdictions

In addition to unincorporated Keokuk County, the following sixteen communities and three educational institutions within the county are officially represented in this plan:

Participating jurisdictions		
Delta	Martinsburg	
Gibson	Ollie	
Harper	Richland	Keota Schools
Hayesville	Sigourney	Sigourney Schools
Hedrick	South English	Tri-County Schools
Keota	Thornburg	
Keswick	Webster	
Kinross	What Cheer	

Planning Committee

The primary point of contact for the 2024 Keokuk County Hazard Mitigation Plan Update (HMP) is Keokuk County Emergency Manager Jorie Altenhofen at jaltenhofen@keokukcounty.iowa.gov

Planning Staff

Name	Community	Contribution to the plan
Jorie Altenhofen	Keokuk County EMA Coordinator jaltenhofen@keokukcounty.iowa.gov	Led the project, provided guidance, recruited committee members, organized meetings, provided local knowledge and previous planning history, hazard data, and local insight
Gail Thomas	Staff Planner grthomasplans@gmail.com	Conducted research, public engagement, led meetings, draft documents, incorporate public comments, submit drafts and revisions, discuss vulnerabilities and impacts with individual jurisdictions, organize potential mitigation actions, update plan document

Participating Jurisdictions. Committee members from participating jurisdictions performed each of the following tasks unless otherwise noted:

Meeting 1: Capability assessment, risk assessment, local vulnerabilities and impacts

Meeting 2: Recommend, review and approve select mitigation actions. Review drafts

Participating Jurisdictions	Primary contact		Meeting 1	Meeting 2
Delta	Sheri Walker	Clerk	Yes	Yes
Gibson	Steve Van Zee	Mayor	Yes	Yes
Harper	Dawn Minard	Clerk	Yes	Yes
Hayesville	Chris Gammack	City Admin	Yes	Yes
Hedrick	Ashley Olinger	Clerk	Yes	Yes
Keota	Alycia Horras	City Admin	Yes	Yes
Keswick	Mark Zittergruen	Mayor	Yes	Yes
Kinross	Ben Mast	City Council	Yes	Yes
Martinsburg	Mike Jasper	Mayor	Yes	Yes

Ollie	Scott Vetter	Mayor	Yes	Yes
Richland	Michael Hadley Jr.	City Council	Yes	Yes
Sigourney	Angela Alderson	City Clerk	Yes	Yes
South English	Cameron Miller	City Council	Yes	Yes
Thornburg	Jeannie Bos	Clerk	Yes	Yes
Webster	Brian Lee	Mayor	Yes	Yes
What Cheer	Melanie Vermillion	Clerk	Yes	X
What Cheer	Christine Howard	City Council	X	Yes
Keota PSD	Seth Milledge	Superintendent	Yes	Yes
Sigourney PSD	Kevin Hatfield	Superintendent	Yes	Yes
Tri-County PSD	Mrk Hatfield	Superintendent	Yes	Yes

Other Committee members assisted with vulnerability and impacts, mitigation solutions		
Pie Reighard	Keokuk County	Keokuk County Conservation
Andrew McGuire P.E.	Keokuk County	Keokuk County Engineer
Allie Helmuth, BSN RN	Keokuk County	Keokuk County Public Health

Emergency Management Agency Commission

The EMA Commission is made up of mayors or city council representatives from each jurisdiction. Members also represent other interests such as Farming, Business, Education and those who have retired from a variety of occupations.

Emergency Management Agency Commission
Chairman – Casey Hinnah, Sheriff, Farmer
Vice-Chair – Mike Hadley, Board Supervisor, Retired Mechanic/Business Owner and Firefighter
Executive Member – Cameron Miller, Trucking, Firefighter/QRS First Responder
Executive Member – Bryan Lee, retired, Mayor of Webster
Executive Member – Jimmy Morlan, retired, Mayor of Sigourney
Member – Mike Hadley, Business Owner, Richland City Council Member
Member – Mark Zittergruen, Farmer, Mayor of Keswick
Member – Christine Howard, Educator, What Cheer City Council Member
Member – Tyler Olsen, Harper City Council Member
Member – Donald Bird, Mayor of Delta
Member – Mike Jasper, Mayor of Martinsburg
Member – Chris Gammack, Mayor of Hayesville
Member – Steve Van Zee, retired, Mayor of Gibson
Member – Kathy Hasbrouck, Thornburg City Council Member
Member – Scott Vetter, Mayor of Ollie
Member – Daryl Gehman, Mayor of Kinross
Member – Tony Cansler, Mayor of Keota
Member – Robert Crawford, Mayor of Hedrick

A2. Other Stakeholders

The table below is a record of other stakeholders; organizations and agencies that made contributions to the HMP. Each of these participants provided hazard information, data, comments, suggested mitigation strategies or agreed to review the plan.

Neighboring Communities Contacted

Community	Contact person	How contact was made
Henry County	Walt Jackson, Coordinator	Personal visit, Email
Des Moines County	Shannon Prado, Coordinator	Phone, Email
Lee County	Jason Dinwiddie, Coordinator	Phone, Email
Louisa County	Brian Hall, Coordinator	Phone, Email
Van Buren County	Max Harlan, Coordinator	Personal visit, Email
Washington County	Marissa Reisen, Coordinator	Phone, Email

Local and Regional Agencies Contacted

Agency	Contact person	How contact was made
Iowa HSEMD	Jack Stinogel	Email, Video conference
Iowa Floodplain and SW Mngmnt	Teresa Stadelmann	Email
Keokuk County Public Health	Allie Helmuth	Personal contact
Iowa DNR	Gail Kantak	Email
Iowa DNR	Jason Conn	Email

A3. Public Participation and Feedback

Public input is essential to Planning. With direct engagement, valuable and diverse local perspectives can be factored into mitigation of hazards. Everyone that lives or works in the county is a stakeholder in the outcomes of hazard mitigation planning in Keokuk County.

A3-a Public Participation

Public comments were requested by press release, posted notices, personal interviews and distribution of a survey through local governments. These methods of soliciting public comments ensured that the invitation to participate reached a representative sample of the community, including underserved populations.

Underserved Communities and Socially Vulnerable Populations

In an effort to reach underserved and socially vulnerable populations, the following organizations were contacted directly and invited to distribute the Public Survey and submit comments. Only an estimated 52 people (.5%) in the county have limited English proficiency, therefore no organizations are in place to serve that specific community.

Outreach to Underserved and Vulnerable Populations				
Entity	**Population**	**Primary Contact**	**Communication**	**Response**
First Resources Corp.	Persons with Disabilities	Michelle Smith, Area Coordinator	Email 4/22/2024	Participated in Survey
Milestones Area Agency on Aging	Elderly & Aging	Sally Herd, HR Generalist/Office Manager	Email 4/22/2024	Declined to participate

Keota CSD	Children	Seth Milledge, Curriculum Director	Email & Phone 5/15/2024	Completed HMP Survey and Capability Assessment
Sigourney CSD	Children	Kevin Hatfield, Superintendent	Email 12/11/2023	Completed HMP Survey and Capability Assessment
Tri-County CSD	Children	Jennifer Berg, Principal	Email 5/14/2024	Completed HMP Survey and Capability Assessment
Amish Community	Vulnerable/ Underserved	Personal contact	4/22/2024	Chose not to respond

General Public Participation Opportunities

The public was invited to attend the County Supervisor, City Council and HMPC meetings. Notice of Public meetings were posted at the County Courthouse, City Hall buildings and other public places. Public comments were requested by Press release, posted flyers, personal interviews and distribution of a survey through City Halls.

The table below describes ways in which the general public was informed and invited to participate in the planning process.

Event	Entity	Date	How public was informed
Co Supervisor Meeting	Keokuk County	8/29/2023	Posted Agenda
Public survey distributed	All Jurisdictions	10/19/2023	Distributed by City Halls
Citizen Interviews	Planner, EM Staff	Throughout process	Personal contacts
City Council Meeting	Keota	8/7/2023	Posted Public Agenda
City Council Meeting	Sigourney	8/2/2023	Posted Public Agenda
City Council Meeting	Hedrick	9/11/2024	Posted Public Agenda
City Council Meeting	Keswick	10/9/2024	Posted Public Agenda
City Council Meeting	Ollie	9/6/2023	Posted Public Agenda
City Council Meeting	Richland	11/13/2023	Posted Public Agenda
City Council Meeting	Webster	11/6/2023	Posted Agenda
City Council Meeting	Hayesville	8/6/2023	Posted Agenda
City Council Meeting	Harper	8/10/2023	Posted Agenda
City Council Meeting	Kinross	3/14/2024	Posted Agenda
City Council Meeting	Martinsburg	8/14/2023	Posted Agenda
City Council Meeting	South English	9/12/2023	Posted Agenda
City Council Meeting	What Cheer	8/8/2023	Posted Agenda
City Council Meeting	Delta	11/8/2023	Posted Agenda
Public survey distributed 2	Keokuk Co website	3/29/2024	Keokuk Co website
Press release	Sigourney News Review	4/1/2024	Published: 4/3/2024
Co Supervisors Meeting	Keokuk County Final Draft	6/11/2024	Posted Agenda
Co Supervisors Meeting	Keokuk County Adoption		Posted Agenda

How public feedback was included in the plan:

The public was involved throughout the planning process. Survey results and public comments were organized and recorded. These were provided to the HMPC and discussed during planning meetings.

Public feedback was incorporated into the vulnerability and impact sections for each hazard in Section B Risk Assessment, and each of those concerns was considered during the development of the mitigation action plan. The final draft was edited to reflect comments made during the final public comment period.

A4. Other plans and references

Plans, studies, reports and technical information were reviewed and incorporated into the plan

Plans, Studies, Reports Reviewed or Incorporated	Section of this document
Iowa Comprehensive Emergency Plan (Ch. 5 – Hazard Mitigation) 2018 & 2023	Hazard Risk assessment, goals, objectives, mitigation strategies, climate trends
Iowa Comprehensive Emergency Plan (Ch. 3 – Hazard Mitigation) 2018 & 2023	Hazard Risk assessment, mitigation strategies, climate trends
Climate Change Trends: Iowa HMP 2023	Climate trends in Iowa, probability
Keokuk County Hazard Mitigation Plan 2018	Hazard risk assessment, goals, objectives mitigation strategies
Jefferson County Hazard Mitigation Plan 2016	Hazard risk assessment, goals, objectives mitigation strategies
Henry County Hazard Mitigation Plan 2024	Hazard risk assessment, goals, objectives mitigation strategies
Iowa's Groundwater Basics 2003 (IDNR)	Risk assessment, vulnerability, impacts
Keokuk County NFIP Flood Maps	Risk Assessment
Marion County Iowa Hazard Mitigation Plan 2023	Risk assessment, Vulnerability, Impact
Dallas County Iowa HMP 2023	Hazard Risk assessment, doc organization
FEMA Mitigation Ideas 2013	Hazard Mitigation strategies, actions
Building Community Resilience with Nature based Solutions (FEMA 2021)	Hazard Mitigation strategies, actions
Kansas State Hazard Mitigation Plan 2018	Climate trends, effects on agriculture
Oklahoma, OEM Approved Action Items	Hazard Mitigation strategies, actions
State Mitigation Planning Key Topics Bulletin: Risk Assessment FEMA October 2022	Risk assessment, vulnerability, impacts
FEMA Local Mitigation Planning Policy Guide 2022	Planning process, Document organization, Climate trends
FEMA Community Safe Rooms Fact Sheet 2016	Mitigation strategies

Section B: Risk Assessment

B1. Identified Hazards

The 2023 Iowa State Hazard Mitigation Plan is the guiding document for the hazards considered for the 2024 Keokuk County HMP. Hazards that are profiled in this update are listed below in alphabetical order. Two categories of Hazard were reviewed: Natural Hazards and Other Hazards. See excerpts from Iowa HMP – Appendix A.

Potential Hazards not addressed. The Planning Committee determined that the following hazards assessed in the State plan were not of sufficient risk to require mitigation in Keokuk County. Omitted hazards include:

1. Earthquake: Earthquakes are not as serious a concern as other hazards in Iowa. While more than 20 earthquakes have occurred in or around Iowa over the past 175 years, they have not seriously impacted the state. Earthquakes with epicenters far away are occasionally felt in Iowa but cause no damage. The strongest earthquake in Iowa, one that occurred near Davenport in 1934, only resulted in slight damage (Iowa, 2023).

2. Infrastructure failure: The largest city in the county has a population of about 2,000 people. This places personnel and revenue restrictions on the capability of municipalities to meet the challenge of a major infrastructure failure. Therefore, communities of Keokuk County must rely on a State-level response to a widespread event such as long term loss of power. Most communities rely on regional water and sewer services. Those cities that provide these utilities are serving a small number of households.

3. Landslide: From the Iowa HMP 2023: “While maps show that there are areas of the state that may be somewhat susceptible to landslides, this is not a hazard that has had much impact. Jurisdictions have not reported any significant damage due to landslides; future development and conditions are not likely to increase vulnerability or potential loss estimates.”

   According to USGS, the risk of landslide in Iowa is limited to areas of less than 100 yards and the risk in the county is very low (Iowa, 2023).

4. Levee Failure: No levees are located in Keokuk County.

5. Radiological Incident: No fixed radiological facilities, transfer stations, or receiving stations for radiological material are located in or near Keokuk County. The committee has decided not to include this hazard with those that required mitigation measures.

6. Terrorism – Radiological: While the community recognizes the risk radiological terrorism poses for communities, there are no significant sources of fixed radiological facilities. The committee has decided not to include a radiological terrorist hazard with those that required mitigation measures.

7. Terrorism – Foreign or Domestic Enemy Attack: While the Planning Committee recognized that there is some potential for enemy attack within the continental United States, they determined that general hazard mitigation strategies for continuity of government and critical facilities were sufficient preparation for these unknown hazards.

Planning Committee members and other 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 that data was incorporated into this plan.

Staff provided information to the committee about hazards included in the 2018 Keokuk County HMP, 2016 Jefferson County HMP, the 2024 Henry County HMP, the State of Iowa Hazard Mitigation Plan and current FEMA guidance to the committee.

2018 Keokuk County HMPU:

Previous Plan: Natural Hazards			
Thunderstorm/Lightning/Hail	River Flood	Landslide	Extreme Heat
Tornado/Windstorm	Flash Flood	Sinkhole	Drought
Severe Winter Storm	Earthquake	Expansive Soils	
Technological Hazards			
Dam/Levee Failure			

2024 Keokuk County HMP

The planning committee applied a three-step assessment process to identify threats and hazards and what they need to do to address those risks by answering the following questions:

- ✓ What are the most locally significant hazards that affect our community?
- ✓ When they occur, what impacts do those threats and hazards have on our specific community?
- ✓ What can be done in the next five years to improve capability and mitigate hazard risk?

This assessment was used as a tool to understand threats and hazards, assess risks, evaluate and improve capabilities, reduce vulnerability, and identify ways to increase resilience. Risk assessment is Section B of this document, Capability assessment and Mitigation strategy are addressed in Section C.

The Planning Committee and public surveys both named Severe thunderstorms (Hail, High wind and Lightning) as the number one hazard, followed by Tornado, Winter storms and Drought. Survey results are summarized in Appendix E.

The hazards selected to be addressed by this plan are listed below in alphabetical order.

2024 HMP Natural Hazards	
Drought	Lightning
Expansive soils	Sinkhole
Extreme heat	Tornado
Flood, Flash Flood	Wildfire
Hail	Winter storm
High winds	
Other Hazards	
Dam Failure	Hazardous Materials Incident
Animal, Crop or Plant Disease	Human Epidemic or Pandemic

Disaster History

There were four Federal declarations of disaster in Keokuk County during the years 2014 through 2023, for three events. Two were in response to severe storms and flood, and two declarations were related to the COVID-19 pandemic.

Federal Disaster Declarations for Keokuk County 2014 through 2023			
DR-4187-IA	Severe Storms, Tornados, High Winds, Flooding	Severe storms, Flood	June 26, 2014 - July 7, 2014
DR-4421-IA	Severe Storms and Flooding	Severe storms, Flood	March 12, 2019, continuing
EM-3480-IA	Iowa Covid-19	Human disease	Jan 20, 2020-May 11, 2023
DR-4483-IA	Iowa Covid-19 Pandemic	Human disease	Mar 17, 2020-May 11, 2023

State declared disasters:

During the years since the previous plan was written, a Proclamation of a State of Disaster was also made by Governor Kim Reynolds on April 1, 2023.

State of Iowa Disaster Declarations for Keokuk County 2014-2023		
Category	**Incident period**	**Date Declared**
Severe Storm	March 31, 2023 and continuing	April 1, 2023

Hazard Probability Rating

The word "probability" is used here to mean the chance that a particular event (or set of events) will occur expressed on a linear scale from 0 (impossibility) to 1 (certainty), also expressed as a percentage between 0 and 100% (Wolfram, 2023).

To determine the probability of future hazard events, the number of events of each type was documented and divided by the number of years being considered, giving the % chance of an event occurring in any given year. For this analysis, probability is categorized as follows:

Unlikely ___Moderate chance ___Even Chance ___Somewhat likely ___Likely ___Very likely

Total number of events/Total number of years = Probability as a percentage.

Unlikely = < 10%
Moderate chance = 10 - 44%
Even chance = 45 - 54%
Somewhat likely 55 - 74%
Likely = 75 - 89%
Very likely = 90 - 100%

HAZARD	EVENTS/TIME	PROBABILITY
Drought	Occurrences in 9 of 10 years = 90%	Very likely
Extreme heat	Occurred 10 of 10 years = >100%	Very likely
Expansive soils	98% of soils have limitations = 98%	Very likely
Flood	12 events/10 years = >100%	Very likely
High winds	8 events/10 years = 80%	Likely

Hail	11 events/10 years = >100%	Very likely
Lightning	15 events/10 years = >100%	Very likely
Sinkholes	0 events/10 years = <10%	Unlikely
Tornado	5 events/10 years = 50%	Even chance
Wildfire	33 events/10 years = >100%	Very likely
Winter storm	31 events/10 years = >100%	Very likely

OTHER HAZARDS		
Dam Failure	0 events/10 years = 0%	Unlikely
Animal/Crop/Plant Disease	Determined to be 50%	Even Chance
Hazardous Material spill	39 events/10 years = >100%	Very likely
Human Epidemic or Pandemic	1 event/10 years = 10%	Unlikely

Probability and Climate Change

Data indicates that Iowa's climate is growing warmer with more precipitation and more frequent severe weather events. Trends show small increases in average temperatures, but nighttime temperatures in Iowa have been increasing at a much higher rate over the last 100 years. Seasonal cycles and ranges of species have been observed to be shifting. For example, cold-water species of fish populations have been dropping due to groundwater temperatures and sedimentation.

Because it is impractical to limit a discussion of climate change to the scale of local government, we rely on the *2023 State of Iowa Hazard Mitigation Plan: Summary of Climate Change in Iowa and Effects upon Hazards* to assess the probable effects of climate trends on the SE Iowa region. From there, we can infer likely impacts on specific hazards in the county.

Significant trends and their effects on hazards in Iowa can be summarized as follows (Iowa B, 2023)

- An increase of 8 percent more precipitation from 1873-2008
- An increase in extreme heavy precipitation in summer in the last 40 years, with more precipitation coming in the first half of the year and less in the second
- A larger increase in precipitation in eastern Iowa than in western Iowa
- Long-term winter temperatures have increased six times more than summer temperatures.
- Nighttime temperatures have increased more than daytime temperatures since 1970.
- A substantial rise in humidity, especially in summer, providing more water to fuel convective Thunderstorms that provide more summer precipitation
- The increase in precipitation has contributed to a rise in streamflow levels and the potential for more frequent and greater flooding. The changes in precipitation patterns and higher winter and spring temperatures contribute to summertime becoming the new seasonal flood norm
- The rise in the number of large summertime rainfall events increases the probability of summertime floods, while higher winter and spring temperatures result in snow melting earlier and more slowly, reducing springtime flooding

Increased floods also pose health hazards in addition to death from rising water, including:

- Disbursement of hazardous chemicals into flood waters
- Dissemination of microbial pathogens from livestock facilities and sewage treatment plants
- Carbon monoxide poisonings from use of gasoline-operated tools after floods

- Molds contaminating flooded homes and businesses
- Potential impacts on infrastructure and emergency services include:
- Stresses on infrastructure due to warmer temperatures, such as a roadway buckling
- Increased risk of extensive damage to water supply and waste treatment systems
- Greater demand for disaster-response services, including monitoring disaster potentials, identifying vulnerabilities, and procuring governmental resources for recovery assistance
- A need for enhanced emergency management training and technical assistance to respond to a changing range of disaster consequences
- Increased Flood mitigation efforts reflecting warmer winters, greater annual stream flows, and more frequent severe precipitation events

Tornado patterns. Over the past decade, researchers have identified a decrease in tornados throughout Tornado Alley, which typically includes the central Great Plains states including Iowa, and an increase in Dixie Alley, which includes parts of eastern Texas, Arkansas, Louisiana, Mississippi, and Alabama (USA Facts, 2023).

Projected climate conditions were addressed in the Probability section under each hazard profile below.

B1-a-f Profiled Hazards

Hazards. Each hazard listed in the plan has been profiled and includes the following sections: Description, Location, Extent, Previous Occurrences, Probability of future events, Vulnerability and Impact. Hazards are essentially consistent across all jurisdictions because of the limited geographic extent of the study area. In general, the communities are similar enough that the elements of the hazard risk assessment need not be repeated for each participating jurisdiction in order to avoid redundancy.

Vulnerability, Impacts. Because of the similar characteristics of participating jurisdictions, vulnerability and impacts of each hazard are also similar with some exceptions. Vulnerabilities specific to a particular jurisdiction are described in more detail in the Vulnerability and Impacts elements of the hazard profiles and are included in the community profiles in Section G.

Drought

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. Drought follows a slow, accumulating process, different from other natural hazards such as flood or wildfire where negative impacts are observed more quickly. Three types of drought are recognized: Meteorological, Agricultural and Hydrological. Together, these contribute to social and economic effects of drought.

Meteorological drought is when lower precipitation occurs 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 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, public water supplies and wildlife.

Location

The entire Planning Area is affected by drought.

Affected Jurisdictions County, Cities, Schools

Extent

The Palmer Drought Severity Index (PDSI) is used to classify a deficiency of precipitation. Values in Keokuk County could be expected to fall at any point on the scale. All participating jurisdictions have experienced drought conditions ranging from 0 to <-5.0 on the scale and may expect such conditions to occur in the future.

The National Weather Service Drought scale (NOAA, 2023) provides the descriptive definitions below:

- D0 – Minor Drought: Going into drought; short term dryness slowing growth of crops or pastures; fire risk above average. Coming out of drought: lingering water deficits, pastures or crops not fully recovered.
- D1 – Moderate Drought: Some damage to crops or pastures; fire risk high, streams, reservoirs or wells low, water shortages developing, voluntary water use restrictions requested.
- D2 – Severe Drought: Crop or pasture losses; fire risk very high; water shortages common; water use restrictions imposed.
- D3 – Extreme Drought – Major crop and pasture losses, extreme fire danger; widespread water shortages and use restrictions.
- D4 – Exceptional Drought – Exceptional and widespread crop and pasture losses; exceptional fire risk; shortages of water in reservoirs, streams and wells, creating water emergencies.

Palmer Drought Severity Index			Drought Category
	< -5.00	Exceptional Drought	D4
	-4.99 to -4.00	Extreme Drought	D3
	-3.99 to -3.0	Severe Drought	D2
	-2.99 to -2.0	Moderate Drought	D1
	-1.99 to -1.0	Mild Drought	D0
	-0.99 to -0.5	Incipient Drought	D0
	-0.49 to 0.49	Near Normal	-

Previous Occurrences

According to the U.S. Drought Monitor, Keokuk County experienced 10 periods of drought from January 2014 through December 2023 (US Drought, 2024).

The Drought Monitor records 301 weeks of drought during the 10 year period from January 2014 through December 2023. Drought data for each category includes all lesser categories. For example, during a week of D2 drought, D0 and D1 conditions are also assumed to be present.

Of the 301 total weeks of drought during the study period, 167 weeks were in the D1 category, 28 were of D2 severity and 27 weeks reached the level D3. No periods of D4 drought were recorded in the National Drought Monitor during those years.

Keokuk County Drought

DROUGHT 1/1/2014 THROUGH 12/31/2023		Wks D0	Category D1		Wks D1	Category D2, D3, D4		Weeks		
StartDate	EndDate		StartDate	EndDate		StartDate	EndDate	D2	D3	D4
12/31/2013	6/24/2014	26	12/3/12013	6/24/2014	26	12/31/2013	4/22/2014	17		
3/31/2015	5/19/2015	8								
10/20/2015	11/17/2015	5								
6/07/2016	8/09/2016	10	6/28/2016	7/12/2016	3					
11/01/2016	4/25/2017	26								
6/13/2017	9/04/2018	65	7/11/2017	10/17/2017	4	8/01/2017	10/03/2017	10		
8/06/2019	9/24/2019	8	9/03/2019	9/17/2019	3					
8/04/2020	11/24/2020	17	8/25/2020	10/20/2020	9	9/01/2020	9/08/2020	2		
4/27/2021	5/04/2021	2								
6/08/2021	12/26/2023	134	9/21/2021	10/19/2021	5					
			2/15/2022	3/29/2022	7					
			7/19/2022	2/21/2023	32	8/09/2022	2/14/2023	28		
			5/30/2023	12/26/2023	31	6/20/2023	12/26/2023	28	27	
TOTAL weeks of drought		**301**		**Total D1**	**167**		**Totals D2, D3**	**85**	**27**	

Probability

Evaluating the county over the ten-year study period 2014-2023, data from the U.S. Drought Monitor shows at least some portion of Keokuk County experienced moderate drought for periods of three weeks or longer in 9 out of 10 years, indicating similar drought conditions are very likely to occur in future years.

Annual probability that drought over D1 level will occur = 90%, Very likely probability.

Climate Trends

Drought is a normal part of climate fluctuation. The highest occurrences of drought conditions with recorded events in Iowa are associated with agricultural and meteorological drought as a result of either low soil moisture or a decline in recorded precipitation.

Southeast Iowa counties may be affected by drought more often than they are now. Precipitation could be expected to vary more both temporally and spatially, with one area experiencing record heat and drought while nearby areas experience heavy precipitation. Drought may take on a seasonal aspect, with excessive moisture in spring and insufficient moisture in summer. Iowa already sees wetter spring and fall and dryer summers than in its previous climate decade. Higher temperatures will increase evaporation rates, intensifying naturally occurring droughts (Iowa, 2023).

Water supply in Keokuk County

Municipal and rural water supply is sourced from bedrock and alluvial aquifers in the county.

Drought Regions. Iowa is divided into five drought regions based, in part, on the landform regions of Iowa delineated in *Landforms of Iowa* by Jean C Prior, University of Iowa Press, 1991. The landform regions reflect the diversity of geologic landscapes shaped by Quaternary age glacial deposition and post-glacial erosion over the last two million years or so. Each landform region has similar topography, soils, geology and hydrology, making landform regions appropriate for classifying drought regions in the state. The landform regions have irregular boundaries, but the drought regions follow county boundaries for planning and administrative purposes.

Keokuk County is in drought region 5, which is characterized by shallow geology consisting of loess over glacial till, except the loess thickness thins to the eastern part of the state. The area is characterized by steeply rolling hills and a well-developed dendritic drainage system. Water resources are poor in the south-central portion of the region but improve to the east where shallow carbonate rock and deeply buried rocks are used for water supply (Prior, 1991).

Two primary bedrock water sources in Keokuk County are the Mississippian aquifer, closer to the surface, and the deep bedrock Cambrian-Ordovician Aquifer also known as the Jordan Aquifer, a primary source of water for all uses in southeast Iowa.

The Mississippian aquifer underlies about 60 percent of Iowa, where it forms the upper bedrock surface and is generally overlain by the surficial (alluvial) aquifer system.

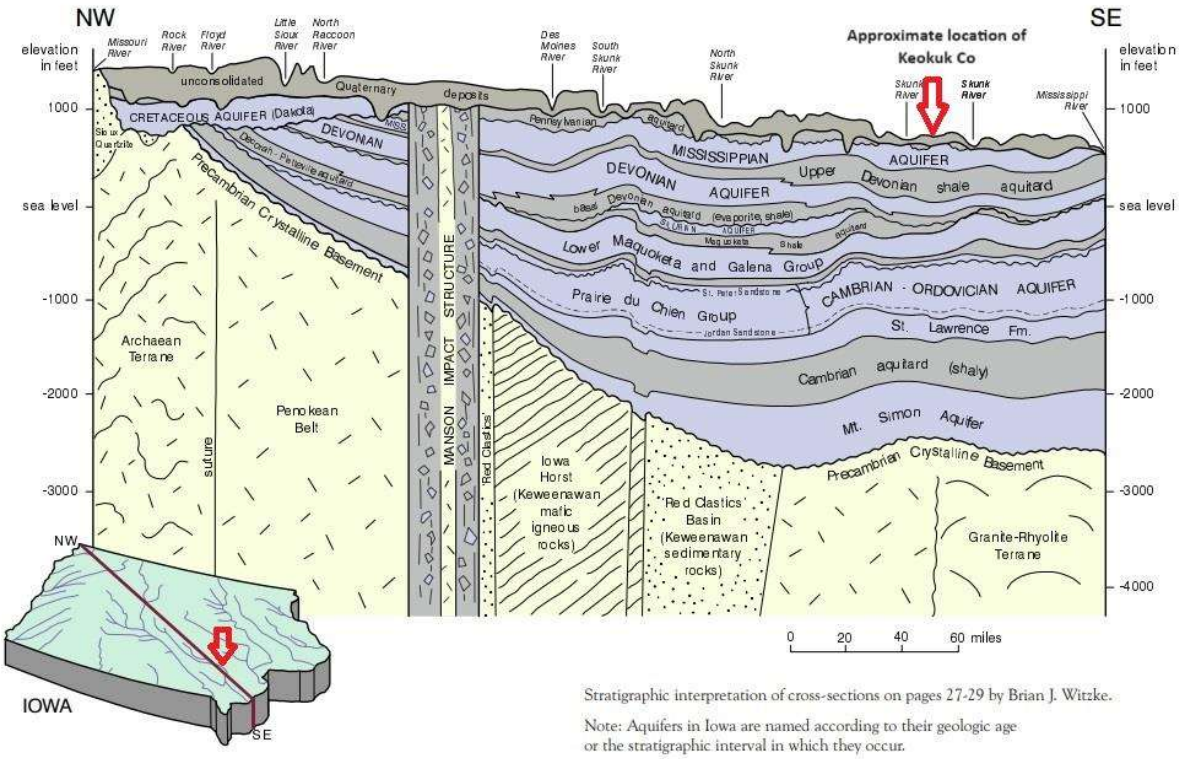
The Cambrian/Ordovician Jordan aquifer is a deep bedrock water body that underlies virtually the entire state of Iowa.

Aquifer depletion. From an article in the Des Moines Register:

> Rapidly growing industrial and residential use of the Jordan aquifer is prompting Iowa environmental leaders to consider new restrictions to better protect the massive underground water source.
>
> The Jordan aquifer provides drinking water to about a half-million Iowans, as well as water that is critical to industries that range from data centers to food processing and ethanol production.
>
> The recommendations are designed to warn users that Iowa's now-rich water levels could decline enough in the years ahead that they could hinder job creation and economic development efforts if not managed carefully.
>
> "We know at some point we can't keep pumping it down and pumping it down," said Todd Steigerwaldt, manager of the Marion Water Department and leader of the task force looking at the issue. "We know there is additional cost — it's more energy, which is money; and at some point, the lower we pump that water, the poorer the water quality would become." (Eller D. , 2014)

Bedrock Aquifer Systems across Iowa

Northwest to Southeast



Stratigraphic interpretation of cross-sections on pages 27-29 by Brian J. Witzke.

Note: Aquifers in Iowa are named according to their geologic age or the stratigraphic interval in which they occur.

https://s-iihr34.iihr.uiowa.edu/publications/uploads/2014-08-24_08-08-21_es-06.pdf

Vulnerability and Impacts

Drought: Affected Jurisdictions			
X	Delta	X	Richland
X	Gibson	X	Sigourney
X	Harper	X	South English
X	Hayesville	X	Thornburg
X	Hedrick	X	Webster
X	Keota	X	What Cheer
X	Keswick	X	Sigourney CSD
X	Kinross		Keota CSD
X	Martinsburg		Tri-County CSD
X	Ollie		Keokuk County (Unincorporated)

Vulnerability to drought is driven by three factors:

Exposure - the frequency of drought, the population, and the freshwater ecosystems that could be affected.

Sensitivity – the county's likelihood of being negatively impacted by drought, considering industries such as agriculture, water recreation and hydropower.

Adaptive capacity - a county's preparedness for drought and ability to recover, looking at the state's drought plan, irrigation infrastructure and economic strength.

There are four communities in the county which rely on groundwater wells: Keota, Richland, Sigourney and Webster. Others rely on Rural Water Districts. Regardless of the source, all communities are potentially vulnerable to the effects of drought on water supplies. The table below provides details of the municipal wells within the county.

Water Supply Wells

Local Name	Status	Depth	Construction Date	Aquifer
Keota #3	Active	1557.5	2/19/1960	Cambrian-Ordovician
Keota #2	Standby	153	12/31/1942	Mississippian
Richland #3	Active	1875	10/20/2005	Cambrian-Ordovician
Sigourney #91-1	Active	199	3/7/1991	Mississippian
Sigourney #91-2	Active	215	10/27/1991	Mississippian
Sigourney #02-5	Active	67	10/17/2001	Mississippian
Sigourney #02-6	Active	230	11/5/2001	Mississippian
Sigourney #07-1	Active	1785	11/6/2007	Cambrian-Ordovician
Webster #3	Active	180	12/31/1986	Mississippian

Drought can devastate crops, dry out forests, reduce food and water available for people, wildlife and livestock, restrict recreational activities, and stress businesses and economies.

People in cities and towns benefit from water utilities that are intended to smooth out variations in natural water supply. Drought intensifies these variations in quality and available water may be reduced.

Vulnerability and impacts of Drought	
Bedrock Aquifers	
Vulnerability	Drought reduces the availability of fresh water for aquifer recharge
Vulnerability	Bedrock aquifers are a regional groundwater supply and cannot be placed under local control. Industrial, agricultural and rural uses intensify depletion during periods of drought
Impact	The Jordan Aquifer is expected to undergo significant depletion by 2060
Impact	Long term depletion of the Jordan Aquifer is a hazard to the sustainability of business and public health in Keokuk County
Alluvial Aquifers	
Vulnerability	Lack of precipitation prevents recharge of alluvial aquifers, at the same time water is drawn more heavily from those sources.
Impact	The quantity and quality of fresh water for municipal use is reduced
Impact	Depletion of alluvial groundwater is intensified, reducing the supply of fresh water for residential, agricultural and industrial uses
Impact	Private well owners may need to restrict water use, dig deeper wells or monitor water quality more frequently during drought
Surface water, ponds, streams, rivers, reservoirs	
Vulnerability	Livestock and wildlife depend on surface water, while quantity and quality are reduced during periods of drought
Impact	Health of livestock and wildlife are negatively impacted by deteriorating fresh water conditions
Vulnerability	Low water levels reduce recreational opportunities
Impact	Loss of revenue to the local economy from recreation and tourism

Unincorporated Keokuk County	
Vulnerability	Drought reduces quantity and quality of water for residential, agricultural and business purposes
Impact	Rural households may have to reduce residential water uses; wells may go dry
Vulnerability	Agricultural production is important to the local economy. Agricultural crop production relies on sufficient water supplies and precipitation at key points in the growing cycle. Agricultural uses draw heavily from both underground sources and surface waters
Impact	According to crop insurance data, Keokuk County is one of the fifteen Iowa counties with the greatest crop losses by dollar value (after adjusting for inflation) in the past 32 years (Iowa, 2023)
Impact	Loss of agricultural production and resulting economic stress can result in reduced business activity, jobs and lower tax revenue to local government

Impact	Drought impacts livestock feed supply
Vulnerability	During drought, surface water is reduced, therefore water supplies for crops and livestock are drawn more heavily from wells and aquifers
Impact	Short term surface water shortages intensify long term groundwater depletion
Vulnerability	Natural vegetation, wildlife, stream flows, fish and aquatic life all rely on good quality fresh water
Impact	Environmental impacts of drought include direct damage to plant and animal species, loss of wildlife habitat (wetlands, lakes, and vegetation) and biodiversity
Vulnerability	Risk of fire increases with drought and low humidity
Impact	There is an increased risk of fire at the same time as a reduced availability of water for fire suppression
Conservation Lake Belva Deer:	
Vulnerability	Drought reduces quantity and quality of water in the Lake
Impact	Impacts tourism, water recreation, camping, fishing, health of wildlife
All Cities: City Water and Rural Water supply to cities	
Vulnerability	Some cities provide a public water supply. Other cities depend on Rural Water Associations to serve the public. Both types of suppliers are responsible for the health of residents and business needs
Impact	Quantity and quality of potable water may be reduced
Impact	Shortages in available water can lead to increased operating costs and difficulty meeting regulations for water supply and water treatment systems
City of Thornburg	
Vulnerability	Thornburg water services are provided by Poweshiek Water Association. Recently, PWA has issued notices requesting that customers observe voluntary water conservation practices during times of drought
Vulnerability	The City of Thornburg relies on Rural Water provided by PWA because the wells they previously used are no longer producing safe drinking water. There is no backup source of water available to the community
Impact	The community could be at risk if any problems occur that disrupt the delivery of water
City of Webster	
Vulnerability	Webster relies on an aging water supply well and has no backup alternative supply
Impact	The community could be at risk if any problems occur that compromise the functioning of the well

Climate Change Impacts: Increased length and intensity of drought will elevate risks.

Land use development: Intensified agriculture and urbanization will place aquifers at risk of accelerated depletion from both increased demand and reduced infiltration.

Population patterns: Increased population will place additional stress on diminishing water resources.

Expansive soils

Expansive soils typically contain clay materials that absorb water and expand or contract according to the amount of soil moisture available. When water is added to these expansive clays, the water molecules are pulled into gaps between the clay plates. As more water is absorbed, the plates are forced further apart, leading to an increase in soil pressure or an expansion of the soil's volume. Changes in soil volume present a hazard to structures built in proximity to expansive soils. The effect of expansive soil is most prevalent in regions where prolonged periods of drought are followed by periods of rainfall.

Expansive soils can be recognized by visual inspection in the field or by conducting laboratory analysis of the soil. Soils containing expansive clay become very sticky when wet. The presence of surface cracks is usually an indication of an expansive soil in its dry condition. The width of cracks provides a visual clue to the amount of shrinkage that has recently occurred.

Cracks in expansive soil: Desiccation cracks in soil caused by drying. U.S. Army Corps of Engineers Photo. https://geology.com/articles/expansive-soil.shtml

According to a recent study by Tassbaum and Bulut, at the University of Oklahoma, slab on grade construction is among the foundation types vulnerable to deformation and shift. The potential effects of expansive soils on slab foundations have proven difficult to quantify due to the wide variety of conditions that can exist in adjacent soils on a single site, in addition to challenges of slab shape and loading. They write:

> The problems with expansive soils are global. Expansive soils are considered the most common geologic hazard. According to the American Society of Civil Engineers, one in every four residences in the continental United States has experienced disturbances by expansive soils, with the yearly cost of damages to buildings and infrastructure surpassing $15 billion, which is more than twice the amount of destruction that all other natural disasters cause combined, including earthquakes, hurricanes, tornadoes, and floods (Jones and Jefferson, 2012).

Building damage: Note displaced bricks and inward deflection of foundation. U.S. Army Corps of Engineers Photo. https://geology.com/articles/expansive-soil.shtml

Design methods currently used have significant shortcomings for structural analysis of slabs and do not possess a rational approach for establishing and modeling deformed ground surfaces due to swelling and shrinking of soils. The frequently used PTI method and some other methods assume an overlapping approach for residential house slabs that are not square or rectangular in shape. In other words, current methods simply cannot handle a nonrectangular shape slab for

structural analyses of deformations, moments, and shear forces. The overlapping rectangle approach is simply not realistic and misses stress concentrations at critical locations in the slab due to the nonrectangular nature of the slab geometry and various loading and boundary conditions . . . Current procedures also make unrealistic assumptions by assigning only uniform foundation soil parameters around the perimeter of the slab, as well as uniform loading patterns (Tabassum, 2023).

Location

The entire Planning Area is affected by Expansive Soils with moderate to significant shrink-swell potential. The location information was generated using the Web Soil Survey website for Keokuk County. The data is from the NRCS soil survey. See maps below.

Affected Jurisdictions County, Cities, Schools

Extent

The Planning Area evaluates soil by category of limitation based on the USDA-NRCS Web Soil Survey. According to the NRCS soils database an estimated 98.6% of Keokuk County is subject to soils with at least moderate shrink-swell potential. Expansive soils can be recognized by visual inspection in the field or by conducting laboratory analysis of the soil.

For a good example of limitations in a particular area, we chose to look at suitability for basement construction, as that is a typical risk factor when expansive soils are present.

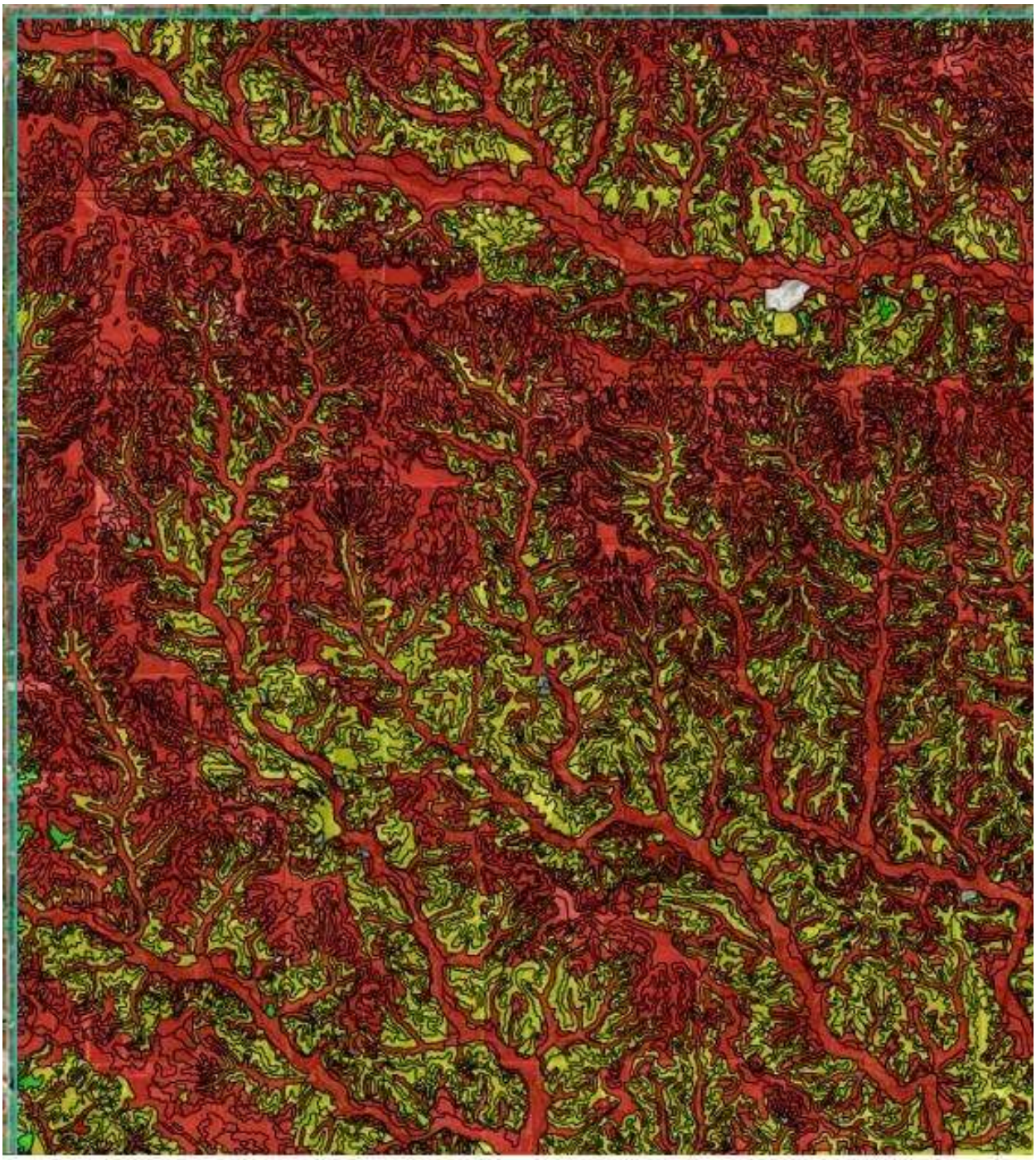
Soil limitations for Basement Construction	**Northwest**	**Northeast**	**Southwest**	**Southeast**
Very limited	64.9%	68.5%	57.5%	58.2%
Somewhat limited	34.4%	30.6%	40.8%	39.7%
Not limited	0.2%	0.4%	0.3%	0.4%
Total "Very & Somewhat"	**99.3%**	**99.1%**	**98.3%**	**97.9%**

A small percentage of soils are not rated. https://websoilsurvey.nrcs.usda.gov/app/

To illustrate the soil maps in Keokuk County, we were limited to 100,000 acre Areas of Interest. Therefore, we divided the county up into quadrants as follows:

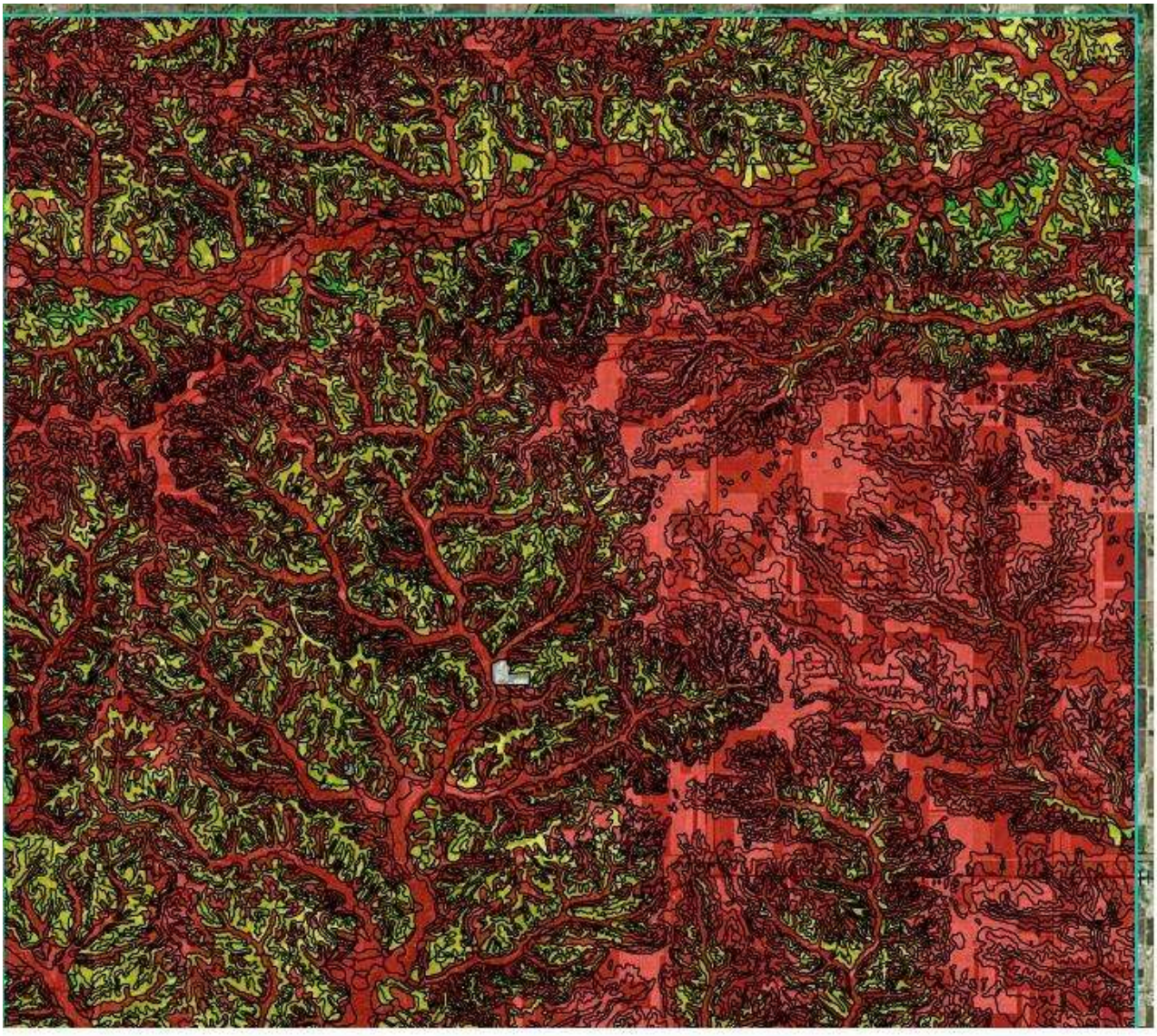
1. Northwest
2. Northeast
3. Southwest
4. Southeast

Northwest. Virtually all soils (99.3%) in the Northwest portion of Keokuk County are either very limited or somewhat limited for basement construction. Towns in this quadrant include Gibson, Thornburg, Keswick, What Cheer, and the NW corner of Sigourney.



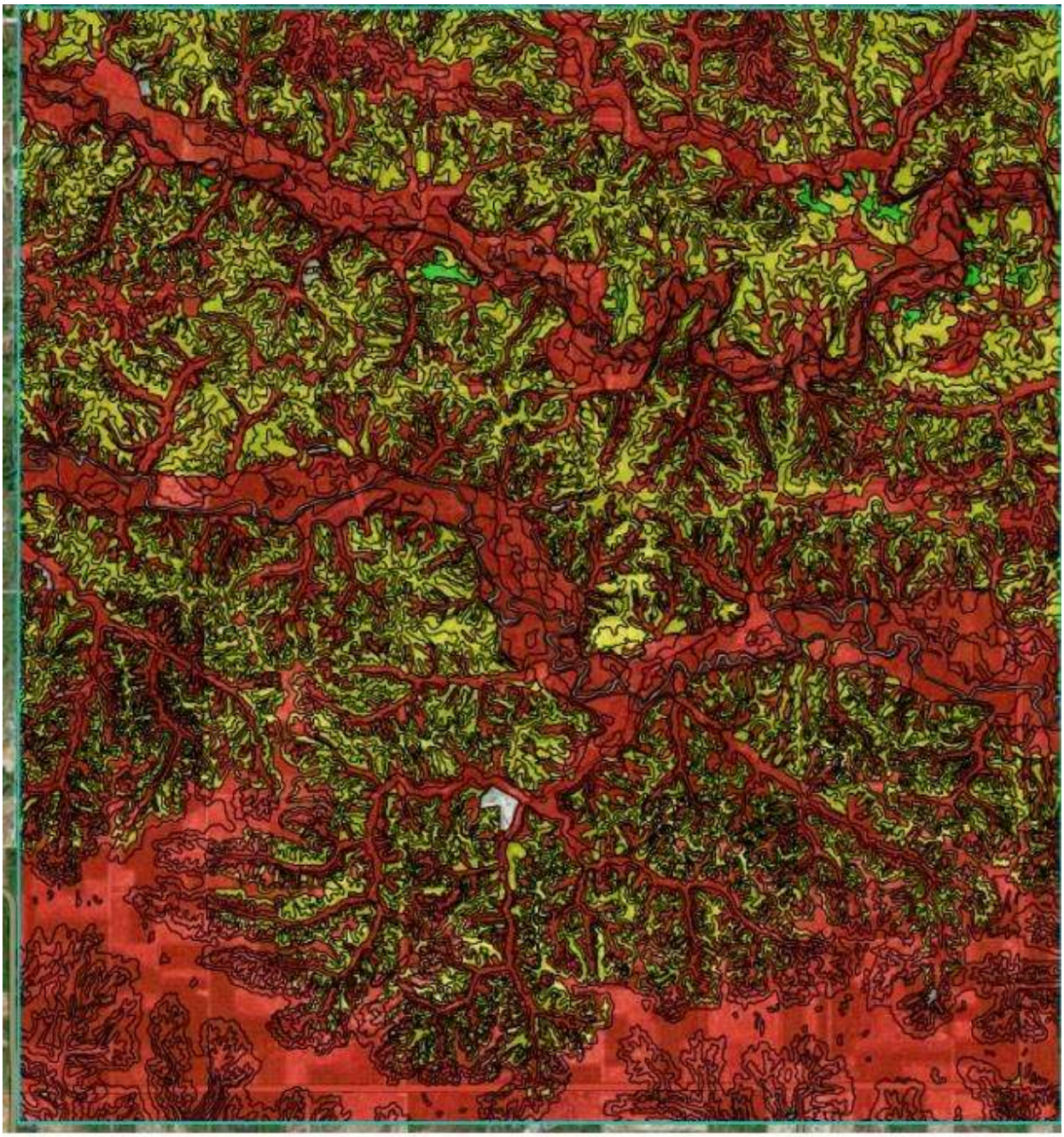
SOIL LIMITATIONS NW KEOKUK COUNTY

Northeast. About 99.1% of soils in the NE quadrant of the county are either very limited or somewhat limited for basement construction. Towns in this area are Webster, South English, Kinross, Harper, Keota and the NE corner of Sigourney.



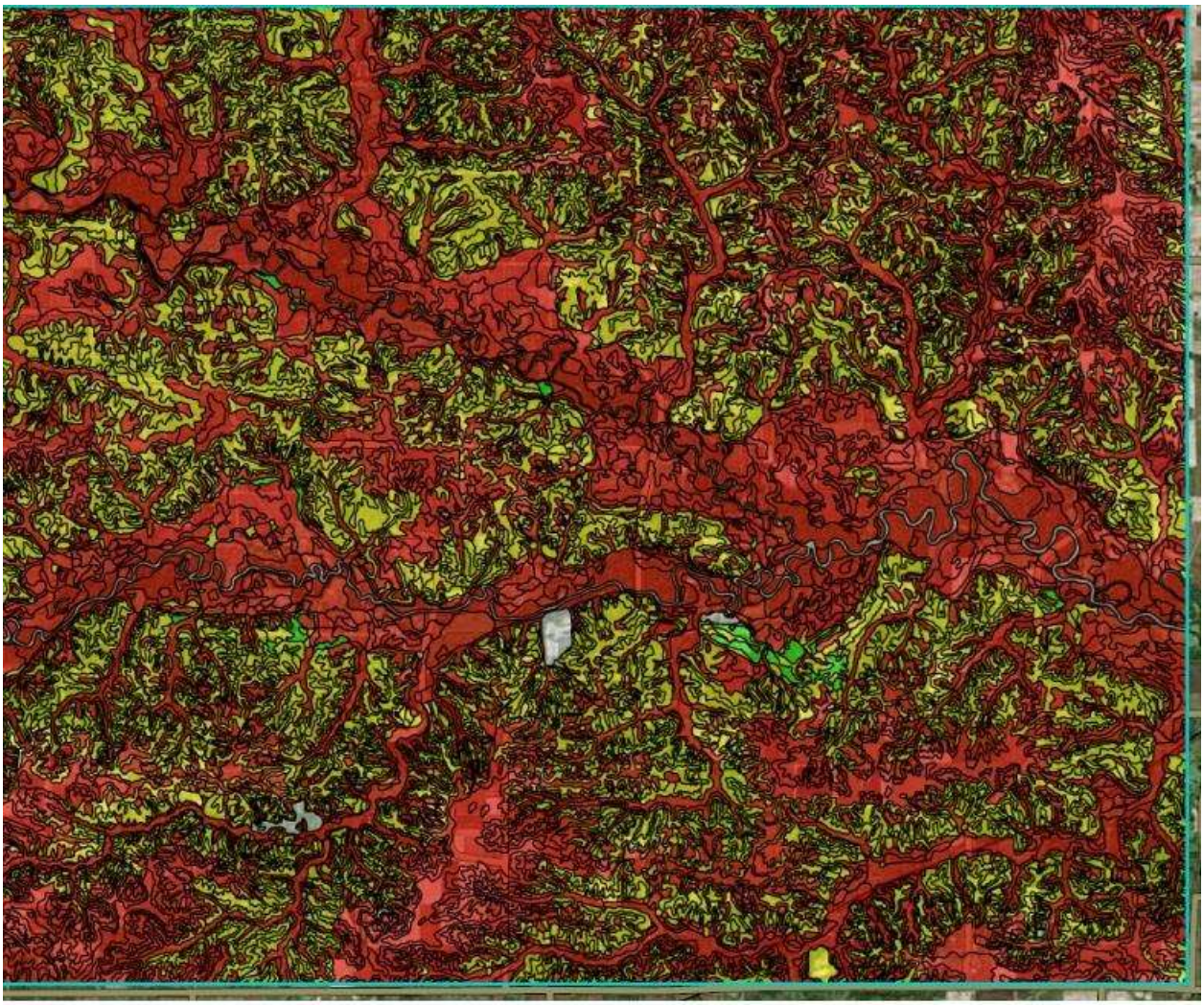
SOIL LIMITATIONS NE KEOKUK COUNTY

Southwest. In SW Keokuk County, an estimated 98.3% of soils are of limited use for basement construction. Towns in this quadrant are Delta, Hayesville, Hedrick and the SW part of Sigourney.



SOIL LIMITATIONS SW KEOKUK COUNTY

Southeast. About 97.9% of soils in Southeast Keokuk County are very limited or somewhat limited for basement construction purposes. Towns in this area are the SE part of Sigourney, Ollie and Richland.



SOIL LIMITATIONS SE KEOKUK COUNTY

Previous Occurrences

No records of structure damage due to expansive soils in the Planning Area are known to have been kept in the years of 2013 - 2022. Since this hazard develops gradually and seldom presents an immediate threat to life, problems may not have been recognized as being related to expansive soils and therefore not reported or tracked. In other words, there are known instances of displacement due to expansive soils, but there is no feasible way to estimate a number of previous occurrences. This is a data deficiency that will be challenging to overcome in the near future.

Probability

Probability varies according to the soil present at a building site. Maps or soil testing must be employed to determine the potential hazard at a specific location.

Overall, the probability that expansive soils in a category of Very limited or Somewhat limited for some building purposes on any given site is 98.6% = Very likely.

Climate trends

From the State of Iowa Hazard Mitigation Plan 2023 Section 3 Risk assessment

"Iowa already sees wetter spring and fall and dryer summers than in previous climate decades."

These trends may intensify the effects of expansive soils on structures in subsequent decades, but according to the Iowa State Hazard Mitigation Plan, no research in the US was readily available to support this projection (Iowa, 2023). That conclusion is supported by the following source as well.

From the EPA What Climate Change Means for Iowa

Heavier springtime rains are expected to be followed by longer periods of drought. From the U.S. EPA Publication on Climate change in Iowa: "Over the last half century, average annual precipitation in most of the Midwest has increased by 5 to 10 percent. But rainfall during the four wettest days of the year has increased about 35 percent, and the amount of water flowing in most streams during the worst flood of the year has increased by more than 20 percent. During the next century, spring rainfall and average precipitation are likely to increase, and severe rainstorms are likely to intensify. Although springtime in Iowa is likely to be wetter, summer droughts are likely to be more severe (EPA, 2016).

From *Residential House Foundations on Expansive Soils in Changing Climates* 2023

"This article outlines the need for improving the current method for analysis and design of slab foundations on expansive soils under changing climate conditions. It is important that modern houses are sustainable, resilient, energy-efficient, and affordable. The current methods that major building codes have adopted for foundation design have significant shortcomings" (Tabassum, 2023).

Stormwater management. The above comments on Climate illustrate that stormwater management is a significant factor in reducing the effects of expansive soils. More information about stormwater management is available under the Flood hazard profile and in Appendix C.

Vulnerability and Impacts

Expansive Soils: Affected Jurisdictions			
X	Delta	X	Richland
X	Gibson	X	Sigourney
X	Harper	X	South English
X	Hayesville	X	Thornburg
X	Hedrick	X	Webster
X	Keota	X	What Cheer
X	Keswick	X	Sigourney CSD
X	Kinross	X	Keota CSD
X	Martinsburg	X	Tri-County CSD
X	Ollie	X	Keokuk County (Unincorporated)

All jurisdictions are affected by Expansive soils.

Dry clays are capable of absorbing water and will shrink or swell in volume depending on the amount of water present. Risk is intensified when extreme periods of heat and drought are followed by extended rains.

Soils capable of these changes in volume present a hazard to buildings, footings, slabs, concrete, asphalt and other structures built over them and to the lines buried in them. Damage occurs to paved roads and streets.

Houses and one-story buildings are more likely to be damaged by the action of expansive clays than are multi-story buildings, which are usually heavy enough to counter shrink and swell pressures, although these foundations can also be affected over time.

Communities in Keokuk County can expect expansive soil movement from moderate swelling to affect public infrastructure. Over time, the effects are cumulative. While these effects may develop gradually, costs can become significant.

EXPANSIVE SOILS	
All jurisdictions	
Vulnerability	Expansive soils are present throughout the County
Vulnerability	Most buildings were constructed prior to a widespread awareness of the hazard of expansive soils
Impact	Roads and buildings undergo structural damage over a period of years
Impact	For property owners, heaving cracks foundations and displaces concrete slabs
Vulnerability	No practical method is in place to record instances of damage from Expansive soils
Impact	Local officials, Developers and the General Public cannot fully evaluate the impact of the hazard
Cities	
Vulnerability	Public works departments have encountered displaced lines from the heaving of expansive soils. Shifting soils cause line breakage over time
Impact	Underground water and sewer lines break, compromising the delivery system
Vulnerability	Even cities that do not manage a water utility are affected by compromised service lines because everyone depends on reliable, safe water delivery
Impact	Broken water and sanitary sewer lines can endanger public health. Problems that result include contamination of water and the environment, the cost of repair and the labor involved to restore service
Impact	When waterlines break, fire protection may be compromised
Vulnerability	Street subgrades have shifted, especially in areas with poor drainage
Impact	Shifting soils cause voids, sub grade pumping, and ongoing pavement damage
Schools	
Vulnerability	Some school buildings may be heavy enough to counter the effects of expansive soils. Other structures may be affected
Impact	Damage from expansive soils can accumulate over time. Annual inspection of vulnerable structures is advised

Pipelines	
Vulnerability	Approximately 167 miles of active gas transmission pipelines and hazardous liquid pipelines are in place in Keokuk County
Vulnerability	Expansive soils may cause underground lines to shift over time, which may compromise the integrity of pipeline structures
Vulnerability	Local governments have no authority to monitor or regulate pipelines
Impact	Potential impacts of a pipeline rupture include injury or loss of life due to release of toxins, explosion or fire
Impact	Contamination of soils and groundwater can result from buried pipelines being damaged by expansive soils

Climate trends. Heavier springtime rains are expected to be followed by longer periods of drought. This more extreme pattern can be expected to intensify the shrink and swell cycle of expansive soils.

Land use development. Expansive soils are present in many areas in the county. Soil testing should be conducted prior to construction.

Population patterns. New development should occur in areas less susceptible to the hazard of expansive soils, or with the application of building standards that mitigate the hazard.

Extreme Heat

According to FEMA, in most of the U.S., extreme heat is a long period (2 to 3 days) of high heat and humidity with temperatures above 90 degrees.

Temperatures that hover 10° 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 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 the Cities of Hedrick, Keota and Sigourney may record a slightly higher temperature than the more rural parts of the county.

Affected Jurisdictions County, Cities, Schools

Extent

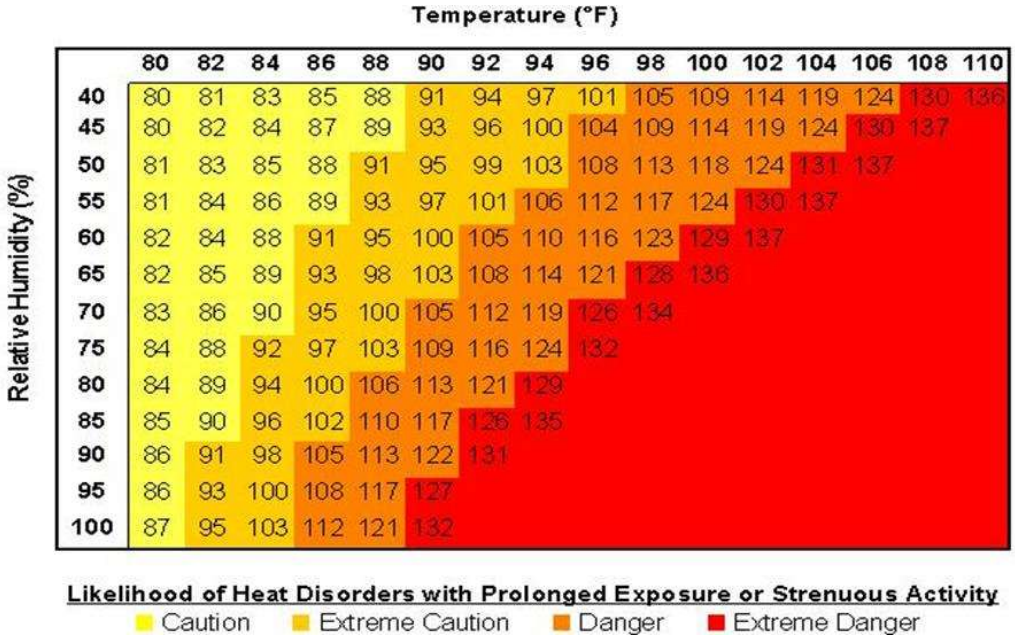
The planning area uses the Heat Index Chart to categorize Extreme Heat, and values that fall anywhere on the Index may be expected to occur.

Temperature and Humidity. Extreme heat conditions are a function of heat and humidity, illustrated below using a Heat Index Chart. For people and livestock living or working without air conditioning, caution should be taken when temperature exceeds 80 degrees and humidity is 40% or more. A status of Extreme Caution can occur at temperatures as low as 82 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. Southeast Iowa humidity typically ranges from 70% to 100% during summer days (wunderground, 2024).

The combined effects of rising temperatures and humidity present a situation where humans and animals may experience heat disorders which, at extreme levels can be fatal.

HEAT INDEX CHART



Previous Occurrences

Referring to the Heat Index and the climatological record, Keokuk County heat and humidity are such that caution should be taken during most summer days.

One way to identify periods of extreme heat is to record the number of days in the danger and extreme danger categories when temperatures reached 90 degrees or more and humidity was greater than 70%. When temperature or humidity exceed those levels, conditions always pose a danger of heat disorders to unsheltered people or animals.

The heat and humidity data below were provided by Weather Underground, based on regional measurement stations. Weather Station ID: KIASIGOU8 is based in Sigourney. Another nearby station is at the Eastern Iowa Airport at Cedar Rapids.

Summer days, heat. Of 920 summer days (June, July and August) from 2014 through 2023, 75 reached or exceeded 90 degrees (8% of summer days). On one day in 2023, the temperature reached 100 degrees.

Humidity. Virtually all summer days reached over 70% humidity (99% of days). 92% were over 90% humidity and 58% of all summer days reached 100% humidity. These humid conditions intensify the risk for heat disorders.

Heat Index. Heat and humidity overlap, and most days with temperatures over 90 degrees reach 70% humidity or more – dangerous heat conditions, and usually, reach heat indices that are extremely dangerous. Some of these days occur each year.

"Danger and Extreme Danger"

Keokuk Co Heat data	Days over 90F	Danger (90 degrees and 70% or more humidity)	Extreme danger (92 degrees and 90% or more humidity)
Summer days	75 of 920 days	74 of 920	61 of 920
10 year average	8%	8%	7%

(wunderground, 2024)

Probability

Eight percent (8%) of all summer days in Keokuk County pose a danger to public health.

Days of heat danger occur each year. Probability of an Extreme Heat event in any given year is 10 of 10 years = 100% Very likely.

Climate Trends

Extreme heat increasing. Days with maximum temperatures above 90 are projected to occur 2 to 5 times more often by 2050 in the best case scenario. Days above 100, currently occurring once every few years in most of Iowa, are projected to happen several times each year by 2050. Days over 105 may not be rare either. 'Cooling degree days' will nearly double in about 50 years, straining energy systems and increasing chances of blackouts and brownouts (barring adaptation measures) (Iowa, 2023).

- ✓ Annual average temperatures at least 2.4°F higher compared to the first half of the 20th century, according to NOAA
- ✓ Increased heat waves. By 2050, most of Iowa is projected to see about one extra month per year of daily high temperatures above 90°F than was observed from 1961 to 1990, according to the U.S. Climate Resilience Toolkit.

Vulnerability and Impacts

Extreme Heat: Affected Jurisdictions			
X	Delta	X	Richland
X	Gibson	X	Sigourney
X	Harper	X	South English
X	Hayesville	X	Thornburg
X	Hedrick	X	Webster
X	Keota	X	What Cheer
X	Keswick	X	Sigourney CSD
X	Kinross	X	Keota CSD
X	Martinsburg	X	Tri-County CSD
X	Ollie	X	Keokuk County (Unincorporated)

Extreme heat events affect all jurisdictions.

EXTREME HEAT	
All Jurisdictions	
Vulnerability	People, livestock, pets and wildlife are vulnerable to heat stress. Children, elderly and disabled persons are especially vulnerable
Impact	Humans, livestock, crops and wildlife suffer injury or death from extreme heat
Impact	FEMA: Extreme heat often results in the highest annual number of deaths among all weather-related disasters
County and Cities Vulnerability	
Vulnerability	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
Impact	More people responding to extreme events places additional people at risk
Vulnerability	About 22% of the Keokuk County population are people over age 65, who may lack resources to respond appropriately to a heat situation
Impact	Older people are more susceptible to a health crisis in the event of extreme heat
Vulnerability	Infrastructure such as roads, bridges and electrical lines are subject to expansion and contraction during extreme temperatures
Impact	Long term damage to infrastructure eventually leads to disruptions in service, costs for maintenance and repair
County Conservation	
Vulnerability	People engaged in outdoor activities, rich wildlife habitat, summer recreation underway
Impact	Extreme heat puts people at risk for heat exhaustion
Impact	Water temperature affects the health and activity of fish and other wildlife on land and in the water
Impact	Extreme heat reduces tourism, reduces revenue that supports the recreational areas
All Cities	
Vulnerability	Designated locations must be available and have backup generators to provide shelter from extreme heat to vulnerable people in the community
Vulnerability	Community shelters lack sufficient capacity
Vulnerability	Residents may not know that cooling centers are available or where they are located
Impact	People may suffer from heat disorders
Hayesville	
Vulnerability	35% of the households in Hayesville are living below the poverty line, and 51% of residents are over age 65
Impact	People with low incomes struggle to afford the cost of maintenance and operation of home air conditioning units
Impact	People over age 65 are more likely to suffer from heat disorders
Hedrick, Martinsburg & What Cheer	
Vulnerability	Poverty: 25% of Hedrick residents, 29% of people in Martinsburg and 26% of those in What Cheer are living below the poverty line.

Impact	People with very low incomes may struggle to afford adequate air conditioning systems at home, placing people at risk for heat disorders
Ollie, Sigourney & Thornburg	
Vulnerability	Over age 65: 28% of residents of Ollie, 33% of those in Sigourney and 39% of people in Thornburg are over age 65.
Impact	Elderly people are more vulnerable to heat stress and may suffer from heat disorders

Impacts of Climate trends. Iowa already experiences heatwaves, but we should prepare for them to occur more often (Iowa, 2023).

From the EPA: "Certain people are especially vulnerable, including children, the elderly, the sick, and the poor. The elderly may be particularly prone to heat stress and other heat-related health problems, including dehydration, cardiovascular strain, and lung problems. Those with low incomes may also be vulnerable if they lack air conditioning.

Rising temperatures can also increase the formation of ground level ozone, a key component of smog. Ozone has a variety of health effects, aggravates lung diseases such as asthma, and increases the risk of premature death from heart or lung disease. As the climate changes, continued progress toward clean air will become more difficult" (EPA, 2016).

Land use development. Increasing number of days with extreme temperatures should be considered when planning new structures or retrofitting older structures to be more energy efficient. Land use development patterns are unlikely to increase the incidence of extreme heat in this rural county, although it may be advisable to plant additional trees in urbanized areas to mitigate effects of heat.

Population patterns. This hazard is unlikely to be affected by population patterns in Keokuk County.

Flood

Two types of floods are tracked by the NOAA Storm Events Database: flash floods and river floods. Flash floods generally cause greater loss of life and river floods generally cause greater loss of property. Stormwater can also cause temporary flooding of streets, homes and basements. While FEMA recognizes all of these flood types, stormwater problems in local communities are not tracked at the State or Federal levels.

Flash flooding occurs when too much rain falls too fast and too long for the ground to absorb all the water. If a storm stalls over one area, the intensity of rainfall can lead to dangerous flash flooding that threatens life and property. Sudden rising water can overwhelm retention capacity and wash out roads.

River flooding occurs when river levels rise and overflow their banks or the edges of the main channel and inundate areas that are usually dry. Most river floods can be linked to a storm of some kind, although floods can also be caused by dam failures, rapid snowmelt or ice jams.

Stormwater. Localized flooding may occur as a combination of excessive rainfall or snowmelt, saturated ground, and inadequate drainage capacity. Without sufficient infiltration or drainage paths, the water will flow overland and find the lowest elevations. Stormwater flooding becomes more prevalent when development of impervious surfaces (such as pavement and roofs) increase runoff which exceeds the

capacity of drainage infrastructure. Flooding also occurs due to combined storm and sanitary sewers being overwhelmed by the high flows that often accompany storm events.

NFIP. The National Flood Insurance Program (NFIP), established in 1968 provides flood insurance to property owners, renters and businesses. Private insurance companies do not cover flood. The NFIP defines Special Flood Hazard Areas (SFHAs) which are FEMA-regulated floodplains. The NFIP works with communities to adopt and enforce floodplain management regulations that help mitigate flooding effects in those areas. Homes and businesses in SFHA areas with mortgages from government-backed lenders are required to have flood insurance (FEMA, 2022).

Base flood. The terms "base flood," "100 year flood," and "one-percent annual chance flood" are often used interchangeably. The boundary of the Base Flood (1% flood) is equivalent to the Special Flood Hazard Area (SFHA) on FEMA's NFIP Maps.

Federal flood insurance is not a disaster assistance program. It is an insurance program established to help property owners to recover more quickly at a lower cost than waiting for disaster aid. Because floods can happen outside of the special flood hazard area (SFHA), flood insurance is available to cover any property in participating NFIP communities.

Location

Three rivers and numerous streams meander through Keokuk County. The English River drains the northern part of the county. The North and South Skunk Rivers flow through the southern half of the county where they join in the southeast to form the Skunk River.

FEMA NFIP Flood Insurance Rate Maps (FIRMs) were updated with an effective date of 08/16/2011. Individual FIRM panels are available at the FEMA Map Service Center website when you enter the community name. Flood areas in affected communities in Keokuk Couty are reproduced below.

Affected jurisdictions.

River flooding: Keokuk County, Delta, Harper, Hayesville, Hedrick, Keota, Keswick, Kinross, Martinsburg, Ollie, Richland, Sigourney, South English, and What Cheer.

Flash floods: Keokuk County, Hayesville, Keswick, Kinross, Sigourney, Thornburg.

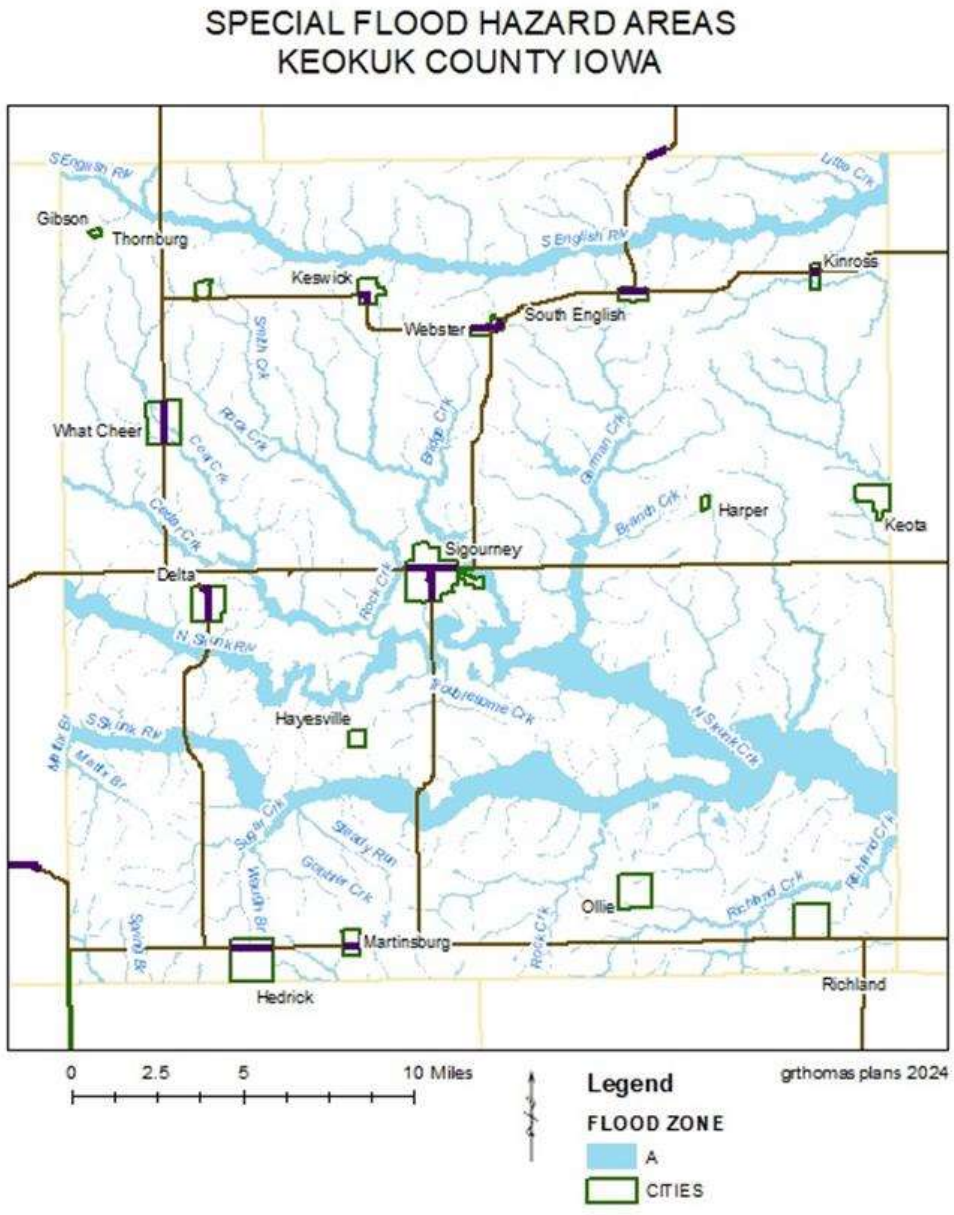
Stormwater: All Cities have the potential to be affected by localized flooding from stormwater. Surface runoff (also known as overland flow) occurs when excess rainwater, stormwater, meltwater, or other sources, can no longer sufficiently infiltrate the soil. This can occur when the soil is saturated by water to its full capacity, or rain arrives more quickly than the soil can absorb it. Surface runoff often occurs because impervious areas (such as roofs and pavement) do not allow water to soak into the ground.

In addition to causing water erosion and pollution, surface runoff in urban areas is a primary cause of urban flooding, which can result in property damage, damp and mold in basements, and street flooding. This can happen almost anywhere and is not tracked by FEMA. Therefore, we cannot include statistics for this hazard in flood data, but we do address the problem in the Mitigation Action Plan. See Appendix C for more information about stormwater management.

Official FEMA NFIP Maps may be accessed from the following site: FEMA Map Service Center. This is the web address:

Official Keokuk County flood maps effective date 08/16/2011:
https://msc.fema.gov/portal/availabilitySearch?addcommunity=19087C&communityName=KEOKUK%20COUNTY#searchresultsanchor

NFIP Digital Maps. Keokuk County: This map illustrates the general location of flood hazard areas geographically. The following maps illustrate the general location of flood hazards as they relate to municipal boundaries and schools.



The cities of Gibson, Thornburg and Webster do not have special flood hazard areas (SFHA) within the city limits and therefore have not adopted a floodplain development ordinance. The town of Webster has chosen to join the NFIP, to provide property owners the opportunity to purchase flood insurance if they wish to do so.

Several cities have a limited amount of SFHA area that intersects with the municipal boundary, but only in locations where development has not occurred or is regulated by local ordinance. Many of these have elected not to participate in the NFIP program. See digital maps below.

Jurisdictions with Special Flood Hazard Areas:

Delta chose not to join the NFIP because the SFHA is in a remote and undeveloped part of the City limits.

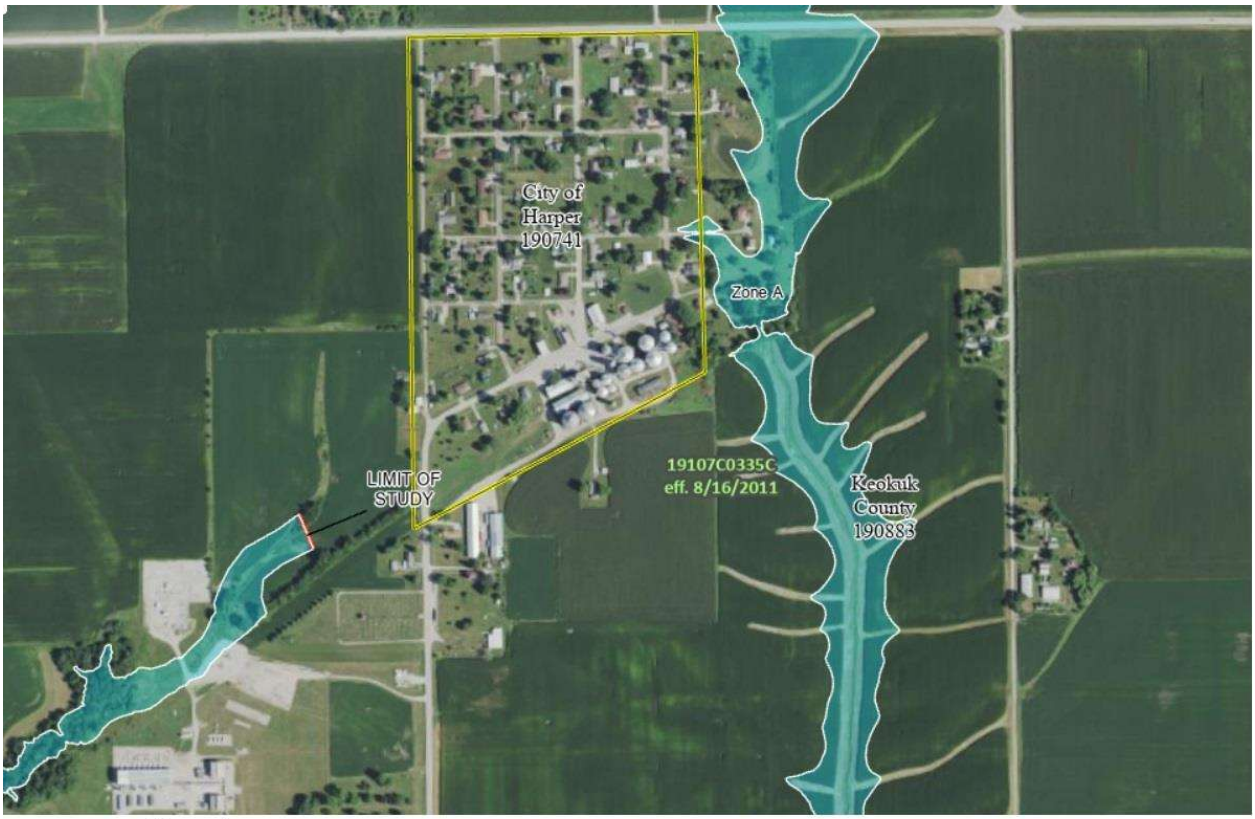
Delta Iowa

Legend

1% annual chance flood area (SFHA)

Municipal boundaries are yellow

Cities of Harper and Hayesville, shown below, chose not to join the NFIP because the SFHA is in a small, remote and undeveloped part of the City.



Harper Iowa

Hayesville Iowa

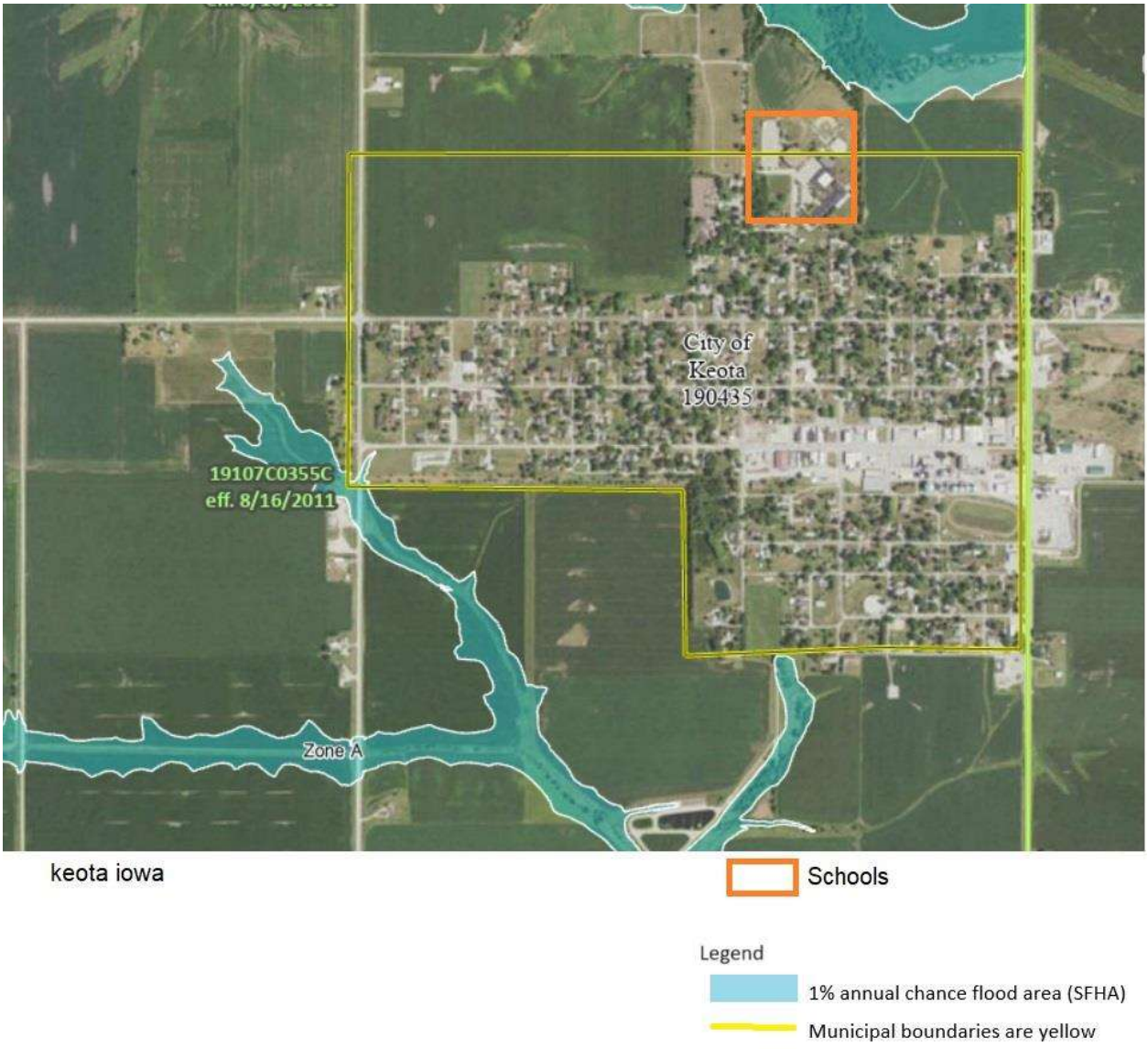
Legend

1% annual chance flood area (SFHA)

Municipal boundaries are yellow

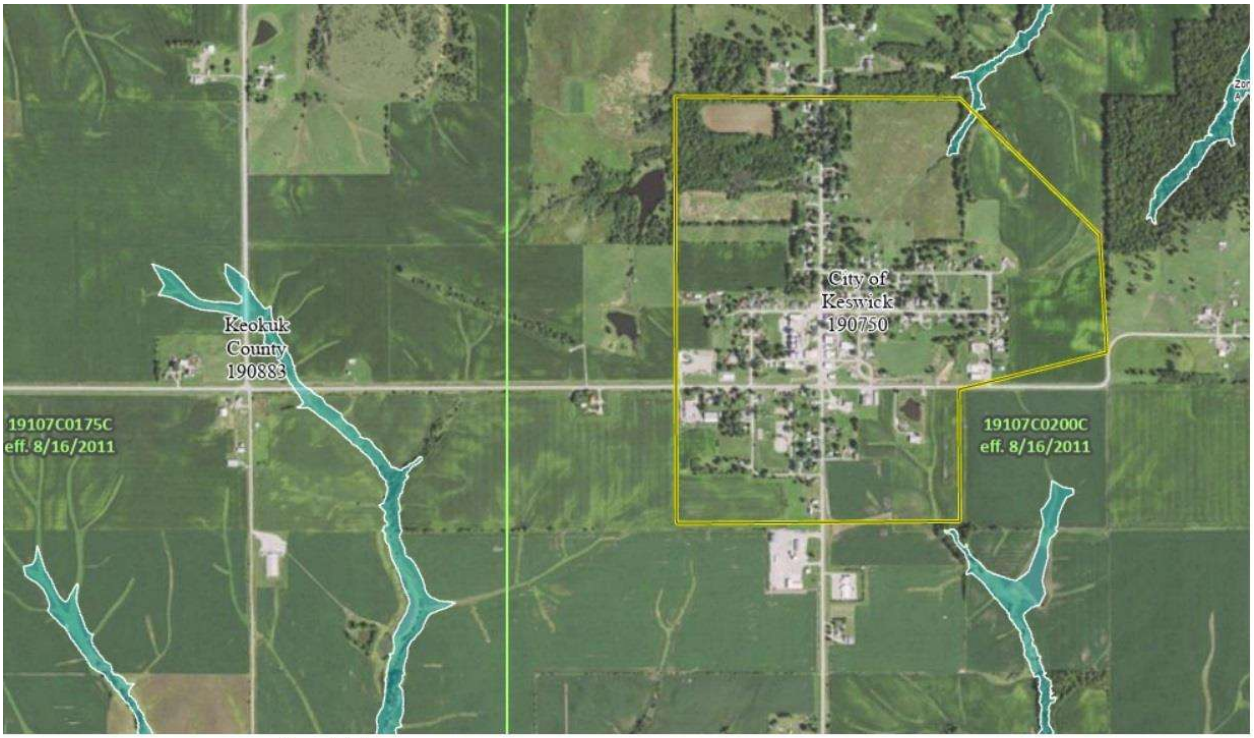
Hedrick Iowa

City of Hedrick, chose not to join the NFIP because the SFHA is in an undeveloped part of the City.

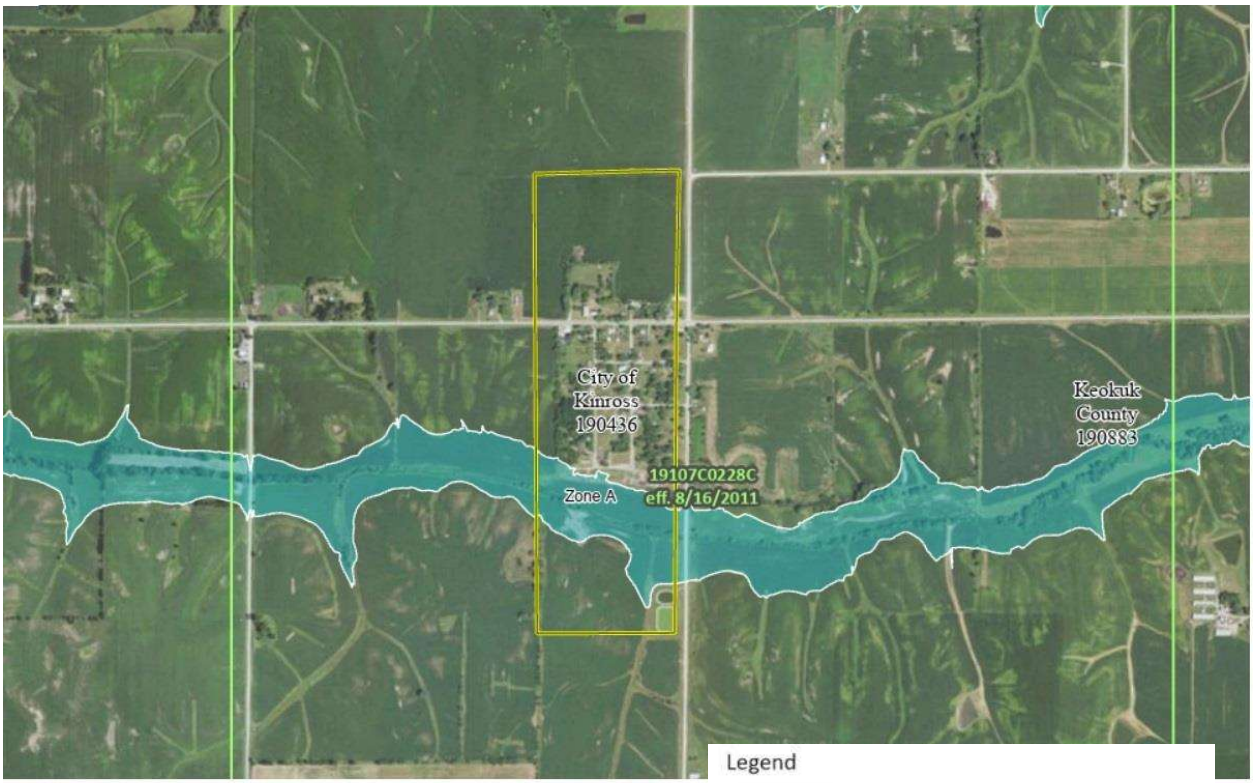


City of Keota chose not to join the NFIP because the SFHA is in a tiny and undeveloped area on the west side of the City.

Below: Keswick does not participate in the NFIP.
Kinross participates in the NFIP.



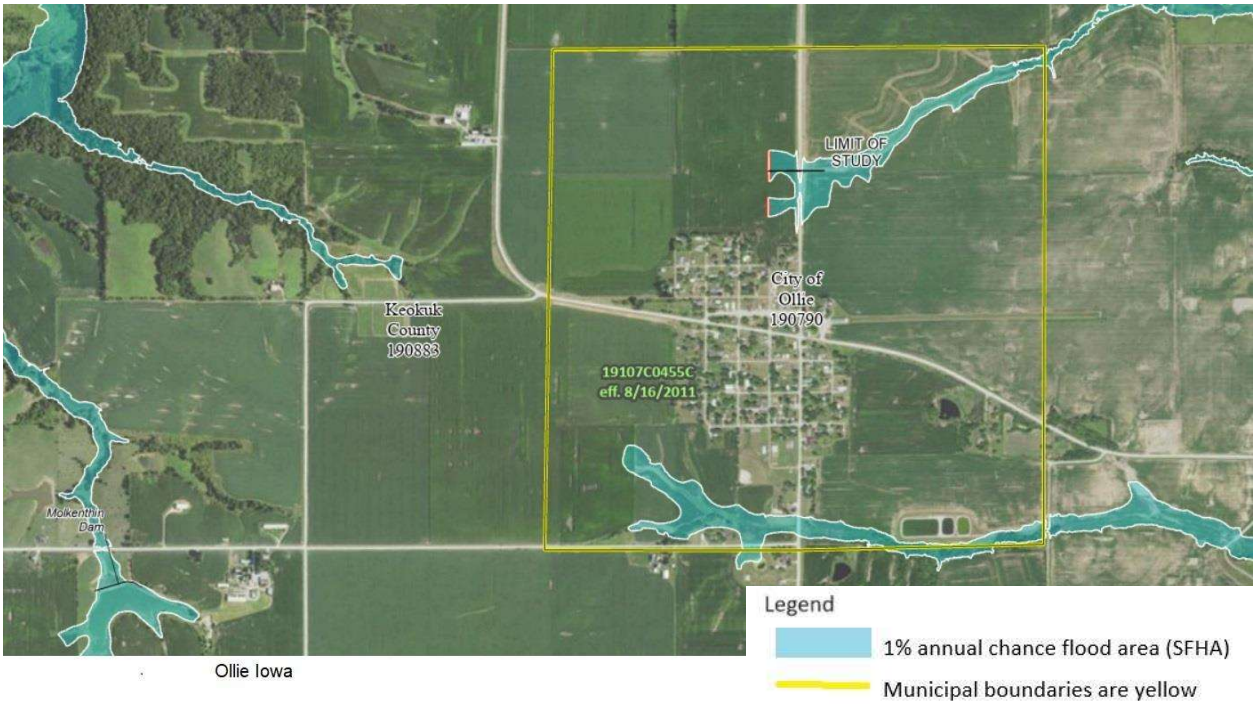
Keswick Iowa



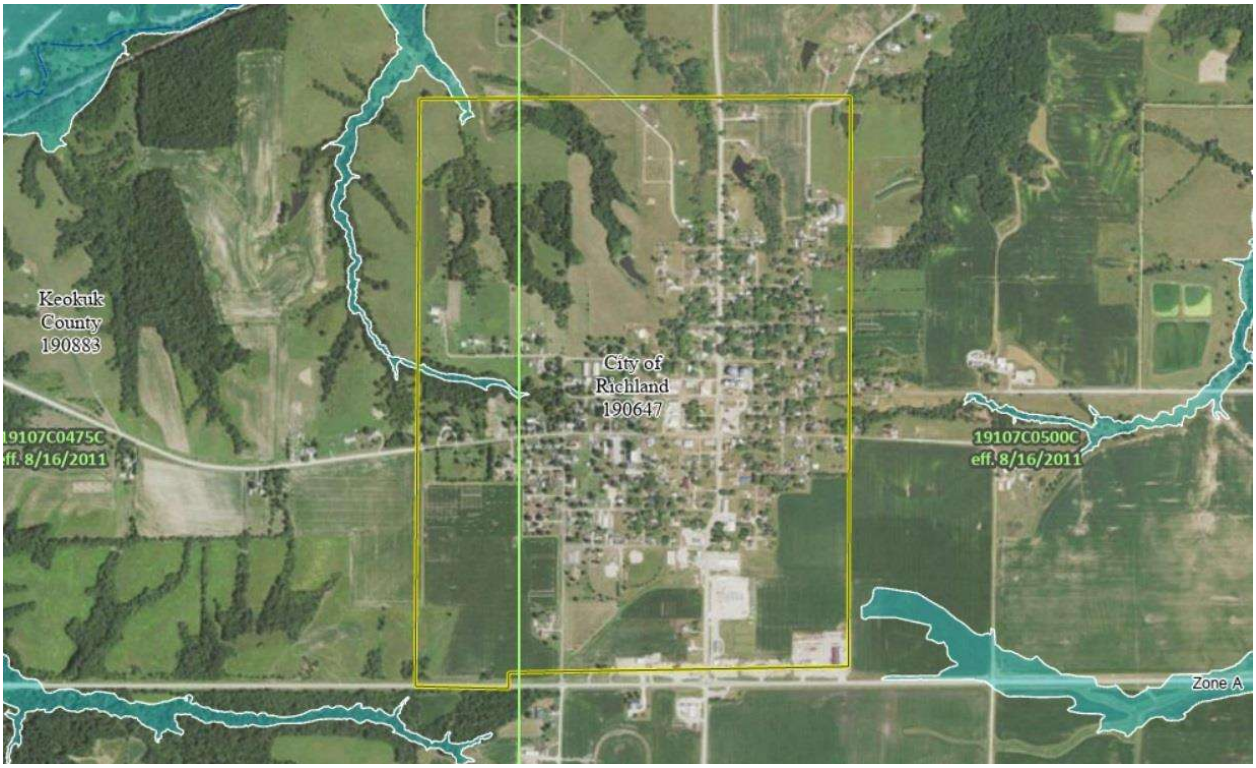
Kinross Iowa

Below: Martinsburg and Ollie chose not to participate in the NFIP because they believe SFHA flooding will only affect undeveloped parts of the City.

Martinsburg Iowa



Ollie Iowa



Cities of Richland and South English chose not to join the NFIP because the SFHA is in a small, remote and undeveloped part of the City.

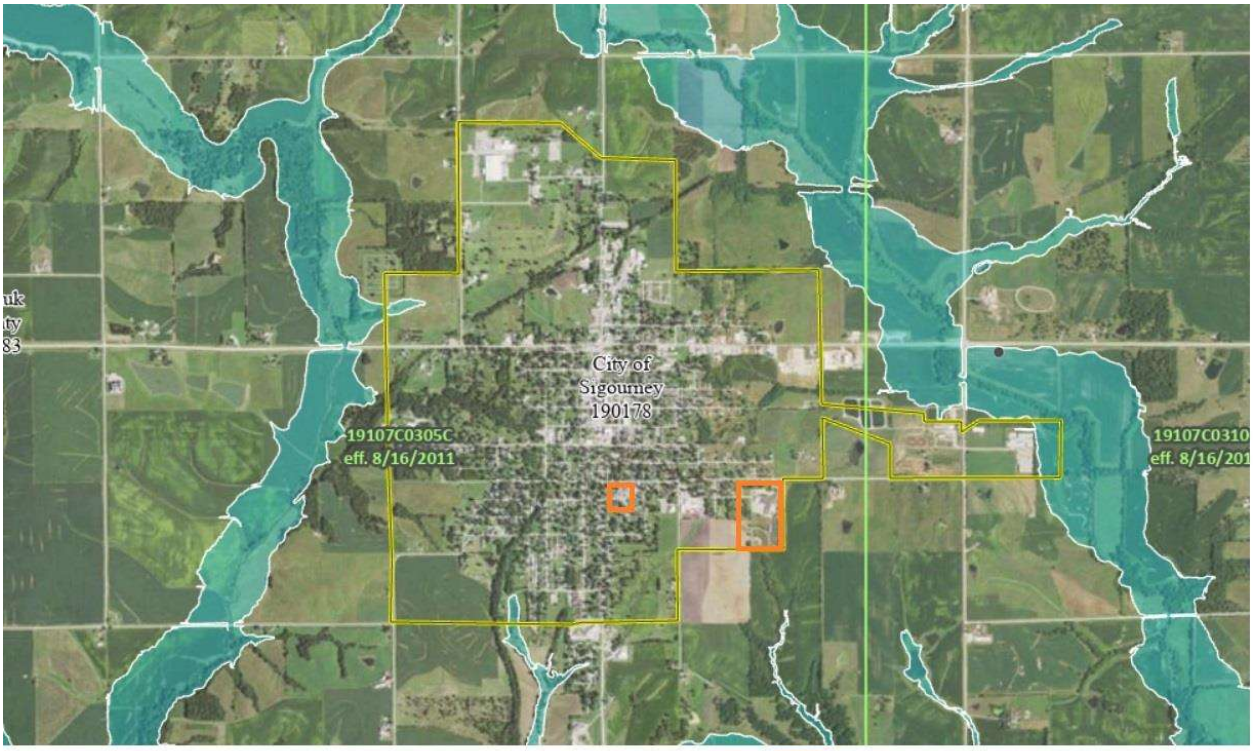
South English Iowa

Legend

1% annual chance flood area (SFHA)

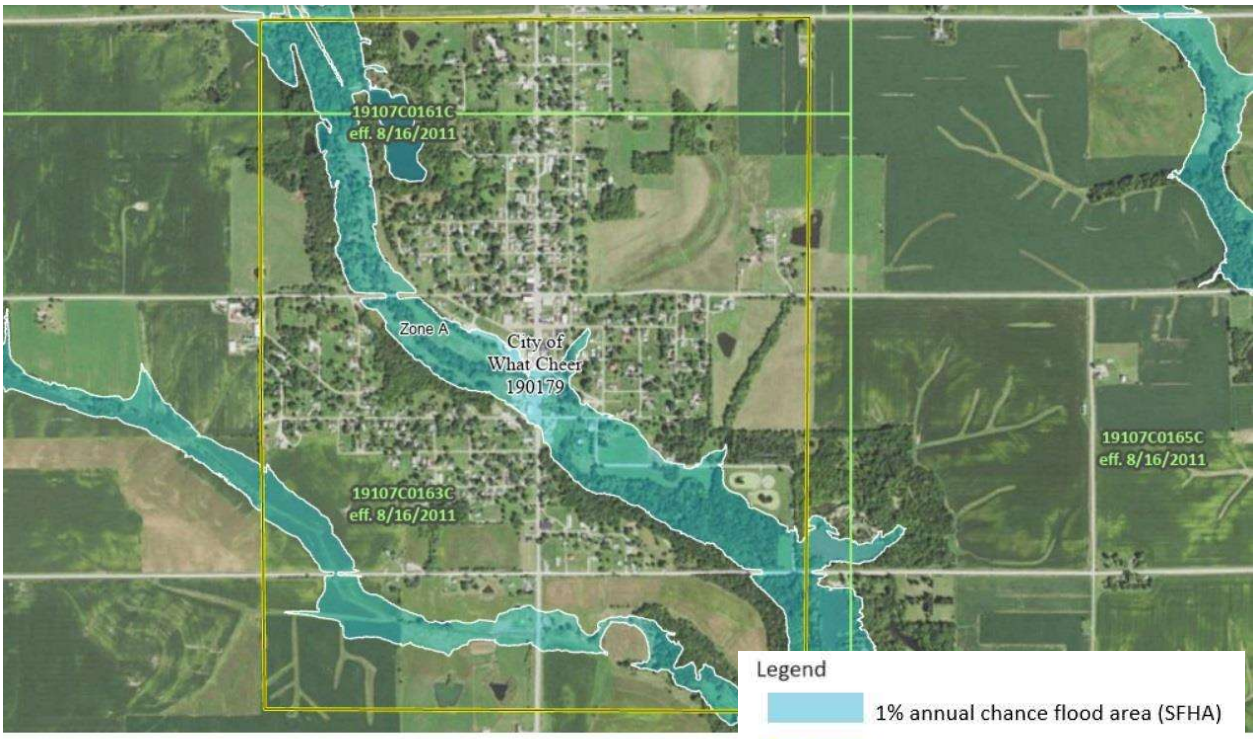
Municipal boundaries are yellow

Sigourney and What Cheer do Participate in the NFIP. See Section C2 for more information about NFIP.



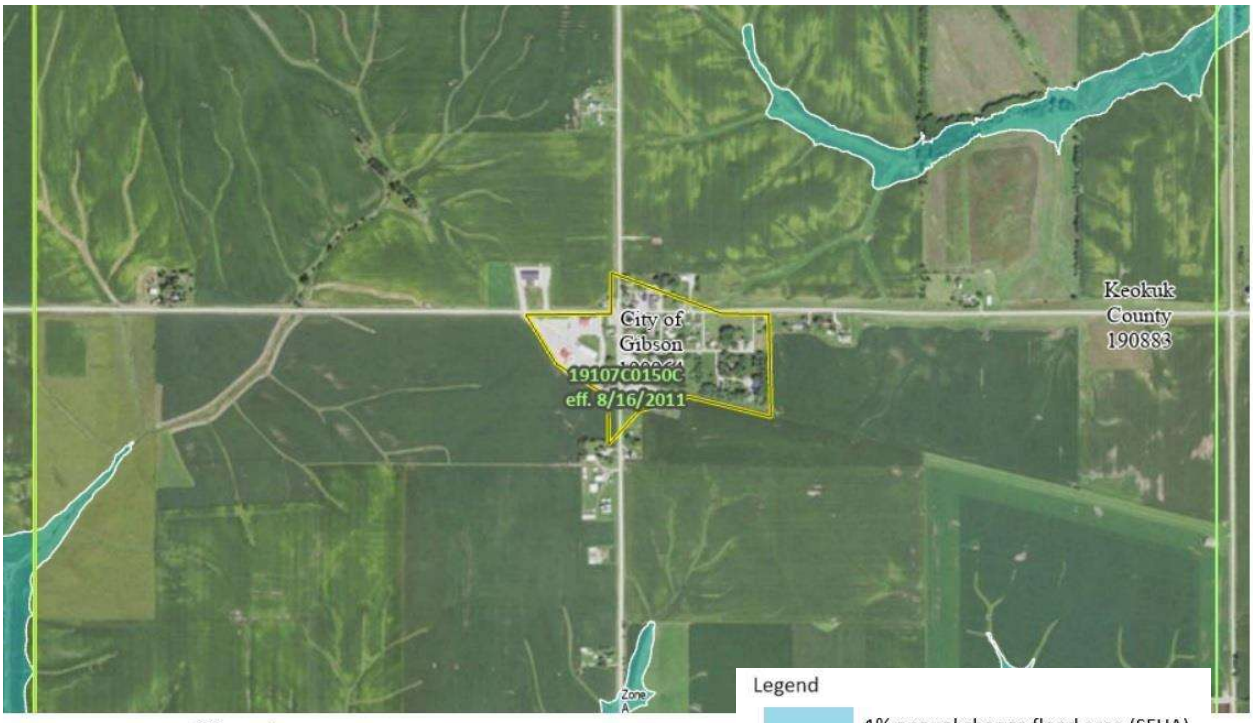
Sigourney Iowa

Schools

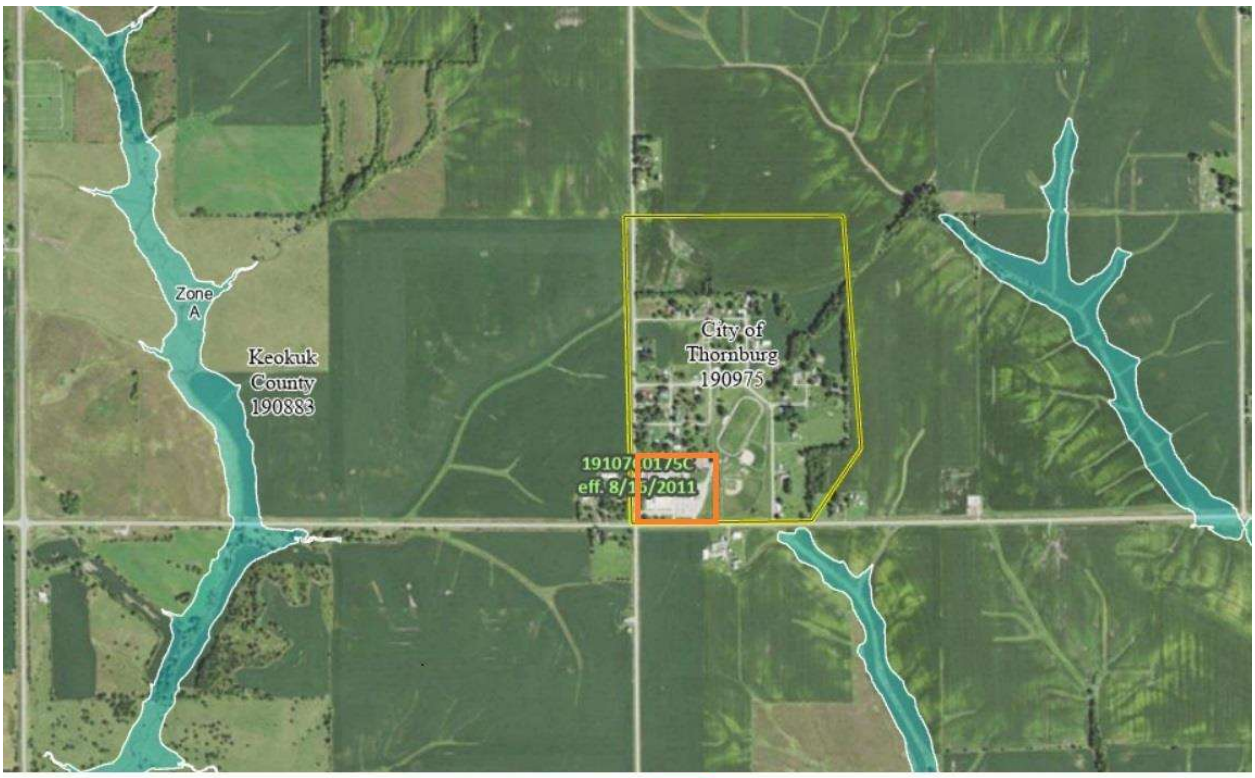


What Cheer Iowa

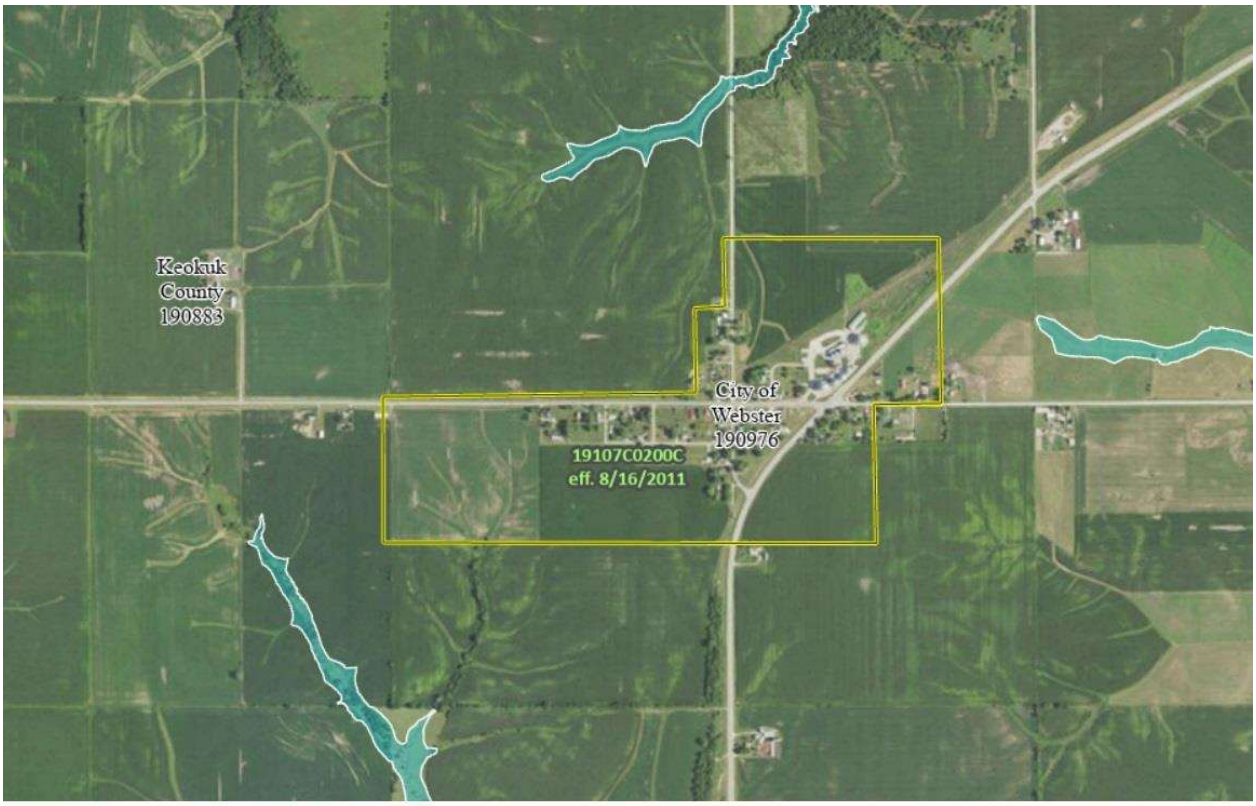
Jurisdictions with No Special Flood Hazard Areas:



Gibson Iowa



Thornburg Iowa



Webster Iowa

Extent

All SFHAs in Keokuk County are “Zone A” floodplains. Zone A depicts the river or stream flood hazard areas with a 1% or greater chance of shallow flooding each year (base flood) usually in the form of sheet flow with an average depth ranging from 1 to 3 feet.

Previous occurrences

Twelve flood events were recorded in the NOAA Storm database during the study period; five of which were Flash floods and seven flooding streams or rivers.

FLOOD			
LOCATION	BEGIN DATE	EVENT TYPE	EVENT NARRATIVE
COAL CREEK	4/18/2013	Flood	Heavy rains of 3 to 7 inches resulted in major river flooding on several area tributary rivers
KESWICK	5/26/2013	Flash Flood	Trained spotter reported very heavy rains with creeks out of their banks and flash flooding occurring.

HAYESVILLE, SIGOURNEY	5/28/2013	Flash Flood	Law enforcement reported 20 roads closed across Keokuk County due to flash flooding. Heavy rain during the last week of May caused a rapid rise on the Skunk River to the south of Sigourney. The river rose above the major flood stage of 21 feet early in the morning of the 28th and fell below major flood stage on the mid morning of the 31st.
SIGOURNEY	6/1/2013	Flood	The North Fork of the Skunk River rose above the major flood stage of 21 feet and fell below 21 feet in the late evening hours of the first.
COAL CREEK	6/30/2014	Flash Flood	Law enforcement reported 140th street at 110th avenue closed due to high water.
SIGOURNEY	7/1/2014	Flood	Heavy rain across the Upper Midwest and eastern Iowa during the last two weeks of June caused the North Skunk River near Sigourney to rise above its major flood stage of 21 feet around 1100 AM on July 1 and fall below major flood stage around 930 AM on July 5. The river crested at 23 feet around 11PM on July 2 and remained at the crest through 100 AM on July 4.
RICHLAND	7/3/2014	Flood	Heavy rainfall across the Upper Midwest during the last two weeks of June
HAYESVILLE	12/16/2015	Flood	The North Skunk River at Sigourney rose above the major flood stage of 21 feet around 1AM on December 16 and fell back below 21 feet on the 16th around 6PM. The river crested at 21.1 feet at 1043 AM on December 16.
THORNBURG	9/1/2018	Flash Flood	Law enforcement reported two paved roads in northern Keokuk County were closed with water over the roads. Flash flooding occurred with areas of 3 to 6 inches of rain
KINROSS	10/6/2018	Flash Flood	A band of 2 to 4 inches of rain fell on already saturated soils, causing a stripe of flash flooding from Keokuk County into northwest Illinois.The Iowa DOT closed Highway 21 in What Cheer due to flooding from Coal Creek. The water over the road was a foot deep, resulting in a detour
DELTA	10/12/2018	Flood	The North Skunk River near Sigourney, Iowa rose above the major flood stage of 21 feet during the mid morning of the 12th and fell back below major flood stage early in the evening of the 12th. The river crested at 21.1 feet around 230 PM on the 12th.

SIGOURNEY	3/15/2019	Flood	Heavy rain and snow melt across the region caused the North Skunk River south of Sigourney to rise above major flood stage of 21.0 feet on March 15th. The river fell back below major flood stage on the 17th. The river crested at 23.01 feet on the 16th.

Probability

Twelve events 12/10 years = >100%, Very likely probability.

Climate trends

Flood Increasing. Precipitation is expected to increase in volume and intensity, with average annual precipitation increasing 1" to 4" in any county by 2050. Because warmer air temperatures can hold more water, storms may be larger but less frequent. Eastern Iowa is seeing a greater increase in precipitation than western Iowa, which indicates a likelihood of more flooding in eastern Iowa in coming decades.

Climate changes already observed – Iowa 2023:

- ✓ Increased humidity, especially in summer, fueling thunderstorms
- ✓ Every 1°F increase in atmospheric temperature allows the atmosphere to hold 4% more water vapor
- ✓ Higher temperatures
- ✓ Warmer nighttime temperatures (DNR)
- ✓ Winters warming six times faster than summers (DNR)
- ✓ Increased precipitation (8 percent from 1873 to 2008)

B2-c Repetitive Loss Properties

NFIP. The National Flood Insurance Program (NFIP) Repetitive Loss Properties (RLP) Report is a record of properties that fall within the four categories of Repetitive Loss and Severe Repetitive Loss that FEMA tracks. The report dated April 17, 2024 does not identify any repetitive loss properties in Keokuk County Iowa (NFIP, 2024)

Vulnerability and Impacts

All jurisdictions are subject to Flood of some type: SFHA Flood zones, Flash Floods or Shallow flow (Stormwater).

Flood: Affected Jurisdictions			
X	Delta	X	Richland
X	Gibson	X	Sigourney
X	Harper	X	South English
X	Hayesville	X	Thornburg
X	Hedrick	X	Webster
X	Keota	X	What Cheer
X	Keswick	X	Sigourney CSD
X	Kinross	X	Keota CSD
X	Martinsburg	X	Tri-County CSD
X	Ollie	X	Keokuk County (Unincorporated)

FLOOD	
Keokuk County	
Vulnerability	Floods affect properties near the rivers and streams of Keokuk County
Impact	Floods increase the amount of agricultural chemicals that are washed into streams
Impact	Negative impacts on water quality and wildlife health
Impact	Increased water volume and intense currents cause erosion
Vulnerability	Conditions on North and South Skunk Rivers such as strong currents, flooding, and log jams present a danger to people engaging in water recreation
Impacts	Inexperienced people may get into situations on local rivers where cell service is not consistent to call for help
SFHAs	NFIP Participating: Keokuk County, Kinross, Sigourney, What Cheer and Webster participates even though they are not in a SFHA
Vulnerability	Not NFIP Participating: Delta, Harper, Hayesville, Hedrick, Keota, Keswick, Martinsburg, Ollie, Richland, South English
Impact	Property owners in cities with flood hazard areas that do not participate in the NFIP do not have to opportunity to purchase flood insurance or receive federally backed mortgage loans
Stormwater All Jurisdictions	See Appendix C for more information about stormwater management
Vulnerability	Stormwater may overwhelm drainage capacity during heavy rains
Impact	Flooded streets place drivers and pedestrians at risk
Vulnerability	Basements and other property are flooded during heavy rain events
Impact	Wet basements, damaged foundations, ruined household property and mold
Vulnerability	Stormwater can overwhelm drainage systems and interact with structures. This can happen almost anywhere for a variety of reasons. Therefore, we cannot include statistics for surface flow in flood data, but we do address the problem in the Mitigation Action Plan.
Impact	Typical impacts range from flooded roads to water backing up into homes or basements, damage to mechanical systems, other property and mold growth
Impact	Damage to property from both moisture and mold
Impact	Soil erosion and the pressure of expansive soils on foundations and slabs
Impact	Runoff that occurs on the ground surface before reaching a channel can be a nonpoint source of pollution, as it can carry human-made contaminants or natural forms of pollution (such as rotting leaves). Human-made contaminants in runoff include petroleum, pesticides, fertilizers, manure and other contaminants
Impact	Water pollution from agricultural chemicals is exacerbated by surface runoff, leading to a number of downstream impacts, including nutrient pollution that causes eutrophication
Impact	Surface runoff is the primary agent of soil erosion by water.

Impacts of Climate trends.

From the US EPA Publication on Climate change in Iowa: During the next century, spring rainfall and average precipitation are likely to increase, and severe rainstorms are likely to intensify. Each of these factors will tend to further increase the risk of flooding. Summer droughts are likely to become more severe, floods may also intensify (EPA, 2016).

Land use development. New development should occur well outside the base flood areas whenever possible. Natural systems should be supported and best practices for stormwater management should be applied to new and rehabilitated development sites.

Population patterns. Population growth should be directed to higher ground, while population decrease may provide opportunities to acquire and demolish structures vulnerable to flood.

Hail

Hail is a form of precipitation associated with thunderstorms 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.

As described by the Department of Atmospheric Sciences at the University of Illinois, hail is produced by intense thunderstorms where snow and rain can coexist in the central updraft. "As snowflakes fall, liquid rain freezes to them forming ice pellets that continue to grow as more and more drops are accumulated.

Upon reaching the bottom of the cloud, some of the ice pellets are carried by the updraft back to the top of the storm. As the ice pellets once again fall through the cloud, another layer of ice is added, and the hail stone grows larger. Once a hail stone becomes too heavy to be supported by the updraft, it falls to the earth."

HAIL DIAMETER SCALE	
Diameter (Inches)	Description
1/4"	Pea
1/2"	Marble
3/4"	Penny
7/8"	Nickel
1"	Quarter
1 1/4"	Half Dollar
1 1/2"	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

Location

Hail affects all locations in the planning area.

Affected Jurisdictions County, Cities, Schools

Extent

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

The severity of damage caused by hail varies with the hailstone size, number of hailstones by area, and associated winds. Another factor that affects the amount of damage that results from hail is the speed at which it falls. Velocity is affected by the height of a falling object due to the constant acceleration of gravity.

According to NOAA, 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), 2 inch hailstones falling at 60 mph certainly have the potential to cause serious damage or injury.

Keokuk County
2014-2023 Hail record

Hail Size (Inches)	Number of events
0.75	1
0.88	1
1	9
1.25	2
1.5	0
1.75	3
Total	**16**

Previous Occurrences

The NOAA Storm Database records hail events when hailstones are .75 inches (penny size) or greater. There were 16 such hail events recorded by NOAA during the 10 year period January 2014 through December 2023.

Two storms produced hail about penny or nickel size. During eleven events, hail was between the size of a quarter and half dollar. Three storms delivered hail of golf ball size.

Probability of Hail

Hail over .75 inches in size typically falls in the planning area more than once a year. The probability of a damaging hail event is greater than 100%; probability is Very likely.

Climate Trends

Some of Iowa's natural hazards are expected to increase in frequency and intensity. The atmosphere acts like a sponge, and the warmer it is, the bigger it gets and the more moisture it can hold. The atmosphere's ability to hold more moisture also means that it takes more moisture to cause a precipitation event, which in turn means that the time between events is increased, and the potential for high-intensity precipitation is increased (Iowa, 2023). Because of the way hail is formed, higher intensity storms can be expected to produce large hail.

Vulnerability and Impacts

Hail: Affected Jurisdictions			
X	Delta	X	Richland
X	Gibson	X	Sigourney
X	Harper	X	South English
X	Hayesville	X	Thornburg
X	Hedrick	X	Webster
X	Keota	X	What Cheer
X	Keswick	X	Sigourney CSD

X	Kinross	X	Keota CSD
X	Martinsburg	X	Tri-County CSD
X	Ollie	X	Keokuk County (Unincorporated)

Vulnerability is consistent across jurisdictions since hail occurs in random locations, and while most storms create relatively narrow paths of destruction, all geographic locations in the county are equally at risk.

Impacts Injury to people or animals, damage to crops and structures varies with the size and velocity of hailstones and the duration of the event. Large hail poses a threat to people caught outside in a storm, but it seldom causes the loss of human life. No personal injuries are recorded in the Storm Data record (Storm, 2023).

Hail damage is the most severe in storms that produce high winds in addition to large hail, as winds blow hailstones into windows and siding that would not be impacted otherwise

HAIL	
All Jurisdictions	
Vulnerability	Due to the random nature of this event, Keokuk County, its communities, and its schools are all vulnerable to possible injuries and property losses due to hail.
Impact	Hail damage to buildings includes roof damage, broken windows and damaged siding. Accessories attached to the exterior of buildings such as antennas, lights, HVAC equipment and other fixtures are impacted by hail.
Keokuk County	
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 or the type and age of roof
Impact	Roofs, siding and windows on residential and business are damaged
Impact	The cost of damages to agriculture, buildings, vehicles and infrastructure must be borne by owners or insurance companies.
Vulnerability	Personal vehicles, farm equipment and larger trucks are often stored outdoors
Impact	Damage to vehicles ranges from minor dents to total loss of value
Vulnerability	Hail events cause crop damage that ranges from minor to total loss
Impact	The economic impacts of crop loss affect family quality of life and reduces tax revenues for local services
Impact	Crops are at greater risk during early spring and late fall when the peak period for hailstorms coincides with critical agricultural seasons.
Vulnerability	Livestock frequently graze open land, away from roofed structures
Impact	Unsheltered livestock are stressed or injured
Vulnerability	Economic loss in is not limited to direct damages
Impact	Other economic losses include jobs, income and tax revenue. Disruption of the economic purpose of affected structures is a cost which may be difficult to quantify and absorb
Vulnerability	Infrastructure such as electrical power lines, transformers and associated equipment is exposed to the weather
Impact	Utility equipment is damaged by large hail, causing loss of power

City jurisdictions	
Vulnerability	Personal vehicles, equipment, trucks and RVs are often stored outdoors
Impact	Damage to vehicles ranges from minor damage to total loss of value
Vulnerability	Municipal utility services such as electric power and communication systems vulnerable to hail are exposed to weather
Impact	Large hail can impact trees and power lines. Damage to electrical infrastructure from tree damage and hail causes loss of power, and secondary effects such as impaired emergency communication and failure of home medical equipment
City of Delta, Thornburg, Hayesville	
Vulnerability	Of 156 homes in Delta, Median housing value is $40,700 and 64% of homes were built before 1940
Vulnerability	Of the 31 homes in Thornburg, Median housing value is $22,500 and 84% of the homes were built before 1940
Vulnerability	The poverty rate in Hayesville is 35%. Almost 60% of housing was built before 1940
Impact	Low value homes may suffer from deferred maintenance and be more vulnerable to the impacts of hail
Impact	Lower income households may not be able to maintain structures in good repair or purchase better quality materials. Older or poor quality roofing and siding is more easily damaged by hail
School Districts	
Vulnerability	Buildings, buses and other vehicles, equipment and other outdoor structures are exposed to the weather
Impact	Hail damages roofs, siding, windows and appurtenances, vehicles stored outside. Light fixtures and scoreboards on athletic fields are damaged by hail
Vulnerability	Outdoor activities and sports events draw large crowds
Impact	People who are caught outdoors in a hail event may be injured
Vulnerability	Hail damage to utility structures causes power loss
Impact	Power loss can result in a total loss of refrigerated food in school kitchens

Impacts of Climate trends. Frequency of hail events may be reduced. Storm severity is expected to increase, which can be expected to increase the size and quantity of hailstones that may be created by strong upper level winds.

Land use development. Changing Land use or Incidence of Hail are not expected to influence each other.

Population patterns. This hazard is unlikely to be affected by population patterns.

High wind

High winds in Keokuk County can result from strong cold front passages, gradient winds between high and low pressure, thunderstorms or tornados. High winds are referred to as "straight-line" winds to differentiate the damage they cause from the rotating winds of tornados.

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. Iowa is in the path of powerful cold fronts traveling down from Canada or the Rocky Mountains which collide with warm, moist air from the Gulf of Mexico. Average wind speed in Keokuk County is estimated to be about 9 mph (IA Meso, 2023)

Affected Jurisdictions County, Cities, Schools

Extent

The Planning Area uses the Beaufort Wind Scale to categorize High Wind. The planning area can expect any range on the Beaufort scale from 0 – 12.

Beaufort Number	MPH		Terminology	Description
	Range	Average		
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. Can 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.

Previous Occurrences; High winds

The NOAA Storm Events Database is a primary source of weather records for the nation. From January 2014 through December 2023, nineteen thunderstorms occurred, eighteen of which had wind speeds of 50 mph or more. Eight of these were "Severe," having speeds of 58 mph or more (Level 10).

Thunderstorm: High wind	
"Severe" = 58+ mph	
4/12/2014	78
4/27/2014	78
3/6/2017	65
7/19/2018	61
8/28/2018	60
6/28/2019	65
5/14/2020	70
8/26/2021	65

Probability; High winds

Eight severe wind events were recorded during the study period, 8/10 years = the probability for damaging high winds is 80%, Likely.

Climate trends

Temperature differentials drive winds. Wind patterns across the North American Continent may shift in ways not yet fully understood. Changes in temperature from one region to the next can be expected to have a dramatic influence on the direction and intensity of winds.

- ✓ Earth's average global temperature is rising, but the amount of warming is not equal in all areas of the world
- ✓ At high latitudes, especially in and near the Arctic, temperatures are warming faster than places closer to the equator. The Arctic is heating up about twice as quickly as the global average
- ✓ As the climate warms, the ocean is expected to warm more slowly than land because it takes much more heat to warm water than air and land. The air right above ocean water are expected to warm more slowly than land too
- ✓ In general, the middles of continents are expected to warm more than coastal areas. Regional topography will influence this too (NSF NCAR, 2023)

JET STREAM WINDS WILL ACCELERATE WITH WARMING CLIMATE

New research by the University of Chicago and the U.S. National Science Foundation National Center for Atmospheric Research (NSF NCAR) finds that fast jet stream winds will get significantly faster by mid-century because of climate change.

The study, in Nature Climate Change, suggests that the fastest upper-level jet stream winds will accelerate by about 2% for every degree Celsius (1.8° Fahrenheit) that the world warms. Furthermore, the fastest winds will speed up 2.5 times faster than the average wind.

Jet stream winds are powerful and narrow bands in the upper atmosphere that generally move from west to east, influencing weather patterns . . . Faster winds would likely increase the potential for severe weather.

Jet streams form because of the contrast between the cold, dense air at the poles and the warm, light air in the tropics, in combination with the rotation of the Earth. The new study, by University of Chicago Professor Tiffany Shaw and NSF NCAR scientist Osamu Miyawaki, uses climate models to show that climate change intensifies this density contrast because moisture levels for air above the tropics will increase more than above the poles.

"This may have implications for air travel," Miyawaki said. "The faster the jet stream winds, the more severe the impacts on turbulence. The faster winds may also lead to conditions that are favorable for stronger and more prolonged storms" (NSF NCAR, 2023).

From the 2023 Iowa State Hazard Mitigation Plan:

"The 2017 U.S. Climate Science Report notes that in a higher greenhouse gas (GHG) concentration scenario, within 80 years we would likely see average global temperatures at least 5°F warmer than the averages of the first half of the 20th century. Furthermore, even if the currently increasing rate of GHG concentrations begins decreasing significantly by 2050, we can expect average temperatures at least 2.4°F and as much as 5.9°F warmer. It is not, however, the average that affects us most, but the extremes. Weather extremes have already begun to worsen and are expected to continue" (Iowa, 2023).

Vulnerability and Impacts

High Winds: Affected Jurisdictions			
X	Delta	X	Richland
X	Gibson	X	Sigourney
X	Harper	X	South English
X	Hayesville	X	Thornburg
X	Hedrick	X	Webster
X	Keota	X	What Cheer
X	Keswick	X	Sigourney CSD
X	Kinross	X	Keota CSD
X	Martinsburg	X	Tri-County CSD
X	Ollie	X	Keokuk County (Unincorporated)

Severe storms cause a significant amount of tree damage. The number of trees damaged, and total cost of damages is difficult to quantify because it is impractical to track local tree damage among private landowners, professional tree service companies, municipal clean-up crews and utility companies. The State does have the ability to interpolate loss estimates, which are reported through the Iowa DNR.

For example, according to the Iowa DNR, the state lost an estimated 7.2 million trees in cities and farms when a hurricane-force derecho struck the state on August 10, 2020. The state estimates the costs to Iowa at $20 million annually, with lost trees no longer able to capture and store carbon that contributes to climate change, reduce air pollution, and provide windbreaks and shade that cut energy use (Eller D. , Iowa DNR survey, 2021). Additional costs include tree removal, disposal, and replacement.

HIGH WIND	
All Jurisdictions	
Vulnerability	Buildings, especially roofs are vulnerable to the effects of high wind. Depending on wind speed and direction, debris of various weight and material is torn apart and carried aloft
Impact	People, livestock, vehicles and structures are impacted by airborne debris
Impact	Wind-blown debris causes injury and property damage. Windows are broken. Eye injuries occur from debris in the air
Vulnerability	Utility infrastructure: above ground power lines and poles are vulnerable to high wind. Trees are uprooted or broken; limbs take down utility lines
Impact	Power outages cause secondary impacts such as endangering the health of people who may be dependent on power for home medical devices or refrigeration of insulin

Impact	When electrical lines fall, it may be necessary to close roads until power companies can ensure public safety
Keokuk County	
Vulnerability	Semi-trucks and other high profile vehicles travel local highways
Impact	Sustained winds of 30 mph or gusts of 45 mph or more 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
County Conservation	
Vulnerability	Derecho & high winds/storm events cause tree damage
Impact	Tree debris in and around the lake creates hazardous conditions for boaters
Impact	Downed limbs and trees block trails and driving paths
County and Cities	
Vulnerability	There are 165 mobile homes throughout the county. Mobile homes are less resilient to the effects of high winds than traditional homes, especially those built prior to modern standards
Impact	People living in mobile homes are at risk of personal injury from damaging high wind events when alternative shelter is not readily available
Vulnerability	RVs and campers are commonly in use and are vulnerable to damage or being blown over with sustained winds of 30 mph or gusts of 45 mph
Impact	People living or travelling in RVs and campers may be injured when alternative shelter is not readily available
Vulnerability	RVs are stored outdoors on residential lots throughout the county
Impact	Lightweight, high profile vehicles may be blown over or impacted by debris
Vulnerability	Wind delivers additional oxygen to fires and it also lays over the flames toward the fire front
Impact	Wind increases fire intensity by pre-heating and drying the fuel ahead of the fire
Vulnerability	Wind carries sparks and embers ahead of the main fire, causing spot fires
Impact	Sparks become wildfires very quickly
Vulnerability	Residential, commercial and governmental buildings and utility infrastructure are exposed to damaging wind events.
Impact	Roofs, siding and appurtenances attached to walls or roofs can become detached, causing damage and debris
Vulnerability	Where vacant lots are unkempt, some of the trees that grow are less resilient species such as cottonwood, mulberry or poplar and are less likely to be trimmed or maintained
Impact	Uprooted trees or broken limbs pull down power lines, damage adjacent structures and block streets. On neglected lots, they become a nuisance and a fire hazard
City of Sigourney and Lake Belva Deer	
Vulnerability	There are RV parks in Sigourney, and at Lake Belva Deer
Impact	RV's and campers are blown over and damaged by windblown debris

Keota, Sigourney and Tri-County School Districts	
Vulnerability	The schools are dependent on the power grid. These systems use above-ground power lines, which are susceptible to high wind damage
Impact	Power outages interrupt school operations and can result in a loss of refrigerated food
Vulnerability	High winds can move high profile vehicles such as school buses
Impact	High winds create dangerous conditions for transport of students

Impacts of Climate trends. Changing wind patterns and increased temperature differences among regions are likely to increase the occurrence of high wind events in coming decades.

Land use development. This hazard is unlikely to be affected by Land use development in the foreseeable future.

Population patterns. Population patterns and high winds are unlikely to have any impact on each other in Keokuk County.

Lightning

The National Weather Service defines a thunderstorm as "a rain-bearing cloud that produces lightning." 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. As lightning passes through the atmosphere, the air immediately surrounding it is heated, causing the air to expand rapidly, producing a sound wave we hear as thunder.

All thunderstorms are dangerous. In the United States, an average of 300 people are injured and 80 people are killed each year by lightning (NWS, 2021).

Positive, negative lightning. Lightning is formed by the separation of positive and negative charges that occur when ice crystals collide high up in a thunderstorm cloud. According to the National Weather Service (NWS), 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 lightning makes up less than 5% of all strikes. However, despite a significantly lower rate of occurrence, positive lightning is particularly dangerous for several reasons.
>
> Since it originates in the upper levels of a storm, the amount of air it must burn through to reach the ground is usually much greater. Therefore, electric fields associated with positive Cloud-to-Ground (CG) strikes are typically much stronger than those associated with negative strikes. The flash duration is also longer with peak charge and potential up to ten times greater as compared to negative CG strikes; as much as 300,000 amperes and one billion volts . . . Also, positive flashes are believed to be responsible for a large percentage of forest fires and power line damage. Thus,

positive lightning is much more lethal and causes greater damage than negative lightning (NWS, 2021).

Location

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

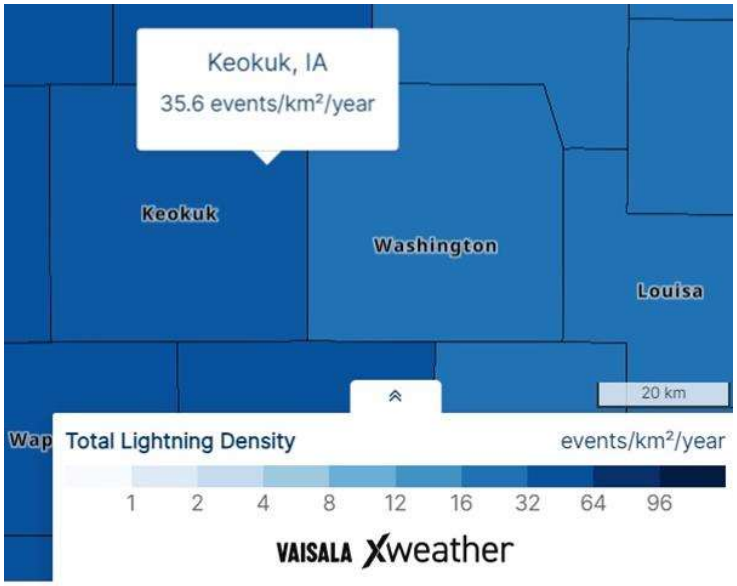
Affected Jurisdictions County, Cities, Schools

Extent

The planning area uses the Lightning Activity Level Scale (LAL Scale) to categorize lightning extent. Any level on the LAL Scale can be expected to occur.

Lightning Activity Level (LAL)	
A scale which describes lightning activity. Values are labeled 1-6:	
LAL 1	No thunderstorms
LAL 2	Isolated thunderstorms. Light rain will occasionally reach the ground. Lightning is very infrequent, 1 to 5 cloud-to-ground strikes in a five minute period.
LAL 3	Widely scattered thunderstorms. Light to moderate rain will reach the ground. Lightning is infrequent, 6 to 10 cloud-to-ground strikes in a 5 minute period.
LAL 4	Scattered thunderstorms. Moderate rain is commonly produced Lightning is frequent, 11 to 15 cloud-to-ground to ground strikes in a 5 minute period.
LAL 5	Numerous thunderstorms. Rainfall is moderate to heavy. Lightning is frequent and intense, greater than 15 cloud-to-ground strikes in a 5 minute period.
LAL 6	Dry lightning (same as LAL 3 but without rain). This type of lightning has the potential for extreme fire activity and is normally highlighted in fire weather forecasts with a Red Flag Warning.

Dry lightning. As noted in the scale above, Lightning Activity Level 6, lightning often occurs in apparently dry conditions. Lightning often strikes outside of the rain in a thunderstorm and may occur as far as 10 miles away from any rainfall. A "dry" thunderstorm is a thunderstorm that produces thunder and lightning, but where most of the precipitation evaporates before reaching the ground. *Lightning density.* Vaisala is a company that has become a leading resource for lightning data, tracking lightning density across the globe. Density is the number of lightning strikes or flashes per chosen spatial area (e.g. km²) and time interval. Vaisala has produced an interactive map that shows

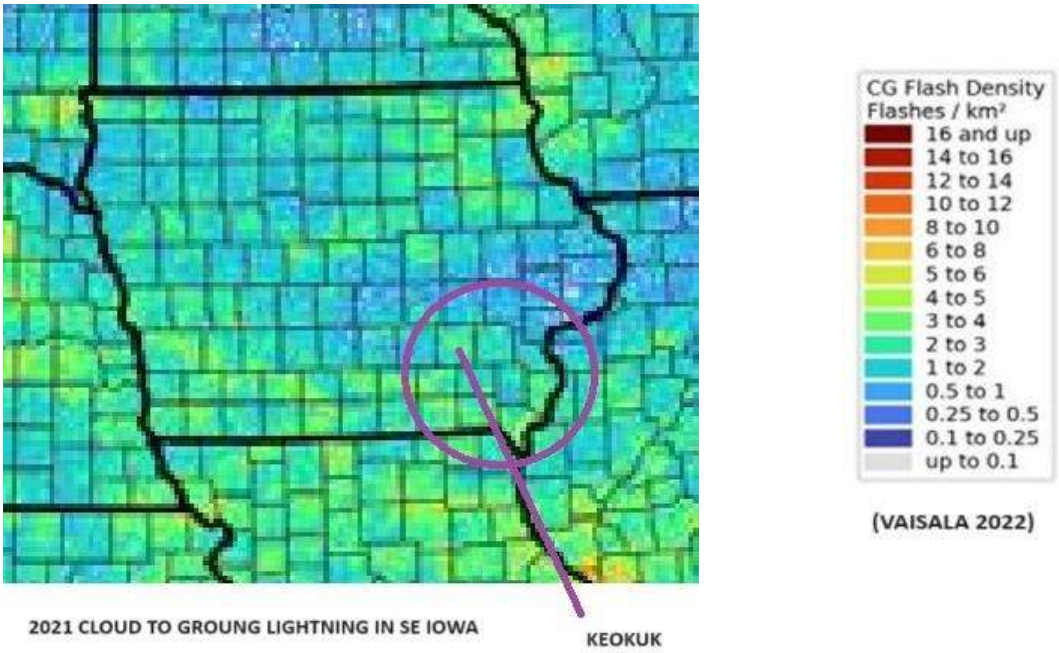


https://interactive-lightning-map.vaisala.com/

yearly lightning density data, averaged from 2016 to 2022.

According to this data, Keokuk County averages about 36 lightning flashes per square kilometer each year (Vaisala, 2022). The U.S. Census Bureau estimates the county has a total area of 580 square miles (1,500 km2). That data includes all flashes, including cloud to cloud lightning and cloud-to-ground strikes.

Cloud to Ground Lightning Strikes. Vaisala estimates cloud-to-ground strikes in southeast Iowa to be about 1 to 4 strikes per square kilometer per year. Therefore, several thousand cloud-to-ground strikes can be expected to occur each year.



2021 CLOUD TO GROUNG LIGHTNING IN SE IOWA

Previous Occurrences

For the period January 2014 through December 2023, there were 19 Thunderstorms recorded in the NOAA storm data record. Many more thunderstorms occur that do not meet the criteria to be included in the database.

During the study period, there are anecdotal reports of lightning events which have damaged structures, electrical wiring or caused loss of power. There is no method of tracking or reporting known or suspected lightning damage to private property. Participating Jurisdictions report that no damages have been attributed to lightning strikes on public buildings during the study period.

Probability

All thunderstorms produce lightning (NWS, 2021). The actual number of cloud-to-ground lightning strikes is undetermined, however known strikes exceed 10 events over a ten year period. 10/10 = greater than 100%; probability that dangerous Lightning will occur is Very likely.

Climate trends

Expected increase in Thunderstorm intensity will likely increase the incidence of cloud-to-ground lightning per storm. Reduced frequency of storms can be expected to reduce lightning density.

Vulnerability and Impacts

Lightning: Affected Jurisdictions			
X	Delta	X	Richland
X	Gibson	X	Sigourney
X	Harper	X	South English
X	Hayesville	X	Thornburg
X	Hedrick	X	Webster
X	Keota	X	What Cheer
X	Keswick	X	Sigourney CSD
X	Kinross	X	Keota CSD
X	Martinsburg	X	Tri-County CSD
X	Ollie	X	Keokuk County (Unincorporated)

From the National Weather Service: Facts About Lightning

- Lightning's unpredictability increases the risk to individuals and property.
- Lightning often strikes outside of the heavy rain in the thunderstorm and may occur as far as 10 miles away from any rainfall.
- "Heat lightning" is actually lightning from a thunderstorm too far away for thunder to be heard. However, the storm may be moving in your direction
- Most lightning deaths and injuries occur when people are caught outdoors in the summer months during the afternoon and evening.
- The chance of being struck by lightning is estimated to be 1 in 600,000 but could be reduced by following safety precautions (NWS, 2023).

LIGHTNING	
Unincorporated Keokuk County	
Vulnerability	Keokuk County is a rural 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
Impact	People and livestock who are caught outside during a thunderstorm—particularly those on hills, under trees, in open areas, or on the water—are at higher risk from lightning
Impact	People or animals struck by lightning need immediate lifesaving medical attention; the low density of the rural population means that emergency responders may have to travel some distance in response to life-threatening events
Vulnerability	Lightning suppression devices are not installed on all county owned buildings. Many privately owned buildings are not equipped with lightning suppression devices.
Impact	Unprotected combustible structures ignite when struck by lightning
All Jurisdictions	
Vulnerability	Periods of drought are very likely to occur; dry conditions intensify the dangers of lightning strikes
Impact	Lightning strikes start fires more readily during drought conditions when any spark can ignite ready tinder

Vulnerability	Most residential, commercial and municipal structures lack lightning suppression devices
Impact	Electronics inside buildings can be destroyed by the power surge of a lightning strike passing through the electrical grid, which can disable critical communication systems
Vulnerability	Utility infrastructure is exposed to weather and components are vulnerable to lightning damage, particularly electrical transformers or substations
Impact	Power loss puts the health of individuals at risk when home medical equipment is reliant on electricity or extreme temperatures threaten health
Cities of Keota, Richland, Sigourney, Webster	
Vulnerability	These cities are dependent on municipal water wells
Impact	Lightning strikes or power failure can disable well pumps and interrupt service

Impacts of Climate trends. Frequency of thunderstorms may be reduced while storm severity is expected to increase, which will likely increase the frequency and severity of lightning incidents.

Land use development. Property owners and developers should be aware of the risk and install proper lightning protection devices when performing major rehabilitation or new construction.

Population patterns. Additional population does put more people at risk. This hazard is unlikely to be affected by population patterns in Keokuk County in the near future.

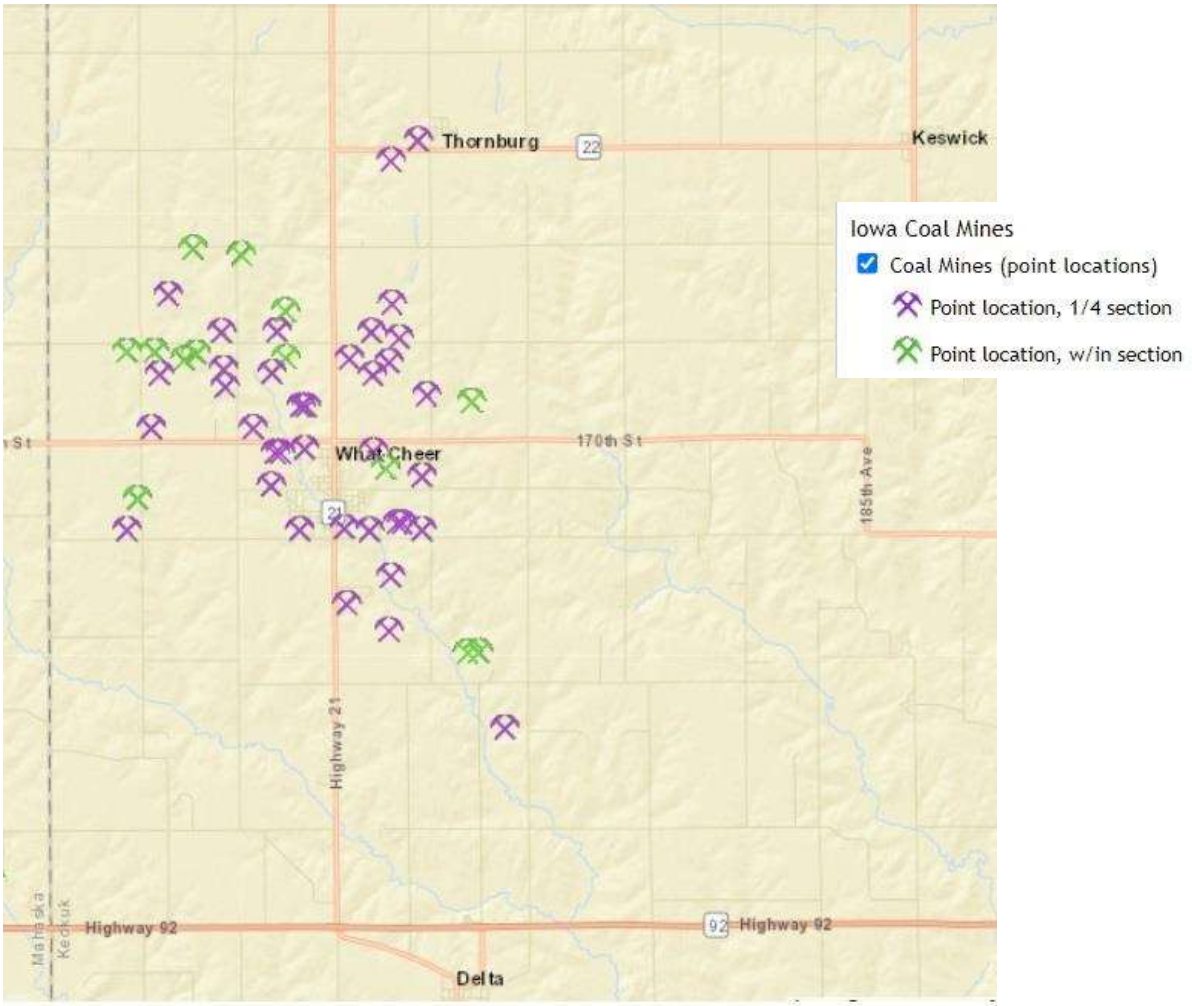
Sinkholes

From the 2023 Iowa State Hazard Mitigation Plan:

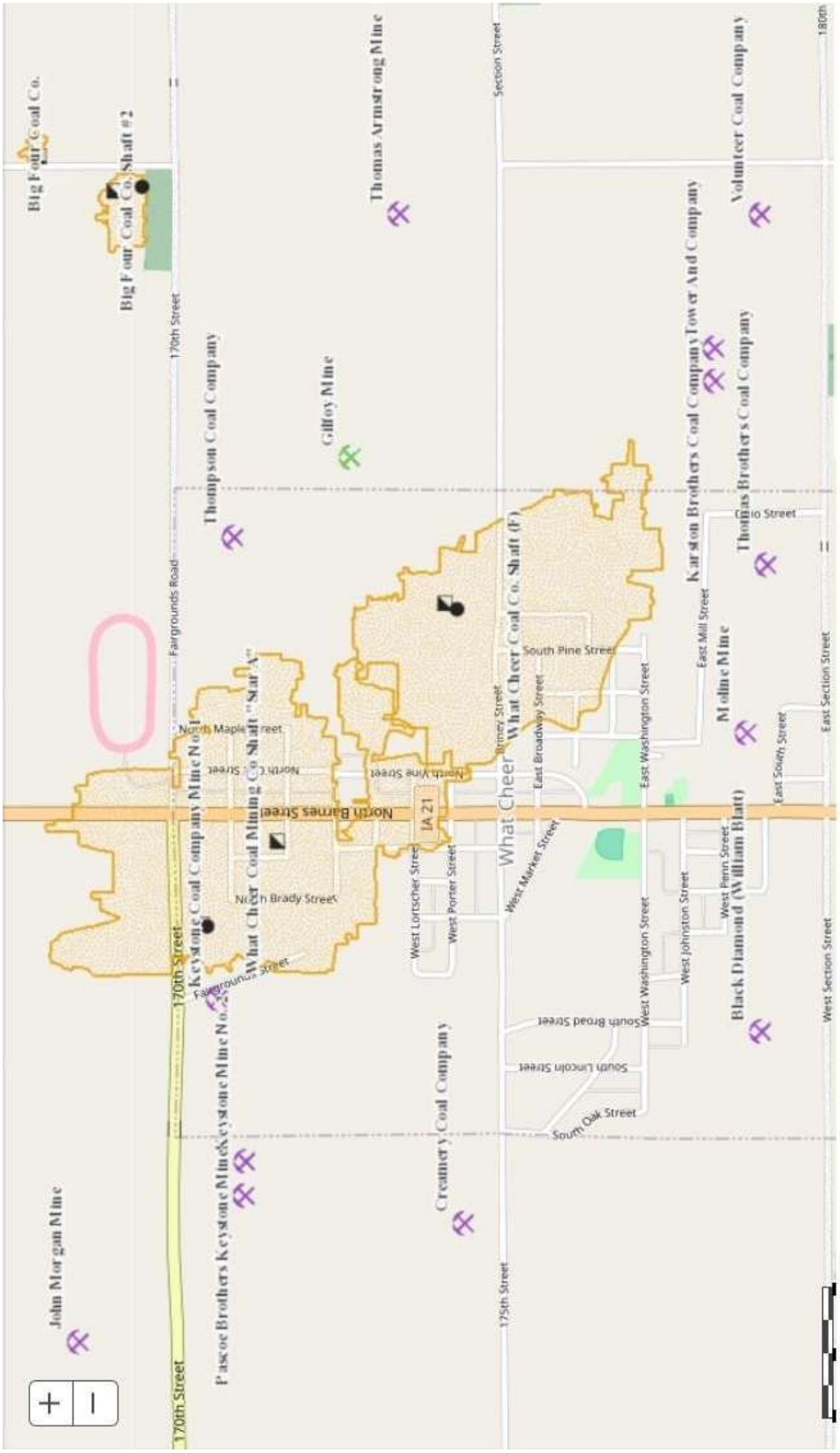
> Sinkholes are common where the rock below the land surface is limestone, carbonate rock, salt beds, or rocks that can naturally be dissolved by ground water circulating through them. As the rock dissolves, spaces and caverns develop underground. The sudden collapse of the land surface can be dramatic and range in size from broad, regional lowering of the land surface to localized collapse. The primary causes of most subsidence are human activities: underground mining of coal, groundwater or petroleum withdrawal, and drainage of organic soils. In addition, sinkholes can develop as a result of subsurface void spaces created over time due to the erosion of subsurface limestone (karst). Land subsidence occurs slowly and continuously over time or on occasion abruptly, as in the sudden formation of sinkholes. (Iowa, 2023).

While carbonate soils are present, the risk for sinkholes in western Keokuk County is primarily a result of Coal Mining activity in the early 1900's. In neighboring counties, such as Marion County and Polk County, some recent sinkholes are also associated with historic limestone mines.

Location



Known coal mine Locations near What Cheer in western Keokuk County (iowa DNR)



Historic Coal Mines within the City of What Cheer

(https://programs.iowadnr.gov/maps/coalmines/)

Coal Mines

Coal Mine Entrances

- Air shaft
- Air slope
- Escape shaft
- Escape way
- Hoisting shaft
- Slope, adit

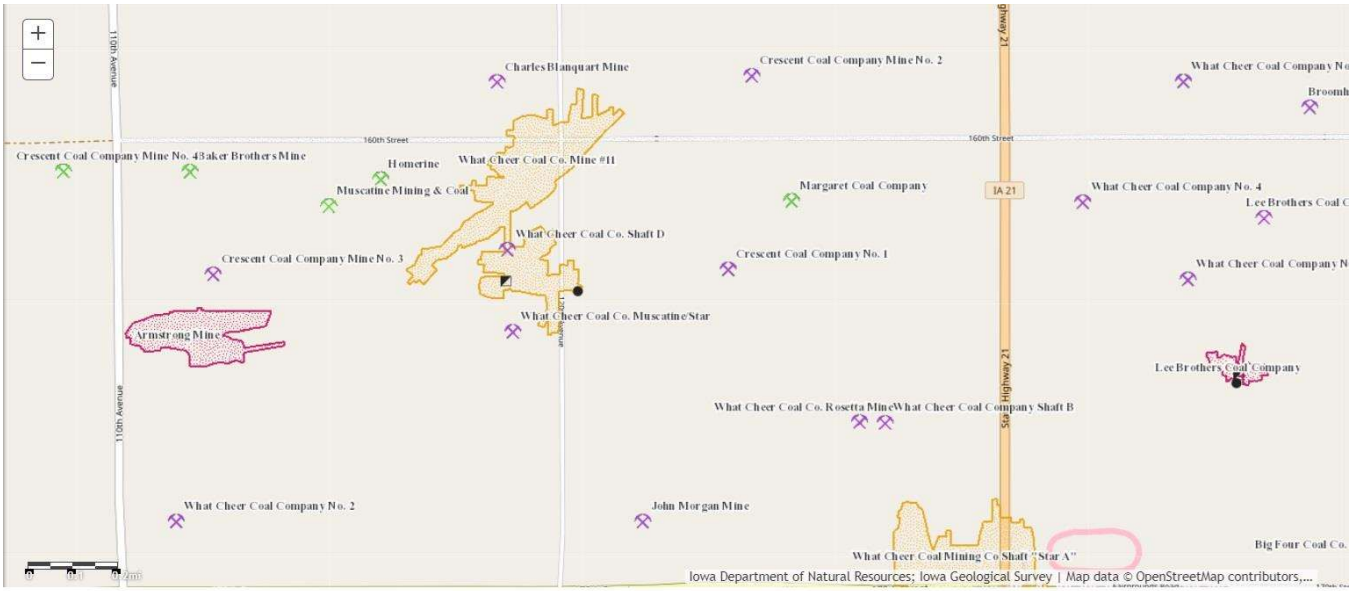
Coal Mines (point locations)

- Point location, 1/4 section
- Point location, w/in section

Coal Mines (known/approx. extent)

- Surveyed map, known loc'n and extent
- No map, approx. extent, known loc'n
- Surveyed map, loc'n known to section, known extent
- Surface mine

Coal Mines near Thornburg https://programs.iowadnr.gov/maps/coalmines/



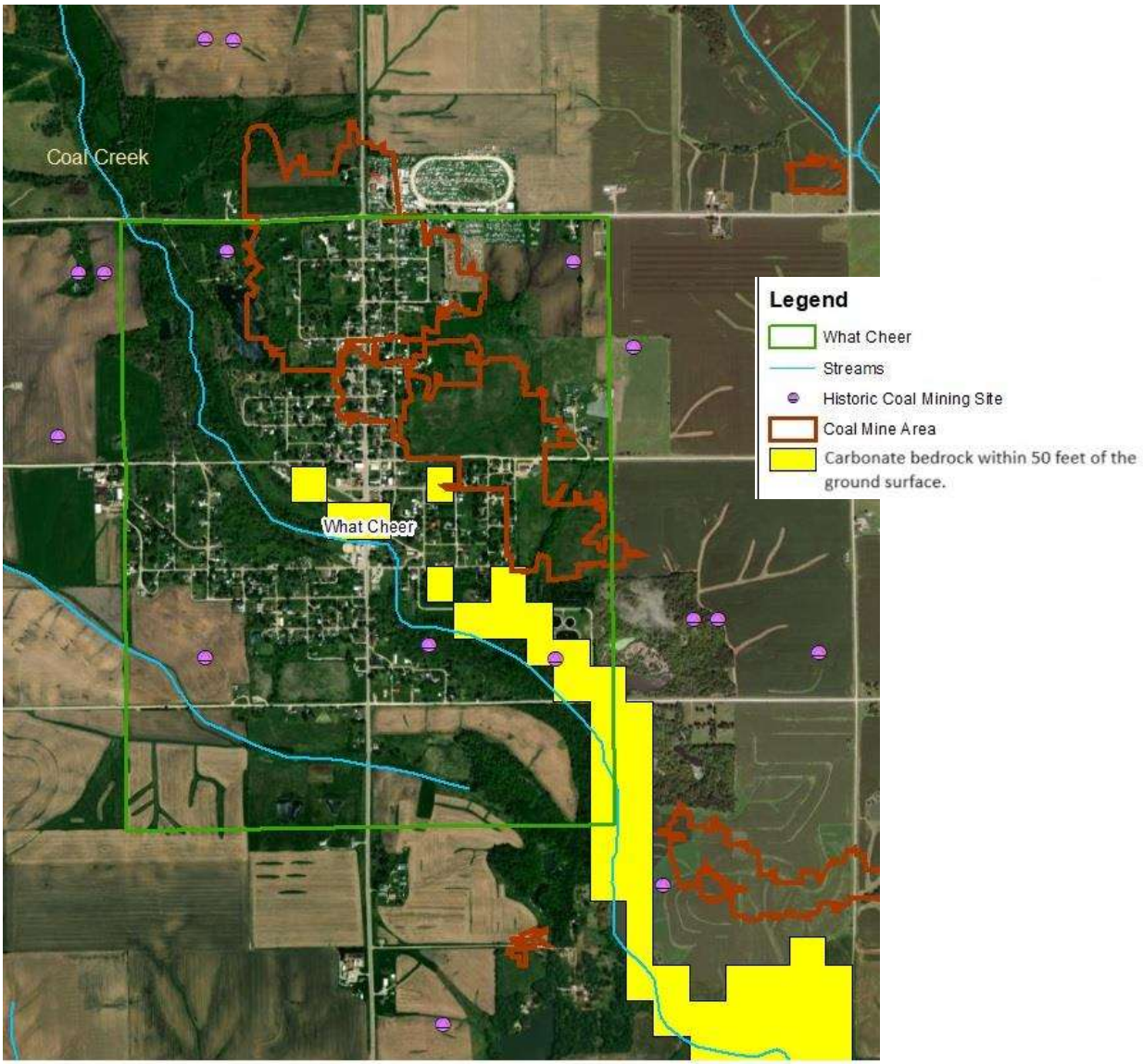
Other Keokuk County Historic Mines

Extent

From the Iowa State Hazard Mitigation Plan 2023:

> On April 14, 2016 the Des Moines Register reported that a geologist with the Iowa Geological Survey (IGS) said that collapsing mines are typically the culprit with sinkholes in central Iowa. When mine shafts are covered by firm bedrock, mine shaft cave-ins have little impact on the surface. But, if shafts are closer to the surface with inadequate bedrock above and mines are relying on old support beams, then the deterioration and failure of such beams can result in a sinkhole at the surface that causes problems. According to the IGS geologist, there is no reason for panic, but abandoned mines are an important consideration for residents and developers (Iowa, 2023).

Keokuk County is considered a low karst area according to Iowa Department of Natural Resources, sinkholes have not occurred but are possible. According to data mapped by Iowa DNR, the location of Karst does not typically overlap with known historic mining activity in this area.



MAP OF SINKHOLE POTENTIAL, WHAT CHEER IOWA grthomas 2024

Previous occurrences

There have been no reported occurrences of major sinkholes or mine subsidence in Keokuk County according to the Iowa DNR and the planning team. However, due to historic mining activity and the presence of karst, there is a known risk from this hazard.

Probability

Although no reported events have occurred, there is a chance that a sinkhole could occur in the future. The presence of karst geology and abandoned mines indicates that this hazard may place property at risk. Zero events between 2014 and 2023 (0/10 years) = Less than 10% probability; Unlikely to occur in any given year.

Climate trends

The impact of climate change on sinkholes can be dependent on soil types. Calcareous soils such as sandstone, chalk, gypsum, or limestone are highly porous and easily erode during extreme groundwater saturation that occurs after heavy rainfall. Higher rainfall rates that are expected with climate change cause extreme groundwater saturation and may lead to more sinkholes in these soil types.

Additional precipitation would accelerate the erosion of substrate and increase the probability that a sinkhole could occur.

Flood Increasing. Precipitation is expected to increase in intensity, though not necessarily frequency. With average annual precipitation increasing 1" to 4" by 2050, heavy precipitation events are likely to become more common. Eastern Iowa is seeing a greater increase in precipitation than western Iowa, which indicates a likelihood of more flooding in eastern Iowa (Iowa, 2023).

Vulnerability and Impacts

Sinkholes: Affected Jurisdictions			
	Delta		Richland
	Gibson		Sigourney
	Harper		South English
	Hayesville		Thornburg
	Hedrick		Webster
	Keota	X	What Cheer
	Keswick		Sigourney CSD
	Kinross		Keota CSD
	Martinsburg		Tri-County CSD
	Ollie	X	Keokuk County (Unincorporated)

Sinkholes have the capability to impact crop land, buildings, roadways and power lines. Loss of function may occur until structures are repaired and stabilized. Pipelines could be impacted, but Keokuk County pipelines do not overlie historic mining areas.

With no reported sinkholes in county history, any that do occur in the next five years are expected to have minimal economic impacts. The primary economic concern is that property damage caused by sinkhole events may be excluded from standard insurance policies.

Sinkholes are a risk to Keokuk County and the What Cheer area.

- ✓ Sinkholes can be aggravated by flooding.
- ✓ Any sinkhole that may occur would likely be isolated to a small area on a single property.

- ✓ As sinkholes sometimes allow surface runoff to directly enter bedrock aquifers, their presence has implications for groundwater quality (IGS, 2024).

There are identified and unidentified abandoned mines in the western part of the county that could potentially cause problems. Sinkholes pose structural risks to buildings as well as roads and infrastructure. There has been no recent property development in the area near these mines.

According to Bankrate Insurance, "When the ground below the land surface becomes eroded with water, this can cause a sudden collapse between one and one hundred feet deep. Whether the damage is minimal or causes a total collapse of a home, homeowners' insurance typically does not cover sinkhole loss unless a sinkhole endorsement is purchased" (Martin, 2024)

Sinkholes	
Unincorporated Keokuk Co and City of What Cheer	
Vulnerability	The hazard of sinkholes is present in western Keokuk County due to historic mining activity
Impact	Problems that arise from sinkholes include damage to crop land, buildings, roads and utilities
Vulnerability	Power can be lost if power poles are moved during a sinkhole event, causing electric power loss, interruption of potable water and wastewater delivery
Impact	There may be the potential for a limited interruption of essential facilities and services
Vulnerability	Homeowners insurance typically does not cover sinkhole loss unless a sinkhole endorsement is purchased
Impact	Property owners may be surprised to find that their property is not covered for sinkhole events
City of What Cheer	
Vulnerability	The most likely cause of a sinkhole in What Cheer would be associated with water flow from the surface into karst or old mines.
Impact	A water main break or a broken storm sewer that has allowed water to flow beneath the surface of the ground may erode the substrate.
Vulnerability	Over time, any water flow will intensify the weakness of substrate and lead to surface collapse into voids
Impact	It will be important to implement high quality stormwater management practices to prevent subsurface erosion of karst or old mines in the vicinity of What Cheer

Impacts of Climate trends. Increased volume and intensity of precipitation may accelerate the effects of water on substrates and increase the likelihood that sinkholes can develop above old mine sites.

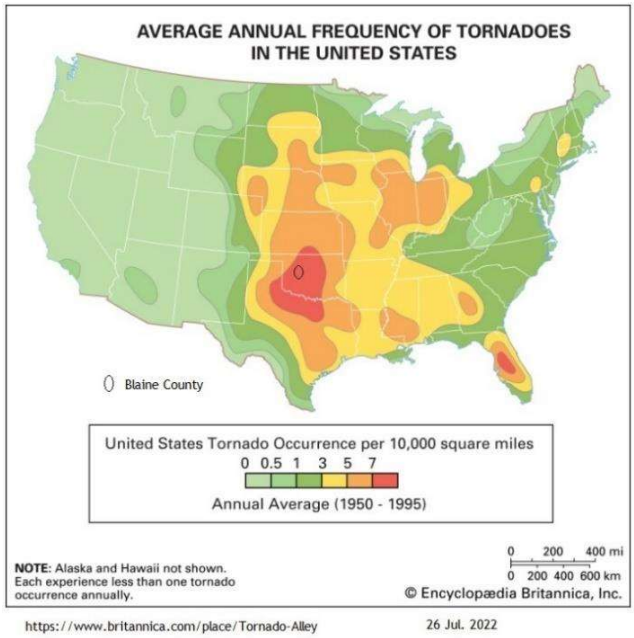
Land use development. Future development over abandoned coal mines will increase vulnerability to this hazard. Future development near historic coal mining sites should be monitored and entities wishing to build in these areas should consider studies of subterranean conditions.

Population patterns. Population increases should be directed to areas where sinkholes are less likely.

Tornado

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 200 mph.



More than half of Iowa's tornados occur during the months of May and June but may occur anytime the necessary atmospheric conditions are present. June is the most active month of the year with 28.8 percent of all tornado reports, closely followed by May with 24.3 percent (MWC, 2023). Most tornados occur between 2pm and 9pm. The state of Iowa averages 48 tornados each year. The record number of tornados in one year was 2021 when 146 tornados were documented in the state (NWS, 2023).

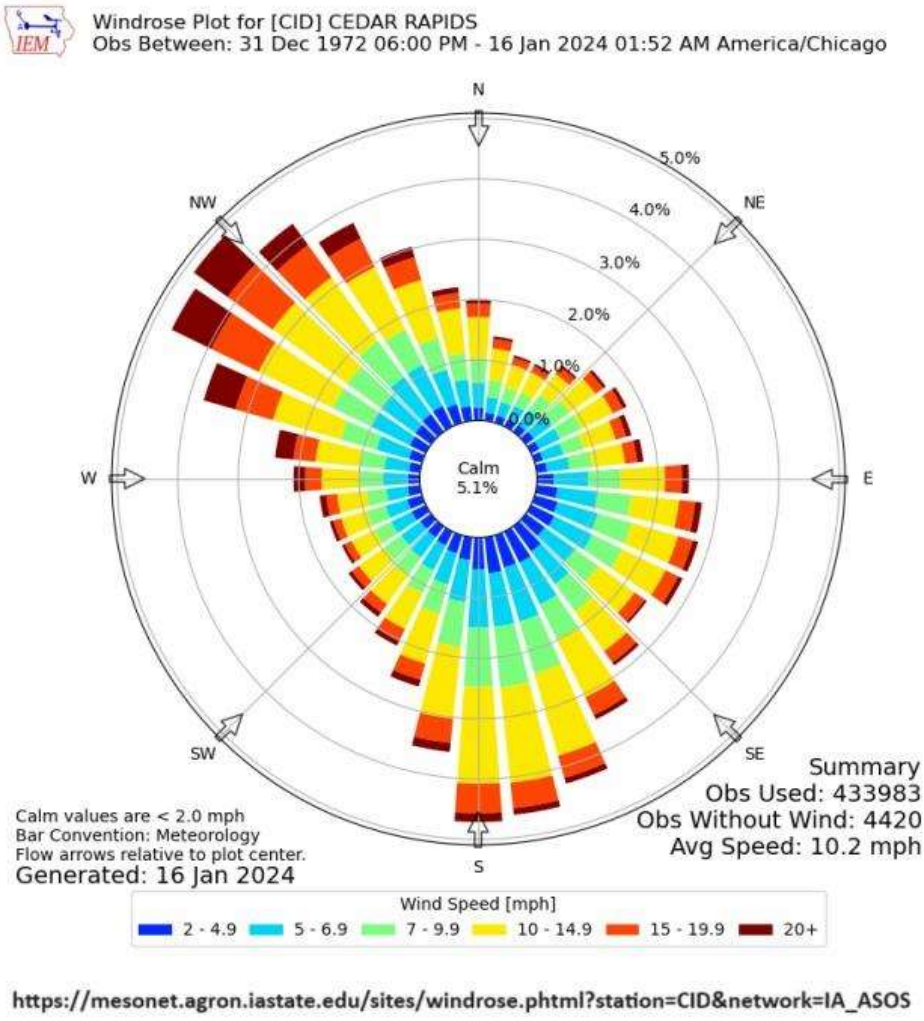
Keokuk County lies in the weather region often referred to as Tornado Alley, where cool, dry air from Canada collides with warm, moist air from the Gulf of Mexico (IA Meso, 2023). Meteorologically, the region is ideally situated for the formation of supercell thunderstorms, often the producers of violent (EF-2 or greater) Tornados (NOAA, 2022).

Wind roses are used to illustrate wind speed and direction for a particular locality over time. Below, a wind rose for the CID Airport at Cedar Rapids, Iowa shows the long term patterns for wind direction and speed in the region, with dominant winds evident from both the south and northwest over a 52 year period. See Illustration below.

Location

Tornados affect the entire planning area.

Affected Jurisdictions County, Cities, Schools



Extent

The scale of intensity for Tornados in Keokuk 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 Enhanced Fujita Scale or EF Scale is used to assign a tornado a 'rating' based on estimated wind speeds and related damage. When tornado-related damage is surveyed, it is compared to a list of Damage Indicators (DIs) and Degrees of Damage (DoD) which help estimate better the range of wind speeds the tornado likely produced. From that, a rating (from EF0 to EF5) is assigned.

Enhanced Fujita Scale

Rating	Winds	Expected Damage
EF0	**65-85 mph**	**Minor damage. Shingles or parts of roof peeled off; damage to gutters and siding; branches broken off; shallow rooted trees toppled.**
EF1	**86-110 mph**	**Moderate damage. More significant roof damage; windows broken; exterior doors damaged or lost; mobile homes badly damaged or overturned.**

EF2	**111-135 mph**	**Considerable damage. Roofs torn off well constructed homes; homes shifted off their foundation; mobile homes completely destroyed; large trees snapped or uprooted; cars may be tossed.**
EF3	**136-165 mph**	**Severe damage. Entire stories of well constructed homes destroyed; significant damage to large buildings; homes with weak foundations may be blown away; trees begin to lose bark.**
EF4	**166-200 mph**	**Extreme damage. Well constructed homes leveled; cars thrown significant distances; top story exterior walls of masonry buildings likely collapse.**
EF5	**> 200 mph**	**Incredible damage. Well-constructed homes swept away; steel reinforced concrete structures critically damaged; high rise buildings sustain severe structural damage; trees usually completely debarked, stripped of branches and snapped.**

https://www.weather.gov/hun/efscale_explanation

Previous occurrences

Five Tornados were recorded in the county during the years 2014 through 2023.

TORNADO			
LOCATION	**DATE**	**F SCALE**	**EVENT NARRATIVE**
MARTINSBURG	4/27/2014	EF1	A tornado developed in far northern Wapello County, crossed Keokuk County and southeastern Iowa County, and ended in rural southwest Johnson County. This entry is for the portion of the tornado that affected Keokuk County. The tornado moved into Keokuk County at around 323 pm CDT (223 pm CST). It then created a near-continuous damage path across Keokuk County, with damage primarily to outbuildings, trees, and power poles. In Martinsburg, a tied-down mobile home was also pushed to the north off its block base. Two fatalities occurred, one west of Martinsburg and one north of Kinross. Both fatalities were associated with people who were outdoors and caught in debris from outbuildings that were destroyed. ||The tornado was on the ground for about 30 miles across Keokuk County. It exited Keokuk County at about 352 pm and moved into Iowa County near the junction of the Keokuk-Iowa-Washington county lines.
DELTA	11/11/2015	EF1	A tornado developed near the Mahaska/Keokuk County line and tracked northeast through just northwest of What Cheer. It then continued on an intermittent track into Iowa County. Multiple structures were damaged or destroyed to include small barns, cattle sheds and outbuildings. Power poles and large trees were snapped. The tornado was rated as an EF-1 with an estimated peak wind of 110 mph. The intermittent path length was 16 miles and a maximum path width of 50 yards. It continued northeast

			into Iowa County. There were 4 confirmed EF-1 Tornadoes with the system
DELTA	6/20/2018	EF0	A storm survey by the emergency manager found that an EF0 tornado occurred between Delta and Sigourney and moved northeast 6.3 miles before lifting. Damage to corn occurred along the path with winds estimated around 65 mph.
MARTINSBURG	3/31/2023	EF3	A large violent tornado developed in Wapello County (see NWS Des Moines Storm Data) and tracked into Keokuk County about 1 mile southeast of Martinsburg on Wapello-Keokuk Road. The tornado continued to the northeast before lifting just north of Highway 92, southwest of Keota. The tornado produced EF-3 damage to a house northeast of Martinsburg and caused additional significant damage to farmsteads and outbuildings. The tornado was on the ground in Keokuk County for about 17 miles, with a maximum width of 1000 yards and peak estimated winds of 150 MPH.
TALLEYRAND (Unincorporated)	3/31/2023	EF4	Another large, violent tornado developed in eastern Keokuk County as the initial tornado was weakening southwest of Keota. The tornado tracked to the northeast, on the western fringe of Keota, and crossed into Washington County near the intersection of Keokuk-Washington Road and 180th St. The tornado then continued through northwest Washington county, extreme southeast Iowa County, and into far southwest Johnson County. The tornado severely damaged several homes near Keota, wiping one house completely off its foundation, resulting in EF-4 level damage. A car was lofted in the air and tossed about 1000 feet into a nearby field and trees were completely debarked with only stubs of the largest branches remaining. As the tornado tracked west of Wellman, Iowa it knocked over a 325 ft cell phone tower. The tornado began to dissipate as it tracked into far southwest Johnson County. The tornado was rated EF-4 in Keokuk County, EF-3 in Washington County, and EF-1 in Iowa and Johnson Counties.

Probability

Five Tornados occurred during the study period. 5/10 years = 50% probability, an Even chance that a tornado will occur in any given year.

Climate trends

Changing jet stream wind patterns can be expected to impact the location and intensity of tornados in coming decades, however, the patterns are not yet clear.

“Tornados, a source of many disasters in Iowa, do not appear to be increasing with climate change. That said, the spatial distribution of tornado occurrences appears to have moved eastward in the past 40 years, with most of Iowa seeing more days favorable to tornado formation, and there has been some variation in when tornados happen. Since these changes have not been directly tied to climate change, it is unclear whether or how long the trends will continue. Nevertheless, warming winters will likely extend tornado season (Iowa, 2023).”

Vulnerability and Impacts

Tornado: Affected Jurisdictions			
X	Delta	X	Richland
X	Gibson	X	Sigourney
X	Harper	X	South English
X	Hayesville	X	Thornburg
X	Hedrick	X	Webster
X	Keota	X	What Cheer
X	Keswick	X	Sigourney CSD
X	Kinross	X	Keota CSD
X	Martinsburg	X	Tri-County CSD
X	Ollie	X	Keokuk County (Unincorporated)

The entire county is at risk from this hazard. Those most at risk from tornados include people living in dwellings without secure foundations or basements, mobile homes and people in campgrounds.

Aside from the soundness of building construction, all structures have statistically equal risk to be impacted by this hazard, due to the random nature and unpredictability of where a tornado may occur.

Tornados strike with an incredible velocity. Wind speeds may approach 300 miles per hour and the storm can travel across the ground at more than 70 mph. While advancements in weather forecasting have allowed watches to be delivered to those in the path of these storms up to hours in advance, tornados have been known to change paths very rapidly, thus limiting the time available to take shelter. Tornados may not be visible on the ground due to blowing dust or driving rain and hail.

Cost as a vulnerability. It is very expensive to prepare for an event of tornadic magnitude when that event is statistically very unlikely to strike any specific location. Public or community sized safe rooms or shelters must withstand tremendous forces, be accessible to all people, and meet all manner of safety and regulatory requirements, while they may rarely be occupied for the intended purpose. Private shelters are an expensive improvement for homeowners to make. Therefore, programs that financially support these efforts are an important factor in public safety.

General Impacts. Rotating tornadic winds uproot trees, damage structures and turn airborne debris into deadly missiles. A tornado can be devastating to any structure it hits. The level of damage can vary from high wind damage to roofs and siding, to a total collapse of the structure in the most intense situation. Windborne debris shatters windows and causes roof damage in adjacent structures. In 2014, two people were killed by debris from destroyed outbuildings in Keokuk County.

Tornado	
County and Cities	
Vulnerability	All structures including critical facilities are susceptible to tornado damage
Impact	If hit directly, necessary public services may cease
Vulnerability	The elderly, very young, and the physically and mentally handicapped are most vulnerable because of a lack of mobility to escape the path of destruction. People who may not understand watches and warnings due to language barriers are also at special risk. It is difficult to quickly transport vulnerable people to a safe place

County statistics	
Vulnerability	Elderly Pop: 1,495 households include a person over age 65 (816 of whom are among the disabled)
Vulnerability	Children under age 10: 698 people, 7% of the population
Vulnerability	Disabled Pop: 1,724 people in the county are disabled
Vulnerability	LEP Pop: 168 people live in homes where a language other than English is spoken, 50 of those people report having Limited English Proficiency
Impact	Vulnerable people and caregivers without appropriate social support may be injured unnecessarily
Keokuk County	
Vulnerability	Mobile homes are more susceptible to damage from a tornado; there are 165 mobile homes in the county, shelter for an estimated 380 people. Mobile homes are less able than traditional homes to withstand the effects of high winds, especially those built prior to modern standards
Impact	When alternative shelter is not readily available, people living in mobile homes are at greater risk of personal injury than people in other residential structures
Vulnerability	In 2022, Ag Statistics reports that there were 172,000 hogs produced in Keokuk County (a county with a human population of about 10,000). Most of these are raised in confinement barns
Impact	When a tornado hits a hog confinement barn, thousands of animals can be killed and injured
Impact	If live animals are exposed to severe weather events or power outages, small farmers have a significant challenge to contain and protect the health of livestock
Impact	Weather events such as tornados or other causes can result in manure spills at hog operation facilities
Specific Vulnerability: No Tornado Siren or inadequate sirens	
All Cities Vulnerability	All cities in the county would benefit from improvements to sirens and tornado warning alert systems
Impact	Lack of sirens may place people at risk when they are unaware of the need to take cover. Old sirens require manual activation, putting workers at risk
Specific Vulnerability: Older housing	
Vulnerability	Depending on original construction and maintenance, risk can be unknown for buildings of any age, but older homes may be constructed with an uncertain variety of building practices
City of Harper	94% of all housing in Harper was built before 1970
City of Kinross	88% of housing in Kinross was built before 1970
City of Ollie	80% of Ollie housing was built before 1970
City of Thornburg	In Thornburg, 87% of housing was built before 1970, but 84% pre-dates 1940. Median home value is $22,500
Impact	People may not know the level of safety that can be expected from a structure, possibly resulting in a miscalculation of the danger posed
Specific Vulnerability: Older population	

Vulnerability	Have a household member over age 65:
City of Hayesville	Hayesville: 23 households = 64% of the community
City of Hedrick	Hedrick: 129 households = 50% of the community
City of Kinross	Kinross: 17 hhds = 50% of the community
City of Thornburg	Thornburg: 18 households = 58% of the community
Impact	Elderly people may need more assistance, families may need support to ensure safety. These factors increase risk
Specific Vulnerability: Limited English Proficiency	
City of What Cheer	Of the 50 people that report Limited English Proficiency, 23 live in What Cheer. People who do not speak or understand English are at greater vulnerability from tornado events
Impact	People that do not have experience with tornados, understand the difference between a tornado watch and a warning, or have familiarity with the locations of safe tornado shelters can be injured from simple communication barriers
All Schools: All local schools need safe room improvements	
Vulnerability	A large number of vulnerable people are concentrated in one location
Vulnerability	Excessive cost may prevent implementation of adequate safety measures
Impact	The logistics and cost of safely protecting all students and staff is complicated and expensive. Rural schools have fewer students and therefore less revenue for safe room construction
Vulnerability	It may be more cost effective to construct a single storm shelter in a small community, to serve both the school and the general public
Impact	School districts must weigh the potential conflicts of allowing the public to shelter in school safe rooms when students are present, and provide adequate student security

Impacts of Climate trends. Warming winters will likely extend tornado season. Changing wind patterns and intensification of wind differentials are likely to impact tornado occurrence in ways that are not yet fully understood.

Land use development. This hazard is unlikely to be affected by land development patterns.

Population patterns. Additional population does put more people at risk. This hazard is unlikely to be affected by population patterns because Keokuk County is unlikely to have significant population growth in the near future.

Wildfire

Wildfire conditions tend to be regional, therefore much of the narrative in this section is drawn from the State of Iowa Hazard Mitigation Plan published in 2023.

A grass fire or wildland fire is an uncontrolled fire that threatens life and property in a rural or wooded area. A grass fire or wildland fire is not a cropland fire. Damage to crops from fire are often covered by insurance on land that is not "wild." Wildland or grass fires occur in natural, wild areas. Wildland fires are more likely to occur when conditions are favorable, such as during periods of drought when natural vegetation is drier and more combustible.

Due to the high quality and quantity of agricultural soils, Iowa and Illinois have the smallest percentage of wild land in the United States. Consequently, there are fewer opportunities for wildfires in Iowa than in other states. Almost the entire state is mapped with a "Very Low" wildfire hazard potential. No event reported in the state has been a historically significant wildfire (Iowa B, 2023).

Location

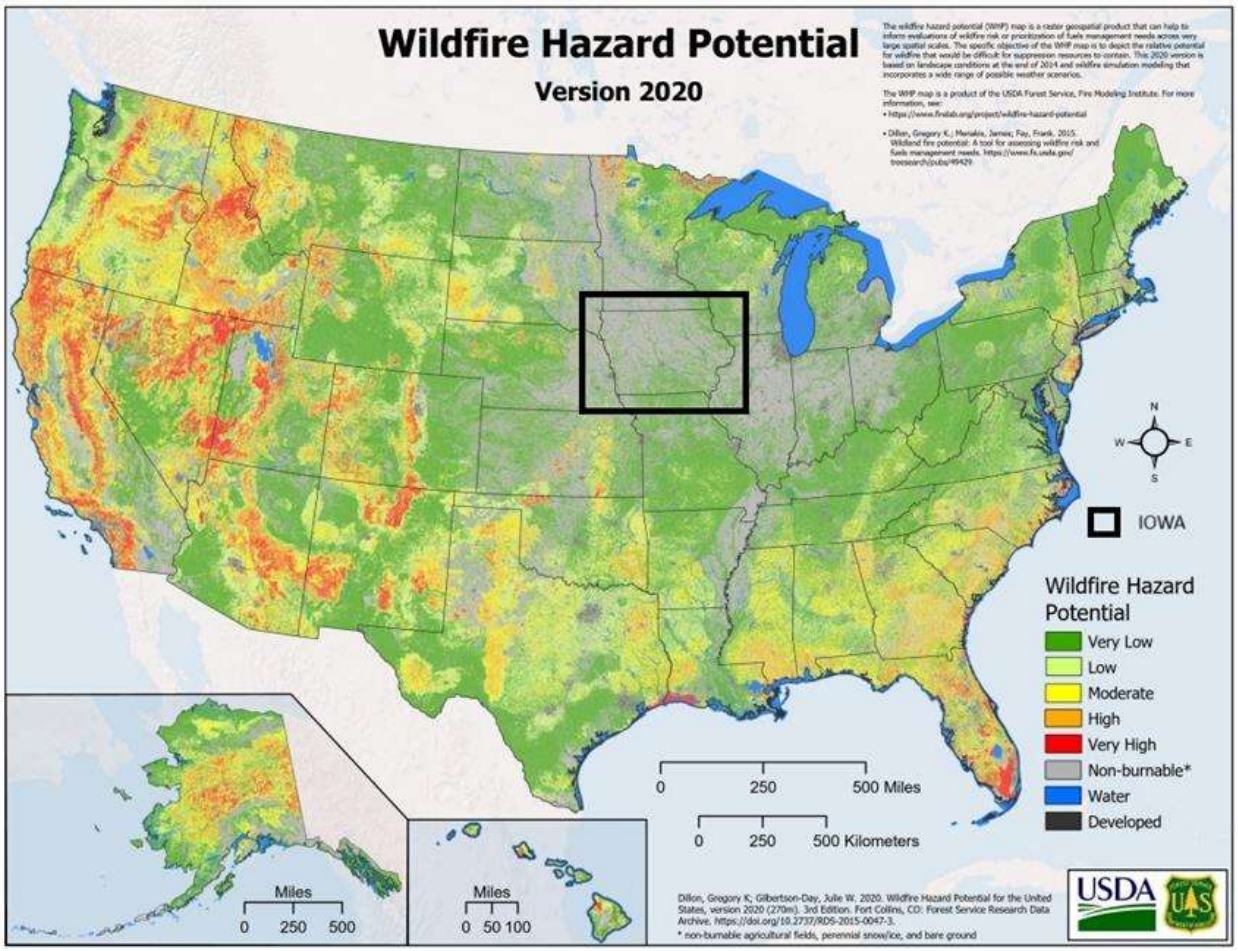
While most jurisdictions have some potential to be impacted by wildland fires, like the rest of the state, Keokuk County has low vulnerability to wildland fires because of the extremely large percentage of tilled agricultural land or otherwise developed property. Schools are unlikely to be impacted by wildfires in Keokuk County because they are located within city boundaries and are not adjacent to wild areas.

Affected Jurisdictions County, Cities

Extent

The map below is a wildfire hazard potential (WHP) map, a geospatial product produced by the USDA Forest Service Fire Modeling Institute that can help to inform evaluations of wildfire hazard or prioritization of fuels management needs across very large landscapes. The specific objective with the WHP map is to depict the relative potential for wildfire that would be difficult for suppression resources to contain (Iowa B, 2023).

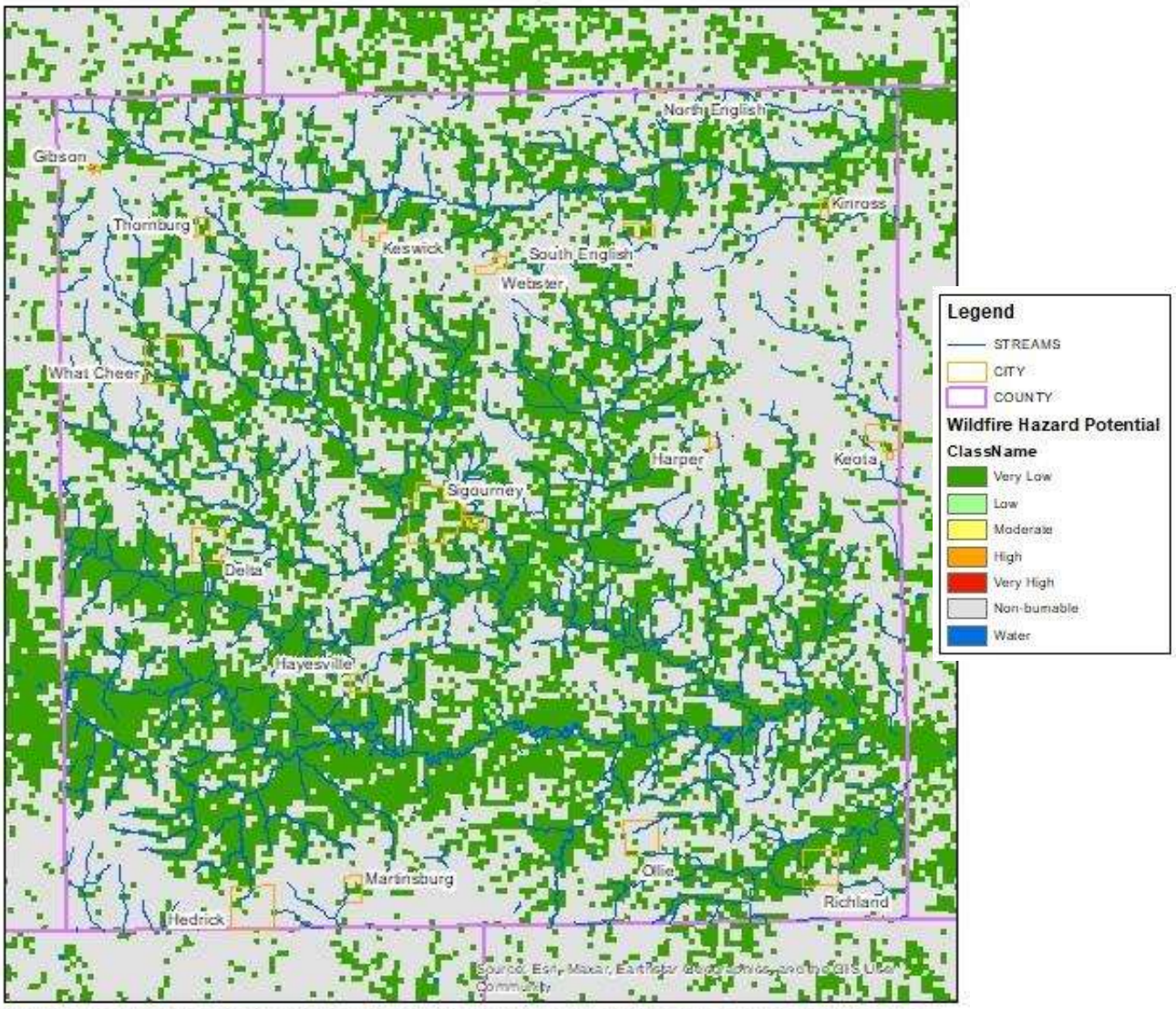
The map below shows the WHP assessed risk in the State of Iowa in context with other states.



On its own, the WHP map is not an explicit map of wildfire threat or risk, it illustrates the locations where wildfire is most likely, or probable, to occur (Iowa, 2018).

The Keokuk County map below was generated from Firelab WHP data made available through ArcGIS online. The WHP map illustrates that when wildfires do occur in Keokuk County they are of limited extent, because of the quantity of tilled land. Virtually all wildfire risk in Keokuk County is classified as Very low. Much of the county is designated as “Non-burnable,” mostly cropland (Firelab, 2020).

Wildfire Hazard Keokuk County



https://apps.fs.usda.gov/fsgisx01/services/RDW_Wildfire/RMRS_WildfireHazardPotential_classified_2020/ImageServer

Another consideration for wildfire risk is the proximity of housing to wild land areas, called the Wildland Urban Interface (WUI).

On the community maps below, yellow or orange indicates Interface or Intermix of wildland with housing. Very little land area in Keokuk County has these classifications.

Red indicates the medium or higher density housing of cities. Tan areas are non-vegetated or tilled agricultural land and considered non-burnable. For example, on the map below, Gibson, Thornburg and Keswick are all in non-burnable (agricultural) areas with medium density housing in town. Virtually the entire county has this pattern where no intermix of wild land and housing occurs. Only the City of What Cheer has some intermix, where the wooded riparian zone of Coal Creek passes through town.

WUI INTERFACE GIBSON, THORNBURG, KESWICK

TRI COUNTY SCHOOL

WUI INTERFACE WEBSTER, SOUTH ENGLISH, KINROSS

Legend

Wildland Urban Interface: 2020

Wildland-Urban Interface (WUI)

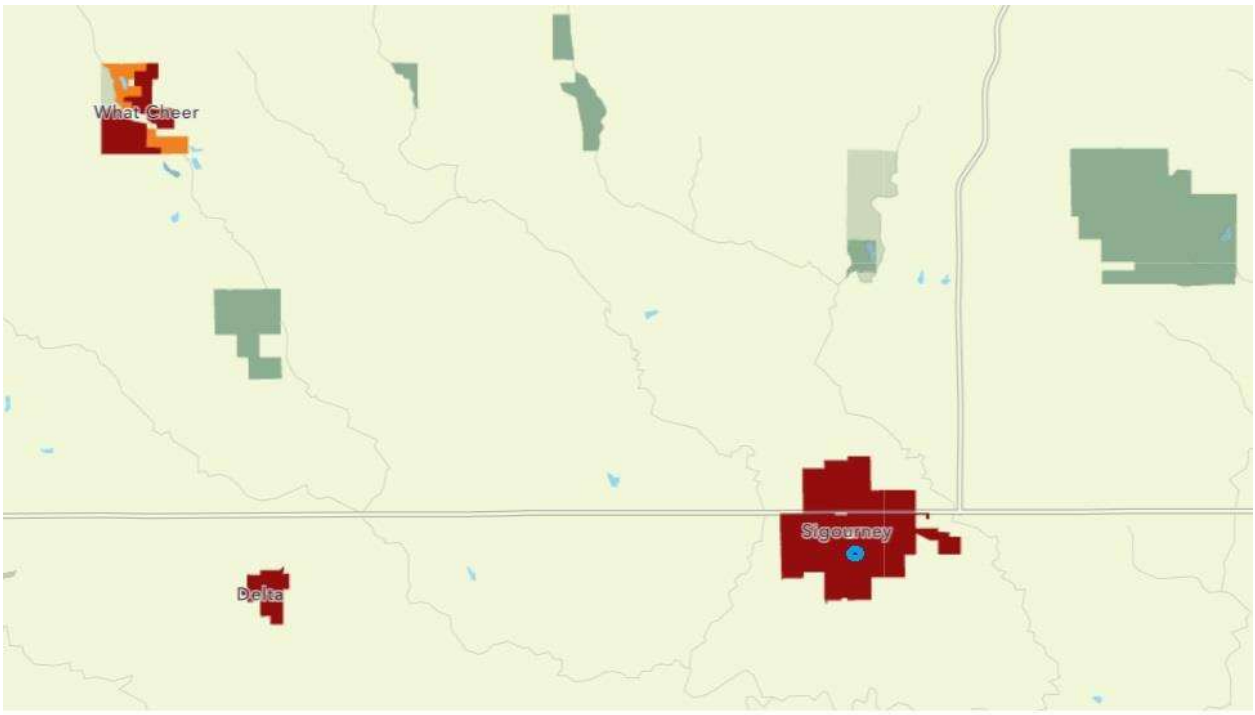
- Interface
- Intermix

Non-WUI Vegetated

- No housing
- Very low housing density

Non-vegetated or Agriculture

- Low and very low housing density
- Medium and high housing density
- Water

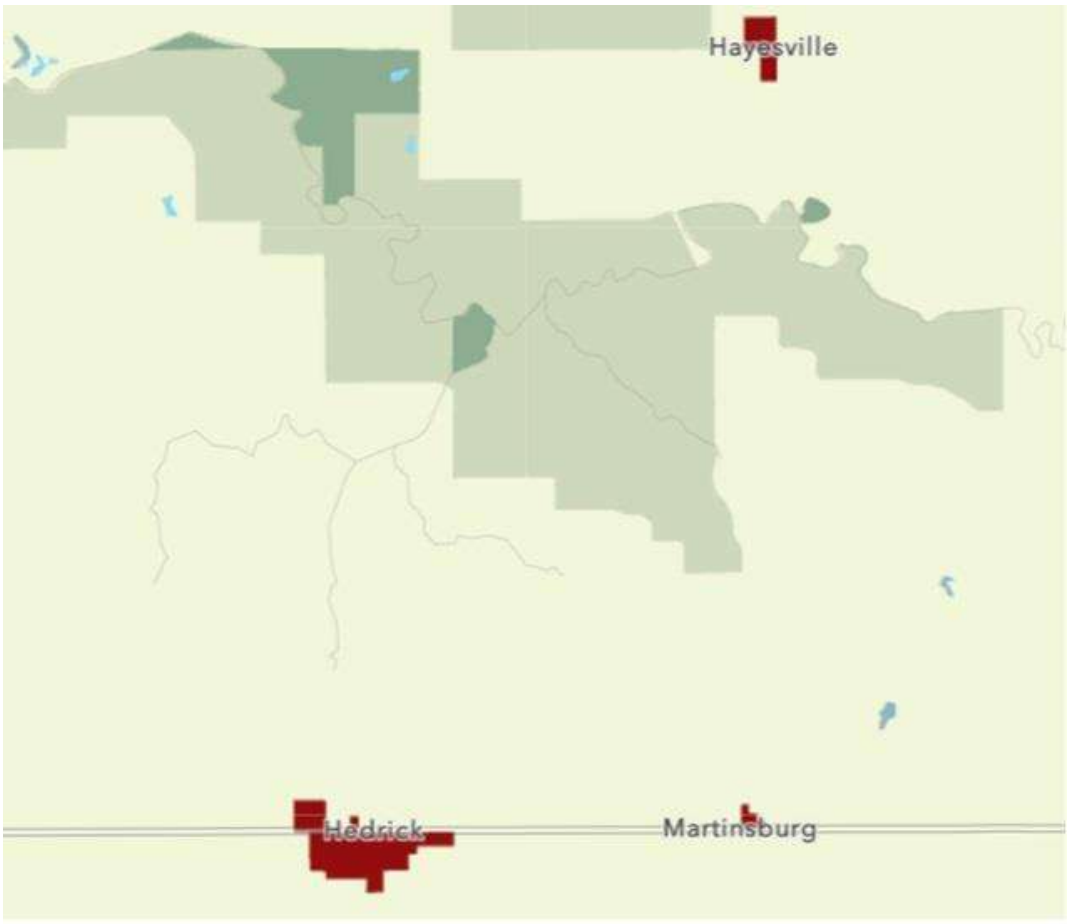


WUI INTERFACE DELTA, WHAT CHEER, SIGOURNEY

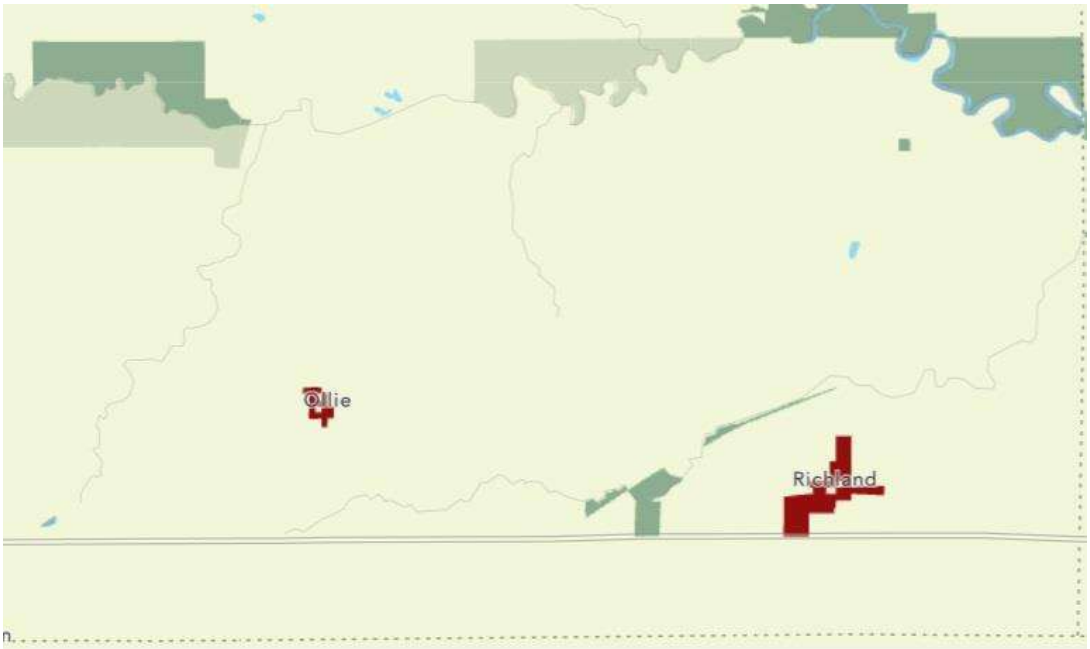
SIGOURNEY SCHOOL

WUI INTERFACE HARPER, KEOTA

KEOTA SCHOOLS



WUI INTERFACE HAYESVILLE, HEDRICK, MARTINSBURG



WUI INTERFACE OLLIE, RICHLAND

Previous Occurrences

Data from the Iowa Department of Natural Resources indicates that 33 grass or wildfire events occurred between January 2013 and December 2022. Data for 2023 is not yet available.

A total of 861 acres were impacted by the 33 events over the 10 year period, averaging about 26 acres per fire. The smallest fires were of one acre or less and the largest was 150 acres, or about one square mile. Event details show that four fires were caused by controlled burns that got out of control, three ditch fires were likely caused by discarded cigarettes, and three occurred when sparks escaped a useful fire. Other fires were a result of unknown causes including lightning.

Probability

Thirty-three events in 10 years, or about 3.3 times a year, is a probability greater than 100% = Very likely. It should be noted that, while a wildfire is very likely to occur during the year, the number of acres burned per fire is relatively few.

Climate trends

Changes in precipitation are expected to increase periods of drought which can be expected to elevate wildfire risk. However, due to the extensive amount of agricultural land, Keokuk County has a very limited propensity for wildfire and that is unlikely to change in the near future.

Vulnerability and Impacts

Wildfire: Affected Jurisdictions			
X	Delta	X	Richland
X	Gibson	X	Sigourney
X	Harper	X	South English
X	Hayesville	X	Thornburg
X	Hedrick	X	Webster
X	Keota	X	What Cheer
X	Keswick		Sigourney CSD
X	Kinross		Keota CSD
X	Martinsburg		Tri-County CSD
X	Ollie	X	Keokuk County (Unincorporated)

Jurisdictions are at Very Low risk; some risk does remain. According to the WHP data, it is estimated that fewer than 5% of structures in the county are at risk from this hazard. Because schools are located both within City limits and in non-vegetated areas, they are not considered at risk for wildfires in this plan.

Wildfire	
Keokuk County	
Vulnerability	Where rivers and streams are present, there are more potential burnable acres than in most of the county, although housing is very low density in these areas
Impact	Wildfires can occur in remote areas, where fire response may be delayed
City of What Cheer	
Vulnerability	While much of Keokuk County is classified as non-burnable with no interface, What Cheer has a somewhat higher potential for wildfire to intersect with development.

	The riparian zone where Coal Creek passes through What Cheer does provide some interface between wild areas and housing
Impact	Tree and vegetation debris can be neglected allowing dry material to collect in natural areas
Impact	Residential or commercial areas adjacent to burnable acres are impacted when natural debris is allowed to collect too close to homes, buildings, or wood piles
Impact	If the interface is not maintained to remove dead material, some structures could be at risk from this hazard

Impacts of Climate trends. Drought is a hazard with the greatest effect on wildfire. Increased length and intensity of drought would elevate risks.

Land use development. Development in wooded areas would increase risk from wildfire.

Population patterns. This hazard is unlikely to be affected by population patterns because Keokuk County is unlikely to have significant population growth in the near future.

Winter Weather

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. Loose snow begins to drift when wind reaches a speed of 9 to 10 mph under freezing conditions.

Blizzards occur when falling and blowing snow combine with winds of 35 mph or greater, reduced visibility of 1/4 mile or less, and white out conditions.

Freezing rain is precipitation that falls onto a layer of freezing air near the surface. When the precipitation contacts 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 are hazardous to all residents and structures.

Affected Jurisdictions County, Cities, Schools

Extent

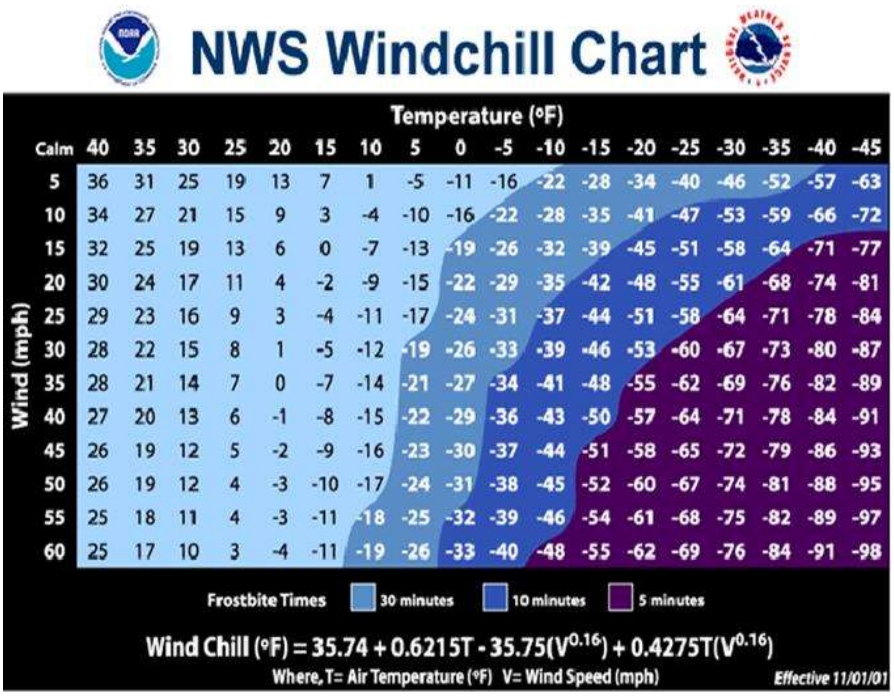
The Sperry-Piltz Ice Accumulation Index is used to categorize ice damage, as shown in the table below. Ice accumulation can be expected to occur at any level on the Sperry-Pilz Index.

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). It is expected that temperatures of -20 or warmer can occur, with potential wind speeds at any level on the NWS chart, below.

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

During the years 2014 through 2023, thirty-one winter weather events are recorded for Keokuk County in the NOAA Storm database. In some years, few severe winter events occur, while at other times, several events can be recorded in a single winter season.

DATE	EVENT	EVENT NARRATIVE
1/5/2014	Winter Cold/Wind Chill	Bitterly cold Arctic air flooded into Iowa. Temperatures remained below zero Sunday into Tuesday afternoon with strong northerly winds of 15 to 25 mph that produced wind chill readings of 30 to 50 below zero. Widespread closing of schools on Monday and Tuesday
3/1/2014	Winter Weather	Light to moderate snow was observed with amounts of 3 to 6 inches common
11/15/2014	Winter Weather	Light to briefly moderate snow of 1 to 2 inches. Winds were light which prevented any blowing or drifting
1/5/2015	Winter Weather	Spotters reported 4 to 5 inches of snow, with numerous school cancellations on January 6th
2/1/2015	Winter Storm	Using surrounding observers, an estimated 7 to 9 inches of snow fell within the county, with the higher amounts near the northern border. Several areas experienced prolonged power outages and downed tree limbs due to the heavy wet snow.
2/25/2015	Winter Weather	Observer reported 3.0 of snow in Sigourney. Northerly winds of 10 to 20 mph resulted in some snow drifts of 1 to 2 feet in parts of southeast Iowa

11/20/2015	Winter Storm	Multiple reports indicate 5 to 7 inches of snow in northern portions of the county. Strong northerly winds created patchy blowing and drifting snow
12/28/2015	Winter Storm	The COOP observer in Sigourney reported 4.0 inches of sleet and snow.The ice and strong winds gusting to 50 mph resulted in widespread downed trees and powerlines, and power outages. Thundersnow was reported in some areas
12/24/2017	Winter Weather	Snowfall reports were between 1 and 2.5 inches
12/29/2017	Winter Weather	Snowfall reports ranged from 0.8 inches at Sigourney to 3.0 inches near North English
2/5/2018	Winter Heavy Snow	Weather spotters reported 8 inches of snow; 7 to 10 inches of snow was observed.
2/10/2018	Winter Heavy Snow	Trained spotters reported 7.9 inches of snow at Sigourney, Iowa and 6.0 inches reported 3 miles west of Richland, Iowa.
4/8/2018	Winter Weather	No reports were received from Keokuk but reports in nearby counties ranged from 1.0 inches in Jefferson County to 1.2 inches in North English
11/25/2018	Winter Blizzard	Multiple sources of snow amounts of 6 inches up to over 13 inches, combined with strong north winds of over 30 mph with frequent gusts over 40 mph produced blizzard conditions in the county. Strong north winds gusted to 40 to 50 mph and combined with the heavy snow to produce widespread blizzard conditions
1/11/2019	Winter Storm	A trained spotter in Keota reported 6.0 inches.
1/18/2019	Winter Storm	Trained spotter reports from neighboring counties were around 5.0 inches. Wind gusts of 20 to 30 MPH caused blowing and drifting snow.
1/22/2019	Winter Storm	A trained spotter reported 7.3 inches in Keota. Freezing drizzle and rain fell for much of the morning and afternoon, causing slick roads
1/29/2019	Winter Cold/Wind Chill	Life threatening wind chills were reported with values below -30 degrees for many hours. Numerous schools, churches, and businesses closed
2/11/2019	Winter Storm	Observer reported 5 inches of snow in Sigourney, Iowa. Significant blowing and drifting snow was widespread with white out conditions. Power outages from down power lines, power poles, and tree branch damage were widespread
10/30/2019	Winter Weather	The COOP Observer snowfall reports ranged from 3.0 inches in North English to 3.9 inches in Sigourney.
1/10/2020	Winter Storm	Freezing rain amounts were estimated between a glaze and a tenth of an inch. Some trees were downed from the weight of the ice and numerous power outages were reported.
1/17/2020	Winter Storm	Snowfall reports ranged from 1.7 inches from the COOP observer in Sigourney to 2.0 inches from a trained spotter in Harper.

4/16/2020	Winter Weather	A late season snow storm brought heavy wet snow. With warm ground temperatures, there were not many impacts to travel other than reduced visibility at times, and minor slushy accumulations on roads
12/29/2020	Winter Storm	The COOP observer in Sigourney reported 4.5 inches of snow and sleet. Also reported that icing occurred. Transportation delays and traffic accidents, along with some isolated power outages.
1/25/2021	Winter Storm	The COOP observer in Sigourney reported 7.4 inches of snow.
1/30/2021	Winter Weather	The COOP observer in Sigourney reported 2.5 inches of snow. Initially, precipitation began as rain. Over time, temperatures began to cool, and precipitation changed to snow
2/4/2021	Winter Blizzard	Rain and wintry mix started the day, leading to snow (heavy at times), where between 3 and 5 inches of snow fell throughout the county. Blizzard conditions were noted through mid to late afternoon, with winds around 25 to 35 mph, gusting up to 45 mph.
1/1/2022	Winter Storm	Spotter and public reports of 4-6 inches of snow fell across portions of Keokuk County with the highest snowfall report in Sigourney at 6 inches. Blowing and drifting snow continued to cause problems on roads after plowing. Just as this storm was moving out, very cold temperatures moved in, with wind chills between -15 to -30 felt
1/14/2022	Winter Storm	5-8 inches of snow fell across portions of Keokuk County. Blowing and drifting snow continued to cause problems on roads after plowing. The highest snowfall report from the event was 7.8 inches in Sigourney.
12/21/2022	Winter Storm	The COOP observer in Sigourney reported 3.2 inches of snow. Winds quickly increased with a gusts up to 47 MPH in Sigourney. Blowing and drifting snow across the area creating ground blizzard conditions. Wind chills as cold as -24
2/16/2023	Winter Storm	Iowa DOT reported snowfall of 6 to 10 inches falling over Keokuk County from midnight through the day. This snow continued to cause dangerous travel conditions into the evening commute

Probability

Thirty-one events over a ten year period gives a probability greater than 100% that a severe winter event will occur, Very likely.

Impacts of Climate trends. Severe winter storms decreasing. As winters warm faster than summers, winter weather is expected to cause less damage in coming decades. Overnight lows are increasing quickly relative to daytime temperatures, meaning there may be less than historical rates of re-freezing of snow and ice at some points in winter, and more at other points. Winters are becoming shorter as well (Iowa, 2023).

- ✓ Frost-free seasons increasing by up to 10 days by 2045 and 20 days by 2065, compared to the period of 1976-2005
- ✓ A shorter, less severe winter may permit the survival of more pests and pathogens.

Climate trends already observed by 2023.

- ✓ Winters warming six times faster than summers
- ✓ Increased precipitation (8 percent from 1873 to 2008)

Vulnerability and Impacts

Winter Weather: Affected Jurisdictions			
X	Delta	X	Richland
X	Gibson	X	Sigourney
X	Harper	X	South English
X	Hayesville	X	Thornburg
X	Hedrick	X	Webster
X	Keota	X	What Cheer
X	Keswick	X	Sigourney CSD
X	Kinross	X	Keota CSD
X	Martinsburg	X	Tri-County CSD
X	Ollie	X	Keokuk County (Unincorporated)

Winter storms impact the entire county with life-threatening conditions.

All forms of travel are vulnerable to ice, snow, and winter temperatures. East/west Highways 78, 92 and 22 each carry between 1200 and 2000 vehicles per day, as does N/S Route149 (IDOT, 2022).

Heavy snows of more than six inches in a 12 hour period or freezing rain greater than 1/4 inch accumulation can cause hazardous conditions in the community by slowing or stopping the flow of vital supplies as well as disrupting emergency and medical services. Ice accumulation of one-fourth inch in thickness is heavy enough to damage trees and above ground electric lines leading to power outages, increasing the vulnerability of people in homes and businesses.

Ice storms often cause tree damage, downed power lines and utility poles. These storms have caused power outages over large areas at times.

Schools may close, and bus travel is more dangerous. The use of alternate bus routes may be necessary, making it more difficult for some students to reach school.

WINTER STORM	
Keokuk County	
Vulnerability	Thousands of people travel local highways each day. Nine hundred thirteen (913) miles of paved and gravel county roads carry thousands more
Impact	Each vehicle carries at least one person and often several, of all ages who are at risk of life threatening exposure to the elements
Vulnerability	Roadways covered with ice and snow create two problems; vehicles become stranded, and first responders are delayed providing emergency services to a large number of people in need of assistance in a short timeframe
Impact	Emergency personnel mobilized to render assistance are additional lives placed at risk during the most hazardous conditions
Vulnerability	Blowing snow across roads in open areas. In January 2024, the State snowplow was transported into Keokuk County to clear an 18 foot deep drift on Hwy 22. See photo below

Impact	Drifting snow, reduced visibility and slick road conditions put lives at risk
Vulnerability	Cold temperature affects agriculture and farm workers
Impact	Frost and freeze impacts are especially destructive to crops early or late in the growing season. Unprotected livestock suffer from cold, and it may be difficult for farmers to deliver sufficient hay and feed in bad weather
County and Cities	
Vulnerability	Costs of snow removal, repairing damage, and loss of business
Impact	The economic impact due to property damage and agricultural production damage can be significant. Lost wages and interruptions to business affect tax revenue. Overtime for local government employees needed to clear the snow can strain City budgets
Vulnerability	Power loss from downed lines and heavy usage
Impact	Power loss during times of extreme temperatures has secondary impacts, especially for those who rely on electricity for medical support equipment
Vulnerability	If power is out, interiors of homes can become very cold. Water pipes freeze, and people may experience hypothermia
Impact	Improper home use of kerosene heaters and other alternative forms of heating create other hazards such as structural fires or carbon monoxide poisoning
Vulnerability	Community shelters are absent or lack sufficient capacity
Impact	Problems include a lack of temperature controlled public space, beds, hygiene facilities, food supplies and personnel to shelter residents and stranded strangers
Vulnerability	Sidewalks and paths become obstructed and slippery
Impact	Ice covered paths and steps lead to falls, especially dangerous for the elderly
Vulnerability	Winter storms make fires more difficult and dangerous to fight due to extreme temperatures and heavy snow
Impact	Fires during winter storms present increased danger because water supplies may freeze, and firefighting equipment may not function effectively. Personnel and equipment may be unable to reach the fire. Firefighters are exposed to water and severe low temperatures, life threatening conditions
All Jurisdictions	
Vulnerability	Ice accumulation takes down power lines
Impact	Loss of heat sources, loss of refrigeration
Impact	Improper use of alternative heat sources can harm health
Impact	Vulnerable people may suffer hypothermia
Impact	Elderly or disabled people may not be able to travel independently to a safe, temperature controlled place
Impact	Power outages impact people who rely on home medical equipment to sustain health or refrigeration for insulin
Schools	
Vulnerability	Buses must travel all types of roads to transport hundreds of children to school in poor road conditions
Impact	Bus routes may be diverted to safer roads, impacting the families who must either transport the students to the nearest bus route or miss days of school

Vulnerability	Schools have to close for staff and student safety
Impact	The closing of schools has a secondary impact on families if parents must arrange last-minute childcare or miss work

Impacts of Climate trends. Extreme cold and winter storms may come less frequently as winters warm.

Land use development. Developers should consider the travel challenges that will be faced by residents and businesses in severe winter weather. Gravel roads, steep driveways and proximity to highways are just a few of the potential factors that would increase or decrease risk from additional new development.

Population patterns. An increase in residential housing would increase the need for roads to be cleared promptly in those areas.

1/18/2024

The Iowa DOT said "the big plow" was sent to Keokuk County from Waterloo last week, where it dealt with 18' snow drifts along Highway 22. (Photo courtesy of Iowa DOT) (McCain, 2024)

Other hazards

Dam Failure

The National Dam Safety Program defines a dam as an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material for the purpose of water control or storage. Dams are used to regulate the flow of water and usually contain a reservoir upstream. Dams are also used for erosion control, hydroelectric power generation, and recreation.

A dam failure occurs when the structural integrity is compromised, and large volumes of water flow uncontrolled downstream into inundation areas. A dam failure can result from flooding, poor construction, poor maintenance, earthquakes, terrorism, vandalism, or burrowing animals.

Causes. Dam failure is usually attributed to one of five causes:

- Overtopping caused by water spilling over the top of a dam. Overtopping of a dam is often a precursor of dam failure. National statistics show that overtopping due to inadequate spillway design, debris blockage of spillways, or settlement of the dam crest account for approximately 34% of all U.S. dam failures
- Foundation defects, including settlement and slope instability, cause about 30% of all dam failures
- Cracking caused by movements like the natural settling of a dam or earthquake
- Inadequate maintenance and upkeep
- Piping is internal erosion caused by seepage. When seepage through a dam is not properly filtered and soil particles continue to progress, sink holes form in the dam. An estimated 20% of U.S. dam failures have been caused by piping. Seepage often occurs around hydraulic structures, such as pipes and spillways; through animal burrows; around roots of woody vegetation; and through cracks in dams, dam appurtenances, and dam foundations

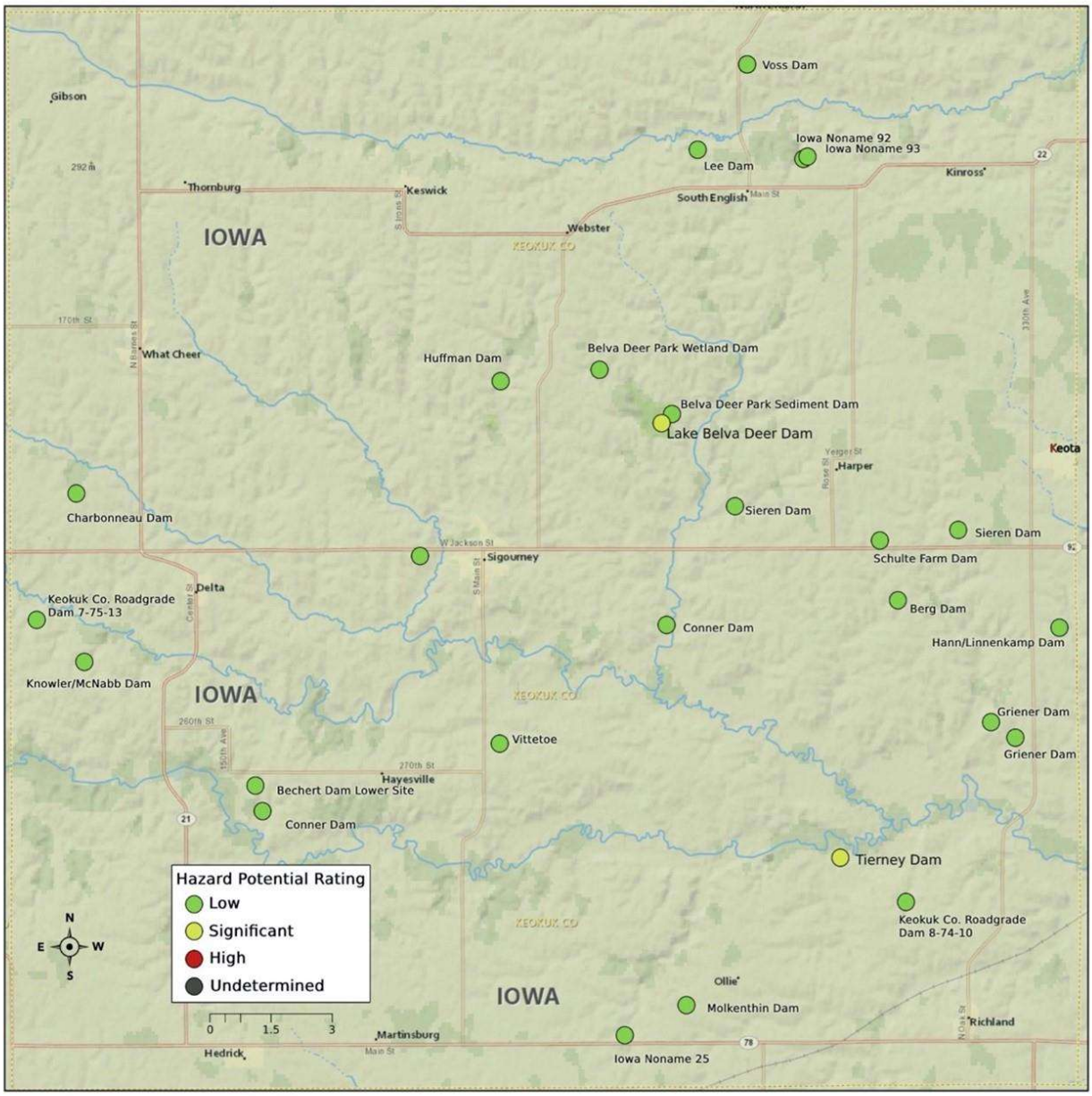
Contributing factors. The Association of State Dam Safety Officials (ASDSO) Incident Database lists nine types of Incident Drivers, a dominant cause or contributing factor for an incident:

Dam Incident Drivers	
Deterioration or Poor Condition	Seepage/Internal Erosion
Hydrologic/Flooding	Seismic
Malfunction of Equipment/Gate	Structural Stability
Manmade action	Other or Unknown

Location

According to the National Inventory of Dams there are 27 state regulated dams located in Keokuk County with an average dam age of 41 years (USACE, 2023). Most dams are located on rural agricultural land in the absence of structures.

Affected jurisdictions: Unincorporated Keokuk County.



Name	Owner type	Purpose	Downstream (miles)	Max storage (acre ft)	Height (ft)
Knowler/Mc Nabb D	Private	Fire Protection, Stock, Or Small Fish Pond	NORTH SKUNK RIVER (1)	52	26
Cassens Dam	Private	Fire Protection, Stock, Or Small Fish Pond	SIGOURNEY (1)	107	29
Voss Dam	Private	Fire Protection, Stock, Or Small Fish Pond	DAYTONVILLE (19)	128	26
Iowa Noname25	Private	Fire Protection, Stock, Or Small Fish Pond	COPPOCK (40)	91	27

Iowa Noname93	Private	Fire Protection, Stock, Or Small Fish Pond	KINROSS (6)	92	31
Hahn/Linnenkamp	Private	Fire Protection, Stock, Or Small Fish Pond	COPPOCK (24)	39	29
Huffman Dam	Private	Fire Protection, Stock, Or Small Fish Pond	SIGOURNEY (4)	59	31
Sieren Dam	Private	Fire Protection, Stock, Or Small Fish Pond	COPPOCK (28)	28	29
Charbonneau Dam	Private	Fire Protection, Stock, Or Small Fish Pond	COPPOCK (50)	50	24
Lee Dam	Private	Fire Protection, Stock, Or Small Fish Pond	RIVERSIDE (30)	46	26
Schulte Farm Dam	Private	Fire Protection, Stock, Or Small Fish Pond	COPPOCK (28)	25	28
Vittetoe/Willcockson	Private	Fire Protection, Stock, Or Small Fish Pond	COPPOCK (38)	55	27
Conner Dam	Private	Fire Protection, Stock, Or Small Fish Pond	COPPOCK (25)	65	37
Conner Dam	Private	Fire Protection, Stock, Or Small Fish Pond	COPPOCK (24)	63	37
Iowa Noname92	Private	Fire Protection, Stock, Or Small Fish Pond	RUBIO (5)	59	25
Berg Dam	Private	Fire Protection, Stock, Or Small Fish Pond	COPPOCK (25)	45	29
Bechert Dam - Lower	State	Fish and Wildlife Pond	COPPOCK (44)	451	7
Roadgrade Dam 7-75-13	Private	Other	NORTH SKUNK RIVER (1)	190	32
Roadgrade Dam 8-74-10	Private	Other	SKUNK RIVER (3)	51	22
Griener Dam	Private	Recreation	COPPOCK (15)	36	39
Molkenthin Dam	Private	Recreation	OLLIE (1)	108	30
Griener Dam	Private	Recreation	COPPOCK (15)	40	30
Sieren Dam	Private	Recreation	COPPOCK (25)	93	23
Belva Deer Park Sediment Dam	Local Gov	Recreation	COPPOCK (25)	149	29
Belva Deer Park Wetland Dam	Local Gov	Fish and Wildlife Pond	BELVA DEER LAKE (0)	277	30
Lake Belva Deer Dam	Local Gov	Recreation	COPPOCK (36)	8,100	55
Tierney Dam	Not Listed			146	14

Lake Belva Deer Dam is located on German Creek, a tributary of the North Skunk River located approximately 5 miles northeast of Sigourney in Lake Belva Deer Park.

Tierney Dam

Tierney Dam is located on a tributary of the South Skunk River on an agricultural tract of land approximately 3.56 miles northeast of Ollie.

Extent

Dams are classified according to the downstream damages that would occur if that dam were to fail. The more risk, the higher the standards that have to be met when that dam is constructed or modified.

There are three dam classifications: High Hazard, Moderate Hazard and Low Hazard. The classification is based on development downstream from the dam and may change over time because of new development since initial construction. The severity of damage could range from minor property damage, if a small impoundment failed, to deaths, injuries and extensive property damage if a large high hazard dam failed. Older dams may not have been built to the standards of its new classification. Below are the hazard classifications defined by Iowa Department of Natural Resources (DNR):

- High Hazard – Dams are classified as High Hazard when it is located in an area where dam failure may create a serious threat of loss of human life.
- Moderate (Significant) Hazard – A Moderate Hazard Dam is where failure may damage isolated homes or cabins, industrial or commercial buildings, moderately traveled roads, interrupt major

utility services, but are without substantial risk of loss of human life. Dams are also classified as Moderate Hazard where the dam and its impoundment are themselves of public importance, such as dams associated with public water supply systems, industrial water supply or public recreation or which are an integral feature of a private development complex.

- Low Hazard – Low Hazard dams are classified as such where damages from a failure would be limited to loss of the dam, livestock, farm outbuildings, agricultural lands and lesser used roads and where loss of human life is considered unlikely.

The Iowa DNR is responsible for tracking all dams that are greater than twenty-five feet high or have storage capacities of at least fifty acre-feet of water. Their inventory excludes all dams that are less than six feet high regardless of storage capacity and dams that store less than fifteen acre-feet of water regardless of height.

Of the twenty-seven dams within Keokuk County, twenty-five are classified as Low Hazard Potential and two, Lake Belva Deer Dam and Tierney Dam, are classified as Significant Hazard Potential. A Significant Hazard Potential means there is no probable loss of human life but probable economic loss including environmental damage and disruption of lifeline facilities (USACE, 2023).

Dam Classification Chart

Hazard-Potential Classification	Risk Involved with Dam Failure	Inspection Frequency
High	probable loss of human life	annually, by a registered professional engineer
Significant	no probable loss of human life but can cause economic loss or disruption of lifeline facilities	every three years by a registered professional engineer
Low	no probable loss of human life and low economic loss	every five years

The classification of dams reflects a dam's potential for doing damage downstream if it were to fail and does not indicate that a dam is in need of repair. The areas impacted are delineated using dam breach analysis. According to the US Army Corps of Engineers, only high hazard dams have inundation zone determinations. There are no High Hazard dams in Keokuk County.

Previous Occurrences

During the period covered in this plan (2014-2023) there have been no dam failures in Keokuk County and only two within the state of Iowa.

Probability

There have been no reports of dam failure in Keokuk County during the study period, or previously. The probability of future events is 0 events in 10 years = Unlikely.

Climate trends

One of the projected impacts of climate change is an increased frequency of severe storms. Changes in the intensity of precipitation events and flooding may have an effect on dams in Keokuk County.

Already observed in Iowa: An 8 percent increase in precipitation from 1873 to 2008.

Flood: Increasing. Precipitation is expected to increase in intensity, though not necessarily frequency. With average annual precipitation increasing 1" to 4" in any county by 2050, heavy precipitation events are likely to become more common. Eastern Iowa has measured a greater increase in precipitation than western Iowa which indicates greater likelihood of flooding in eastern Iowa (Iowa, 2023).

Dams that were designed decades ago are unsuited to a warmer world and stronger storms. The American Society of Civil Engineers, in its report card on infrastructure in 2017, gave the nation's dams a "D" grade. Aging structures along with rising temperatures and storm frequency suggests that there may be an increase in dam failures.

Vulnerability and Impacts

Dam Failure: Affected Jurisdictions			
	Delta		Richland
	Gibson		Sigourney
	Harper		South English
	Hayesville		Thornburg
	Hedrick		Webster
	Keota		What Cheer
	Keswick		Sigourney CSD
	Kinross		Keota CSD
	Martinsburg		Tri-County CSD
	Ollie	X	Keokuk County (Unincorporated)

Twenty-two of the twenty-seven dams are privately owned and located on agricultural land. The failure of any of these low hazard private dams would likely only affect the surrounding farmland. Few structures are present. Owners are required to conduct visual inspection for downstream development that could affect the hazard-potential classification once every five years.

Three Dams are associated with Lake Belva Deer. The largest, Lake Belva Deer Dam does have the potential to cause damage to several homes surrounding Belva Deer Lake and communities downstream. Inundation maps are not available for "significant hazard dams" however, the dam is surrounded primarily by agricultural land and the topography is such that a great deal of land area is available for inundation before it impacts the nearest community of Coppock, 36 miles downstream. More information is needed to fully understand vulnerability of any structures in the event of dam failure.

DAM FAILURE	
Keokuk County: Dam at Lake Belva Deer, Tierney Dam	
Vulnerability	Significant hazard dams, no inundation maps have been developed. Few structures are near the probable inundation zone
Impact	Dam failure will result in inundation of rural land. Keokuk County would benefit from further analysis of the topography and elevations of adjacent land
Private dams in Keokuk County (Rural and Government owned)	
Vulnerability	New development is unrestricted downstream from private dams

Impact	The consequences of a dam failure increase when new development occurs downstream, even when dam condition is unchanged
Impact	Individual decisions of area landowners can impact others in the watershed and increase hazard risk

Impacts of Climate trends. Increased volume of precipitation per storm would increase risk to aging dams.

Land use development. Development permitted below a dam would increase the hazard and potentially result in dam removal. Impacts include loss of the intended function and associated economic benefits of the dam.

Population patterns. An increase in residential housing in the potential inundation zone would elevate the hazard risk.

Animal, Crop, Plant Disease

This hazard includes diseases that affect trees, crops, plants, livestock and wildlife such as deer, birds, rodents, fish, insects and other living things. Infectious diseases are caused by diverse living agents that replicate in their hosts. The agents that cause disease fall into five groups: viruses, bacteria, fungi, and parasites (protozoa and worms) (Janeway CA Jr, 2001).

Large-scale infestations of insects or rodents negatively impact other life and are often fueled by environmental drivers or by the weakened health of another species.

Overpopulation and the geographic movement of wildlife can contribute to the spread of disease. For example, according to the Center for Disease Control, while deer are not infected with Lyme disease, they are an important source of blood for ticks and are important to tick survival and movement of Lyme infected ticks to new areas (CDC Lyme, 2023).

The private practitioner will likely be the first to witness the symptoms of animal disease epidemics. The United States Department of Agriculture monitors reports submitted by veterinarians and labs to identify patterns. Every year the Iowa Department of Agriculture and Land Stewardship (IDALS) conduct numerous animal disease investigations. The department is proactive in providing information to the agricultural community on medical concerns.

International travel and the movement of goods in the global economy create conditions where contamination of native species is unavoidable. “Incidents of animal or plant disease are not solely natural occurrences. Human actions are extensively implicated in the spread and outbreak of disease. In turn, disease affects human interests widely, and much effort is spent in the control of disease (Wilkinson, 2011).”

Location

The potential for Animal, Crop and Plant Disease is present throughout Keokuk County and its cities.

Livestock and crop farms are prevalent throughout Keokuk County and as part of the world food supply, constitute a substantial portion of the local economy. Due to the agricultural production of the area, a high impact occurrence of disease would affect the entire county and beyond.

The rich landscape of SE Iowa provides habitat for a great diversity of wildlife and plant species.

Affected jurisdictions: County and Cities

Extent

Different measures of severity apply to the various fields of study of disease in lifeforms other than humans, and a discussion of all of these is beyond the scope of this study.

For example, plant disease is measured on two scales, the Percent Disease Index (PDI), which is the percentage of diseased plants or parts thereof in the sample or population. The Disease Severity Index (DSI) is the extent or load of infection affecting the sample plant population. The US Department of Agriculture and the Department of Natural Resources both track and report animal disease under different methods.

For this report, we define an animal, crop, plant disease as a hazard event if it would have widespread social, economic or public health impacts.

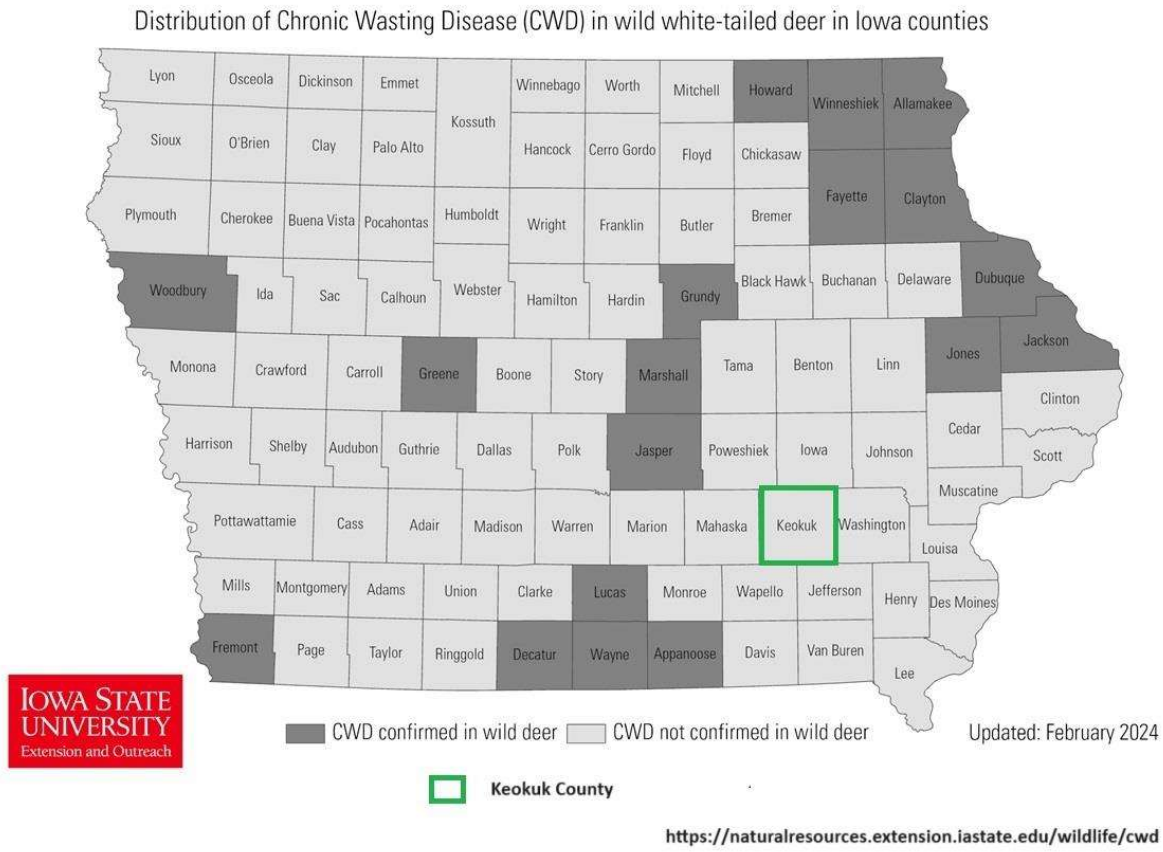
Previous occurrences

The emerald ash borer is an invasive insect known to be highly destructive to ash trees. News concerning the threat to ash trees in the area from the emerald ash borer was mentioned often during Keokuk County hazard mitigation discussions. By 2023, Emerald Ash Borer has been confirmed in all but two Iowa counties, including Keokuk County, according to the Iowa DNR. Experts suggest that emerald ash borer infestation will become more widespread, which will significantly impact trees and forested areas (IDNR, 2023).

Disease in local deer population. At least two diseases are of concern to the Keokuk County community, Chronic Wasting Disease (CWD) and Epizootic Hemorrhagic Disease (EHD), also known as “blue tongue”. While CWD has been detected in Iowa, it is not known to be present in Keokuk County; see map below.

EHD Outbreak in Iowa Deer Herd (from the publication Western Iowa Today 2023)

> An outbreak of Epizootic hemorrhagic disease is occurring amongst Iowa’s deer population, particularly in the eastern half of Iowa.
>
> Keith Ringler, Private Land Biologist for the Iowa Department of Natural Resources, says EHD is a native disease that causes significant morbidity and mortality among whitetail deer in North America. He says the virus is transmitted primarily by biting midges. Ringler says the incubation period for developing disease in deer is five to ten days. Ringler says the condition is also called blue tongue.
>
> Ringler encourages farmers harvesting crops or hunters finding dead deer near a water source to contact the DNR. Ringler says the first hard freeze will eliminate the midges, making this less prevalent through the fall and winter (Robinson, 2023).



Agriculture. A severe occurrence of infectious animal disease causes significant damage to markets. In 2022, Avian influenza outbreaks reduced egg production, driving prices to record highs. U.S. egg inventories were 29 percent lower in the final week of December 2022 than at the beginning of the year. By the end of December, more than 43 million egg-laying hens were lost to the disease itself or to depopulation since the outbreak began in February 2022 (USDA, 2023).

In 2015 Iowa experienced impacts to avian populations when 18 counties and 77 sites across the state were affected by highly pathogenic avian influenza (HPAI). The 2018 Iowa State Hazard Mitigation Plan noted that more than 33 million birds had to be euthanized and disposed of with the cost of replacement estimated at $83.6 million. The replacement cost does not include economic impacts from unemployment and costs to euthanize birds and dispose of carcasses.

Previous. Wet soil conditions are cited as the cause for an epidemic of soybean sudden death syndrome that occurred in Iowa in 2010.

Probability

Five events in the ten years 2014-2023 are noted above (50%) – Ash borer, 2 Deer diseases, 2 cases of Avian flu. Because this is a widely varied topic, the incidence of animal, crop and plant diseases is difficult to quantify, therefore the Planning Committee considered those 5 events, together with the climate changes that have already occurred as environmental guidelines to assess the current probability for animal, crop and plant disease.

Considering these factors, the probability for Animal, Crop and Plant Disease is determined to be 60% = Somewhat likely.

Climate trends

Changes in temperature, precipitation, water levels and a host of other environmental factors will affect the range and survival of many species of plants and animals. Winters are warming faster than summers; therefore, pest and pathogen survival may increase. Changes in the amount of moisture in the local environment will affect the health of plants and pathogens.

Wildlife. As one example of the effects of climate trends on wildlife, according to the National Audubon Society, "Scientists agree that we should take immediate action to hold warming at 1.5 degrees Celsius or else face increasingly dire consequences. If we do nothing, 1.5 degrees is imminent, 2 degrees could happen as soon as 2050, and 3 degrees could occur by 2080."

At an increase of 3 degrees Celsius, Highly and Moderately vulnerable birds may lose more than half of their current range as they are forced to search for suitable habitat and climate conditions elsewhere (Degrees, 2023). Fifty species of bird are classified as having Moderate (36) or High (14) Vulnerability to climate change in Iowa.

Changes already observed in Iowa by 2023.

A shorter, less severe winter may permit the survival of more pests and pathogens.

- ✓ Winters are warming six times faster than summers
- ✓ Increased precipitation (8 percent from 1873 to 2008)
- ✓ Abnormal seasons
- ✓ Longer average growing season by two weeks (frost-free seasons increased by an average of nine days since 1901)
- ✓ Longer pollen season, exacerbating allergies, asthma, and sinusitis
- ✓ Plants leafing out and flowering sooner
- ✓ Migrating pollinators miss plants that bloom too early, endangering both
- ✓ Birds migrating earlier, sometimes missing seasonal waters and food sources
- ✓ Habitable ranges changing (some native plants and animals having a harder time in Iowa, some from warmer regions moving north)
- ✓ Favorable conditions for survival and spread of many unwanted pests and pathogens

Lower air quality (effects on agriculture)

- ✓ Higher temperatures, sun, and stagnant air are generally more favorable to ozone formation. Rain, wind, humidity, clouds, and cool air limit ozone formation
- ✓ High ozone concentrations, which can be high in both rural and urban contexts may reduce soybean and corn yields by 5 and 10 percent, respectively
- ✓ Ozone also negatively impacts human and animal health

(Iowa, 2023)

Vulnerability and Impacts

Animal, Crop, Plant Disease: Affected Jurisdictions			
X	Delta	X	Richland
X	Gibson	X	Sigourney
X	Harper	X	South English
X	Hayesville	X	Thornburg
X	Hedrick	X	Webster
X	Keota	X	What Cheer
X	Keswick		Sigourney CSD
X	Kinross		Keota CSD
X	Martinsburg		Tri-County CSD
X	Ollie	X	Keokuk County (Unincorporated)

Unincorporated Keokuk County is primarily affected by diseases in agriculture and wildlife.
Cities are affected by diseases in domesticated animals, plants and trees.

Plants and wildlife. Pest and pathogen infestations can cause widespread tree and plant loss. Once infestation occurs, a pest may become endemic, causing repeated losses in subsequent growing years, and may ultimately lead to species extinction. Two historic examples of this are the devastating effects of the imported fungus which destroyed the American Chestnut, and Dutch Elm Disease. The Emerald Ash Borer is a current threat to Ash trees in Keokuk County.

Wildlife suffers from pest and pathogen infestations as well. Intensified drought and flood cycles has a negative impact on wildlife. A reduced quantity and quality of fresh surface water during drought impacts the health of wild plants and animals, while too much water and additional flooding damages habitat.

ANIMAL, CROP, PLANT DISEASE	
Keokuk Co Agriculture	In unincorporated Keokuk County, a large percentage of the county is agricultural. It takes time to mobilize assistance from state or federal sources. Animal disease outbreaks can rapidly overwhelm the local animal care system.
Vulnerability	With hundreds of thousands of head of livestock produced and transported in the state each year, Iowa could be a rich environment for a disease epidemic
Impact	An incident of high consequence disease will significantly limit the ability to move, slaughter, and export animals and animal products
Vulnerability	Agriculture is vulnerable to the introduction of foreign plant and animal diseases
Impact	Contamination can occur through material carried by international travel and trade, or by the importation of infected products
Vulnerability	Iowa is the nation's number one producer of corn, soybeans, eggs, and hogs
Impact	A local outbreak of disease in agricultural products could have widespread economic and social implications. Economic impacts of animal, crop or plant disease include not only loss of jobs and exports, but a reduction in the local and even global food supply
Keokuk County Wildlife	A rural county with a significant amount of habitat for wildlife. Climate trends affect habitat and range for traditional species

Vulnerability	There is a rising incidence of blue tongue disease (EHD) among a prolific deer population
Impact	Concerns about the health of deer reduces hunting, increasing the deer population
Impact	Overpopulation leads to increased disease transmission
Impact	Reduced harvesting of game deer has secondary effects: deer feeding on crops and residential plantings, and significant costs to insurance companies from the sheer number of deer/vehicle collisions on Iowa roads
Vulnerability	Local hunting of Whitetail deer in Iowa is not only an important cultural and recreational activity; deer meat is a low cost source of nutrition on which many families rely.
Impact	Doubts about the health of local deer means that a greater percentage of game may not be harvested, families will have to purchase more meat
Vulnerability	Deer hunting tourism is a significant source of fall revenue in rural SE Iowa
Impact	Reduced tourism from out of state hunters impacts sales tax revenue
Keokuk County & All Cities	Wild and domestic trees, plants and animals lack resistance to introduced pests and pathogens, mutations of native pathogens and changing trends in moisture and temperature
Vulnerability	International shipping of plants, animals, grains and containers make the introduction of non-native lifeforms virtually unavoidable
Impact	Changes in moisture, temperature and habitat weaken species and force relocation
Vulnerability	Ash trees throughout the US are infested with the Emerald Ash Borer, an exotic species fatal to Ash trees
Impact	Loss of shade and reduced benefits of evapotranspiration
Impact	Cost of removal and disposal of diseased trees
Impact	Cost to replace lost trees with a resilient species, and the extended time for new trees to reach maturity

Notes on Agriculture

Even rumors of an infectious animal disease can cause disruptions to the economy, often due to a lack of information or misunderstanding about food and health safety. One example of the potential scope of the problem comes from an Article in the Des Moines Register in September of 2019:

Iowa's $8 billion pork industry tests its readiness for African swine fever:

> Dermot Hayes, an Iowa State University agricultural economist, said that in the wake of an African swine fever outbreak, the U.S. likely would lose most of its export markets, which account for about 27% of the country's production.
>
> The lost exports would cut pork receipts by about 45%, and U.S. pork producers would lose $8 billion in just the first year, Hayes estimated.
>
> It likely would mean about 25% of Iowa's producers would close, he said. "When you lose your export markets, you have to downsize your industry," Hayes said.

Getting rid of the disease in the U.S. would be difficult, he said. Pigs are moved around the country daily, and with an incubation period of about 10 days, infected animals could be transported hundreds of miles before showing symptoms.

"We have about a million pigs moving on the road on any given day" in the U.S., Hayes said (Eller D. , Pork Industry Tests its Readiness, 2019).

Impacts of Climate trends. Timing of precipitation or drought is likely to impact agricultural practices, with increased possibility of delayed plantings, and disease outbreaks (Kansas, 2018).

"The National Wildlife Federation . . . released a report stating that the effects of climate change will likely cause increases in populations of disease-bearing deer ticks and mosquitoes and the spread of more, and stronger, poison ivy (Rogers, 2018)."

Projected changes by 2050:

- ✓ Loss of plant and animal habitat, and ecosystems in flux
- ✓ Invasion by non-native species and tropical pests and diseases
- ✓ Decreased corn yields due to heat stress, despite longer growing season and higher CO2
- ✓ Increased soybean yield due to higher CO2, though potentially less so in southern Iowa

Recent trends indicate that surface wind speeds (stand measurement height of 32 feet) over Iowa have been declining, which means less crop ventilation and more heat stress for plants and animals. Reduced winds also create favorable conditions for survival and spread of unwanted weeds, fungi, pests and pathogens. Waterlogged soil conditions during early plant growth often result in shallower root systems that are more prone to disease, nutrient deficiencies, and drought stress later in the season. Heavy spring rains, likely followed by summer droughts will tighten an already shortened planting window, exacerbating soil erosion and nutrient runoff (Iowa, 2023).

Land use development. Land use development is unlikely to increase or decrease risk from this hazard in the near future.

Population patterns. Population patterns are unlikely to increase or decrease risk from this hazard in the near future.

Human Epidemic or Pandemic

Epidemics are geographically localized, high occurrences of disease, while a Pandemic is an incidence of disease that is widely spread across a wide area including several countries.

Epidemic

The Centers for Disease Control and Prevention defines an epidemic as an unexpected increase in the number of disease cases in a specific geographical area. An epidemic disease doesn't necessarily have to be contagious. The term epidemic refers to a disease or health problem when cases are clearly above the expected occurrence in a community or region.

Pandemic

Pandemics are most often caused by viruses, such as influenza or Coronavirus Disease 2019 (COVID-19), which can easily spread from person to person. The World Health Organization declares a pandemic when disease growth is exponential.

From the CDC:

> Although pandemics occur infrequently, planning and preparing for a pandemic is important to ensure an effective response. Planning for and responding to a pandemic is complex and pandemics can affect everyone in a community. Therefore, public health officials, health care professionals, researchers and scientists in the United States and across the world are working together to plan and prepare for possible pandemics. Many resources are available to help international, national, state and local governments, public health and health care professionals, corporations, and communities develop pandemic preparedness plans and strengthen their capabilities to respond to different pandemic scenarios (CDC, 2023).

Location

This is a county-wide Hazard.

Affected Jurisdictions. All Jurisdictions are at risk from a Human epidemic or pandemic.

Extent

A Pandemic Severity Index chart from the Center for Disease Control shows fatality rates and projected deaths for each category. An example of the corresponding steps to take is given for each category (Reed, 2023).

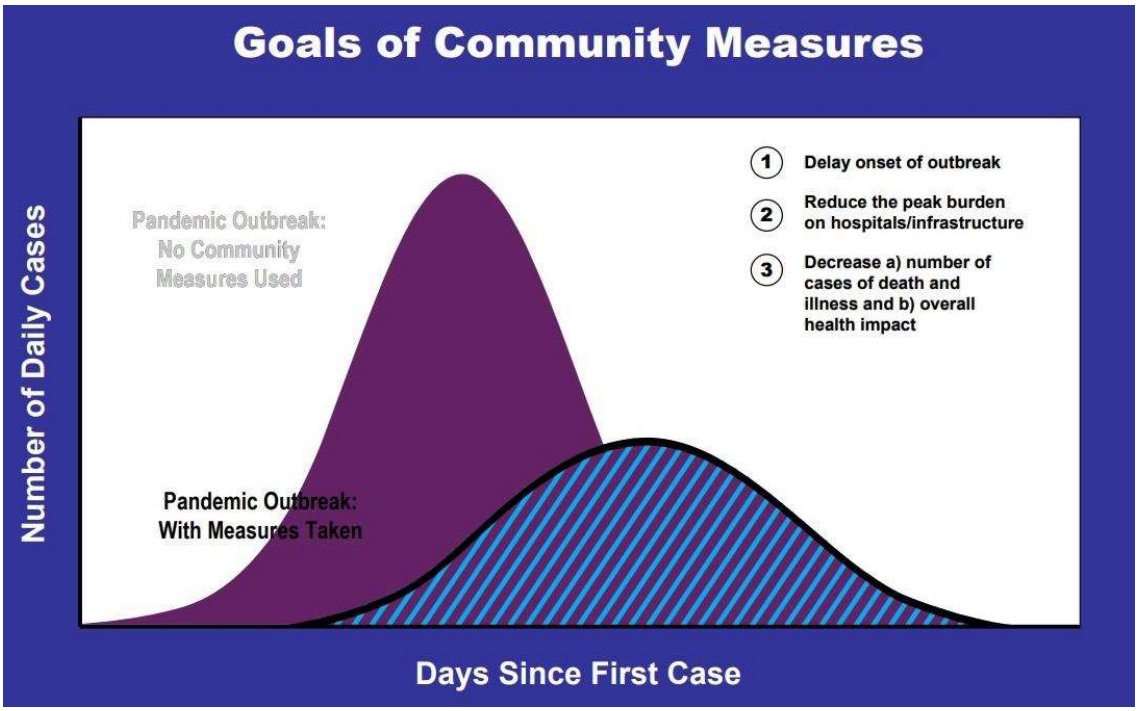
Community Strategies by Pandemic Flu Severity (1)

Interventions by Setting	Pandemic Severity Index 1	2 and 3	4 and 5
Home			
Voluntary isolation of ill at home (adults and children); combine with use of antiviral treatment as available and indicated	Recommend	Recommend	Recommend
Voluntary quarantine of household members in homes with ill persons (adults and children); consider combining with antiviral prophylaxis if effective, feasible, and quantities sufficient	Generally not recommended	Consider	Recommend
School			
Child social distancing –dismissal of students from schools and school-based activities, and closure of child care programs	Generally not recommended	Consider: ≤ 4 weeks	Recommend: ≤ 12 weeks
–reduce out-of-school contacts and community mixing	Generally not recommended	Consider: ≤ 4 weeks	Recommend: ≤ 12 weeks

Community Strategies by Pandemic Flu Severity (2)

Interventions by Setting	Pandemic Severity Index 1	2 and 3	4 and 5
Workplace/Community **Adult social distancing**			
–decrease number of social contacts (e.g., encourage teleconferences, alternatives to face-to-face meetings)	Generally not recommended	Consider	Recommend
–increase distance between persons (e.g., reduce density in public transit, workplace)	Generally not recommended	Consider	Recommend
–modify, postpone, or cancel selected public gatherings to promote social distance (e.g., stadium events, theater performances)	Generally not recommended	Consider	Recommend
–modify workplace schedules and practices (e.g., telework, staggered shifts)	Generally not recommended	Consider	Recommend

Community Measures. The purpose of community mitigation strategies in human disease transmission is to slow the spread of illness and reduce mortality. Unchecked outbreaks of disease result in additional injury or deaths when the healthcare system is overwhelmed with cases (CDC, 2023).



Public health programs guide community-based prevention planning, monitor current infectious disease trends, prevent transmission of infectious diseases, and provide early detection and treatment for infected persons. The Iowa Department of Public Health monitors diseases to identify patterns and provide information to the community on emerging medical concerns

Previous Occurrences

Many diseases throughout human history have been pandemic. In the 1918 Influenza pandemic which lasted about 2 years, about 28% of the US population of 105 million became infected, and 500,000 to 850,000 died (0.48 to 0.81 percent of the population), a Category 3 pandemic. As a result, in one calendar year average life expectancy dropped by 12 years. Influenza pandemics in 1957 and 1968 killed 70,000 and 34,000 people respectively worldwide.

COVID-19. There has been one significant pandemic in the study period 2014-2023. In the United States, more than six million people have been hospitalized and 1.14 million people have died from Covid-19 during the time from March of 2020 through September, 2023.

That level of mortality places the COVID-19 pandemic in Category 4 on the Severity Index.

In 2023, the CDC estimates that 77% of the US population over age 18 had been infected by Covid-19 since 2020. This does not mean that those people should not be vaccinated, because new variants continue to emerge, to which people are not immune.

Probability

There has been one event in ten years. 1/10 = 10%. The probability of a human epidemic or pandemic in Keokuk County is Unlikely in any given year.

Climate trends

Increased spread of some diseases. More favorable conditions for survival and spread of many pests and pathogens (Iowa, 2023).

Vulnerability and Impacts

Human Disease Epidemic or pandemic: Affected Jurisdictions			
X	Delta	X	Richland
X	Gibson	X	Sigourney
X	Harper	X	South English
X	Hayesville	X	Thornburg
X	Hedrick	X	Webster
X	Keota	X	What Cheer
X	Keswick	X	Sigourney CSD
X	Kinross	X	Keota CSD
X	Martinsburg	X	Tri-County CSD
X	Ollie	X	Keokuk County (Unincorporated)

HUMAN EPIDEMIC OR PANDEMIC	
County and Cities	
Vulnerability	Keokuk County is a rural community with one hospital. Health care systems have a limited capacity to shelter and treat large numbers of very ill patients
Vulnerability	It takes some time for medical professionals to develop and distribute vaccinations against new diseases or new variants of known viruses
Impact	In rural communities, the scope and magnitude of a contagious disease can escalate quickly to overwhelm medical staff and supplies
Impact	In the event of a virulent human epidemic or pandemic, it is likely that many people would be exposed before the danger is fully understood or any significant assistance could be provided by the State

Impact	Disruption of business, social life and loss of jobs and tax revenue occur due to an Epidemic or pandemic
Vulnerability	Misinformation, misunderstanding and mistrust can be spread rapidly through modern social media, leaving the general population confused by conflicting information
Impact	When the general public has a chaotic response to an epidemic or pandemic, there is a reduced effectiveness of efforts to contain or manage the situation, or to measure the results of various treatment methods
Schools	
Vulnerability	Schools are a place where many vulnerable people are concentrated in a small space, facilitating disease transmission
Impact	Disruption of the school year and a switch to no-contact learning have serious and long term effects on education of young people, who may have long term difficulty overcoming these fundamental changes

Impacts of Climate trends. The effects of climate change will likely cause increases in the survival of pests and pathogens.

Land use development. Land use development is unlikely to increase or decrease risk from this hazard in the near future.

Population patterns. Population patterns are unlikely to increase or decrease risk from this hazard in the near future.

Hazardous Materials Incident

The accidental release of flammable, combustible, explosive, toxic, noxious, corrosive, oxidizable, irritant, or radioactive substances or mixtures can pose a risk to life, health or property possibly requiring evacuation. As many as 500,000 products can be defined as hazardous chemicals that pose physical or health hazards.

For this plan, evaluation of this hazard included hazardous materials stored at fixed sites and transportation of hazardous materials, including radiological waste.

A fixed hazardous materials incident is the accidental release of chemical substances or mixtures which presents a danger to the public health or safety during production or handling at a fixed facility. Fixed hazardous material incidents usually affect a localized area, and the use of planning and zoning can minimize the area of impact.

The Secretary of the Department of Transportation has the authority to regulate transportation of hazardous materials, including transport over highways, roads, rail and pipelines.

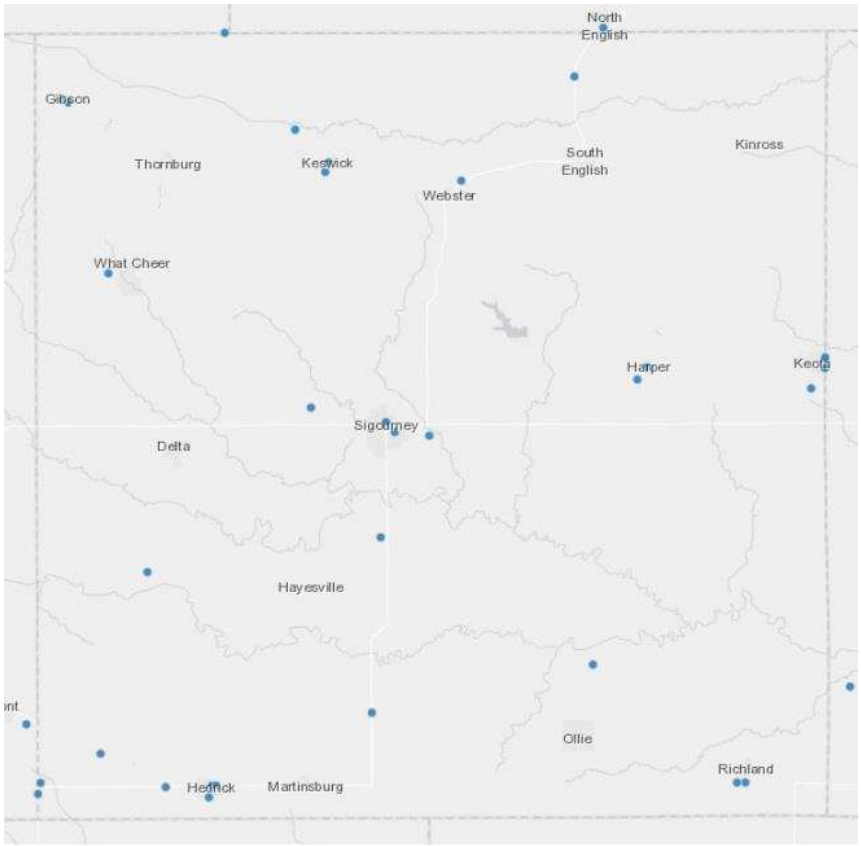
The Pipeline and Hazardous Materials Safety Administration (PHMSA) was delegated the responsibility to write the hazardous materials regulations, found in Title 49 of Federal Regulations Parts 100-185. Shippers and carriers in Iowa are required to comply with those hazardous materials regulations (PHMSA, 2023).

Location

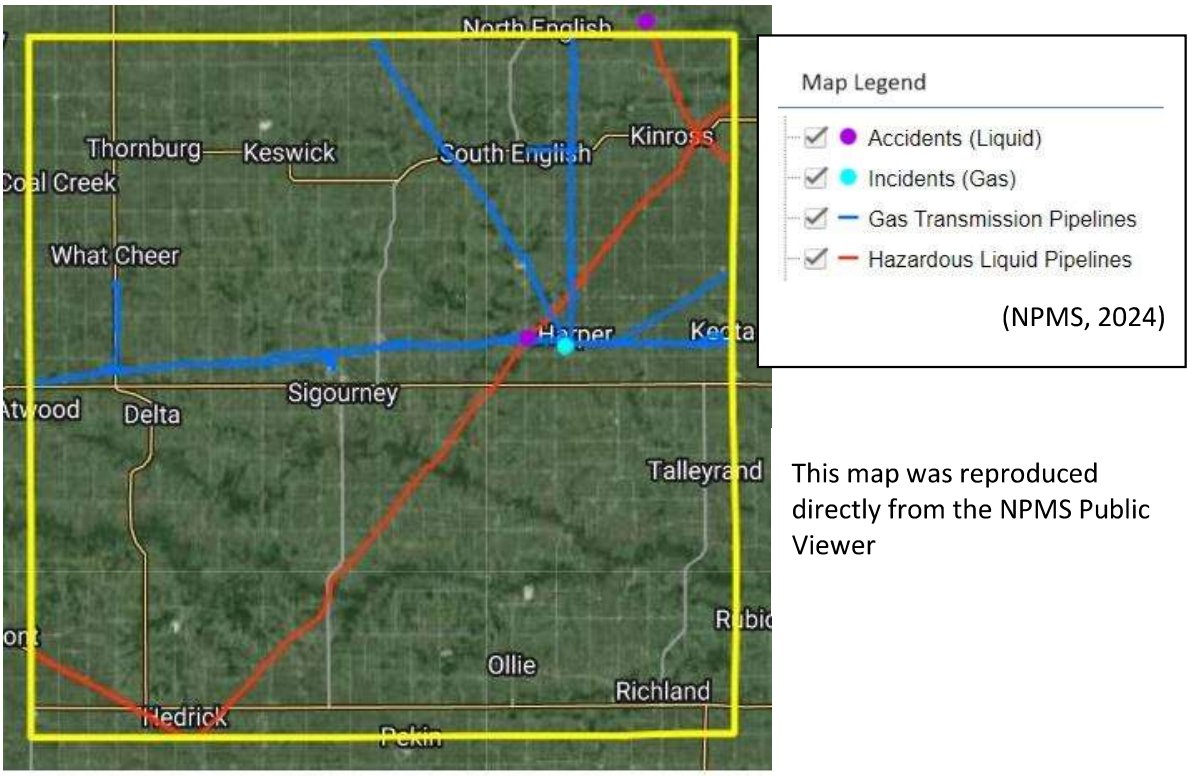
Hazardous materials may be spilled anywhere they are being used, stored or transported. In Keokuk County, spills typically occur at storage sites or on roads and highways. Pipeline and railroad incidents are infrequent. See map of Pipelines, Roads and Rail on the pages below.

Fixed Sites Chemical Storage Facilities Keokuk County Iowa

Iowa Geospatial Data Clearinghouse



Fixed Chemical Storage Facilities, Tier II Keokuk County Iowa



KEOKUK COUNTY IOWA PIPELINES

This map was reproduced directly from the NPMS Public Viewer

Transport of Radiological hazardous waste

From the Iowa State Plan 2023:

> Radiological incidents related to transportation are described as an incident resulting in a release of radioactive material during transit. The transportation of radioactive material by any means of transport is licensed and regulated by the federal government. When these materials are moved across Iowa highways, State officials are notified, and appropriate escorts are provided. As a rule, there are two categories of radioactive materials that are shipped over the interstate highways.
>
> Low-level waste consists primarily of materials that have been contaminated by low-level radioactive substances but pose no serious threat except through long-term exposure. These materials are shipped in sealed drums within placarded trailers. The danger to the public is no more than that which exists from other hazardous materials.
>
> High-level waste, usually in the form of spent fuel from nuclear plants, is transported in specially constructed casks that are built to withstand a direct hit from a locomotive. Potential rail and highway routes for the shipment of radioactive waste have been identified and mapped below (Iowa, 2023).

Potential Transportation Routes for Nuclear Waste. Source: Nevada Agency for Nuclear Projects

Affected Jurisdictions. All Jurisdictions could be affected by a hazardous materials incident.

Extent

As a standard, Hazardous materials have been grouped into nine classes.

Each class includes several subclasses. Warning stickers are required on hazardous materials containers of transport vehicles to provide critical information about the potential dangers involved.

Class	Material
1	Explosives
2	Flammable Gas
3	Flammable Liquids
4	Flammable Solids
5	Oxidizing Agents, Organic Peroxides
6	Toxic & Infectious Substances
7	Radioactive Substances
8	Corrosive Substances
9	Miscellaneous.

The National Fire Protection Association (NFPA) has developed a color-coded number system called NFPA 704. The system uses a color-coded diamond with four quadrants in which numbers are used in the upper three quadrants to signal the degree of health hazard (blue), flammability hazard (red), and reactivity hazard (yellow). The bottom quadrant is used to indicate special hazards. The NFPA system is useful for alerting personnel to the degree of hazard of the chemical and draws attention to storage needs and the necessary emergency equipment needed. This system does not indicate chronic health hazards.

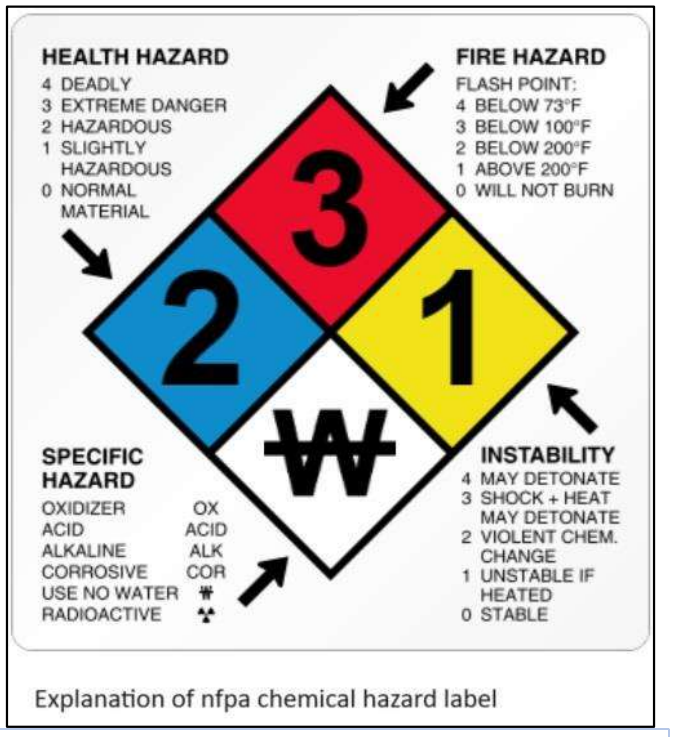
In addition to labels on hazardous materials containers, these markings may be posted on fences or doors to identify general hazards in storage areas.

- ✓ Red quadrant indicates flammability
- ✓ Blue indicates health hazard
- ✓ Yellow indicates instability
- ✓ White indicates a special hazard

Within the red, blue, and yellow quadrants is a hazard rating number. This number can range from 0 to 4, with 0 being no hazard to 4 being extremely hazardous.

Because the white quadrant indicates special hazards, the marking in this area will be either blank for no hazard or an abbreviation or symbol indicating a specific hazard.

Emergency Response Levels. Classifications of HAZMAT-related situations refer to the level of response needed.



Explanation of nfpa chemical hazard label

Hazardous Material Incident Classifications		
Level 1	Involves hazardous materials that can be contained, extinguished, and/or abated using immediately available public sector responders having jurisdiction (local Response)	Level 1 incidents present little risk to the environment and to public health with containment and cleanup.
Level 2	Involves hazardous materials beyond the capabilities of the first responders on the scene and could be beyond the capabilities of the public sector responders having jurisdiction (State response)	These incidents can pose immediate and long-term risk to the environment and public health and may need state- or federal-level level emergency assistance
Level 3	Involves hazardous material incidents beyond the capabilities of a single state or regional response team and requires additional assistance (Federal response)	These incidents generally pose extreme, immediate, or long-term risk to the environment and public health

Pipeline events. A Serious Pipeline Event is defined by the Pipeline & Hazardous Materials Safety Administration (PHMSA) as those incidents that involve a fatality or injury requiring in-patient hospitalization. A Significant Pipeline Event is defined by the PHMSA as those incidents reported by pipeline operators when any of the following specifically defined consequences occur:

1. Fatality or injury requiring in-patient hospitalization
2. $50,000 or more in total costs, measured in 1984 dollars
3. Highly volatile liquid releases of 5 barrels or more or other liquid releases of 50 barrels or more
4. Liquid releases resulting in an unintentional fire or explosion (PHMSA, 2023).

Previous Occurrences

The Iowa DNR Hazardous Substance Incident Tracking Database provides hazardous materials spill data, from both fixed sites and roads. Since the year 2014, 39 hazardous material spills have been recorded in Keokuk County, from a single quart of transmission fluid to 3000 gallons of mouthwash. Agricultural chemicals (fertilizer/pesticide) and diesel fuel were the most commonly spilled material, with 10 events each over 10 years. There were seven transformer oil incidents and 3 manure spills during that time.

KEOKUK COUNTY HAZMAT INCIDENTS 2014-2023

Spill Date	Responsible Party or Reporter	Type	Amount	Unit	Material Name
4/13/2014	MidAmerican Energy	Transformer oil/PCB	10	gal	Transformer Oil (Unknown PCB)
4/13/2014	Alliant Energy	Transformer oil/PCB	5	gal	Transformer Oil (Unknown PCB)
6/19/2014	Liqui-Grow, Inc.	Fertilizer/Pesticide	260	gal	Warrant Herbicide
11/12/2014	LDR Ranch	Manure	1800	gal	Manure Hog
5/3/2015	Unknown	Petroleum	10	gal	Oil
6/3/2015	Lee,Barry	Fertilizer/Pesticide	50	gal	Glyphosate herbicide
7/21/2015	Unknown	Petroleum	1	gal	Diesel Fuel
4/20/2016	Vision Ag LLC.	Animal/Vegetable Product	4	gal	Crop Oil
4/20/2016	"	Chlorine	900	gal	Water
4/20/2016	"	Fertilizer/Pesticide	8	gal	2,4-D, salts and esters
7/7/2016	Chamness Technol	Organic Chemical	3000	gal	Body Wash
7/7/2016		Organic Chemical	3000	gal	Mouth wash
9/14/2016	Alliant Energy	Transformer oil/PCB	10	gal	non-PCB Oil
12/14/2016	Interstate PowerLight	Transformer oil/PCB	10	gal	non-PCB Oil
5/8/2017	Agriland F.S.	Fertilizer/Pesticide	1500	gal	32% Liquid Nitrogen Fertilizer
6/22/2017	Vision Ag	Petroleum	65	gal	Hydraulic Oil
7/9/2017	Vision Ag LLC.	Petroleum	1	gal	Hydraulic Fluid
6/15/2018	Alliant Energy	Transformer oil/PCB	150	gal	Transf Oil (Non PCB)
8/13/2018	Eichelberger Farms	Petroleum	200	gal	Diesel Fuel
5/22/2019	Vision Ag LLC.	Fertilizer/Pesticide	3	gal	Trisidual Herbicide
4/29/2020	Buch Farms, LLC	Manure	500	gal	Manure Hog
5/11/2020	Unknown	Inorganic Chemical	1	Unk	Calcium Chloride
8/10/2020	Alliant Energy	Transformer oil/PCB	1	gal	Transformer Oil (Non PCB)
8/10/2020	"		8	gal	Transformer oil (PCB)
8/10/2020	Koch Nitrogen Company	Fertilizer/Pesticide	100	lbs	Anhydrous Ammonia - Ag related
12/5/2020	Dietrich Hauling	Manure	500	gal	Manure
3/30/2021	Vision Ag LLC.	Fertilizer/Pesticide	1050	gal	32% Liquid Nitrogen Fertilizer
3/30/2021	"	Inorganic Chemical	210	gal	Ammonium thiosulfate

4/21/2021	Vision Ag LLC.	Fertilizer/Pesticide	300	lbs	DAP (Diammonium Phosphate)
4/21/2021	"		7	ton	Potash
6/16/2021	Mccullough, Mark	Animal/Vegetable Product	5	gal	Crop Oil
6/16/2021	"	Fertilizer/Pesticide	250	gal	Roundup Herbicide
7/6/2021	Custard Insurance Adjusters	Petroleum	1	gal	Diesel Fuel
11/15/2021	Tahri,Adil	Petroleum	10	gal	Gasoline
2/4/2022	Casey's General Stores, Inc.	Petroleum	10	gal	Gasoline E-10
7/13/2022	Elliott Oil Company	Petroleum	25	lbs	Diesel Fuel
12/15/2023	Sylvester,Philip	Organic Chemical	1	gal	Antifreeze
12/15/2023	"	Petroleum	1	qt	Transmission fluid

Pipeline spills

Keokuk County. One Pipeline incident occurred on December 23, 2019, when 3 million cubic feet of Natural Gas was released at the rural compressor station near Harper.

12/23/2019	Natural Gas Pipeline Co of Am	Propane/LPG/Natural Gas	3,000,000	cf	Natural gas

This report includes all pipeline systems including Gas and Hazardous Liquids
PHMSA Pipeline Incidents: (2004-2023)
Incident Type: All Reported **System Type:** (All Column Values) **State:** IOWA

Calendar Year	Number	Fatalities	Injuries	Total Cost As Reported
2004	14	0	1	$888,105
2005	11	0	1	$1,152,601
2006	8	0	0	$581,093
2007	5	0	0	$341,393
2008	14	0	0	$1,475,040
2009	10	0	0	$684,536
2010	12	0	3	$2,693,903
2011	12	0	0	$8,097,866
2012	14	0	2	$2,017,354
2013	14	0	0	$2,571,119
2014	8	0	0	$924,368
2015	4	0	1	$229,186
2016	6	0	0	$201,368
2017	5	0	0	$2,928,408
2018	4	0	0	$3,913,981
2019	8	0	0	$772,847
2020	9	0	0	$3,170,119
2021	11	0	0	$2,523,647
2022	8	0	0	$384,412
2023	3	0	0	$240,366
Grand Total	**180**	**0**	**8**	**$35,791,712**

PHMSA Pipeline Incidents: Multi-Year Averages (2004-2023)
Incident Type: All Reported **System Type:** (All Column Values) **State:** IOWA

Iowa. During the last 20 years, records indicate that eight people were injured and none were killed in pipeline events in Iowa. Of all events recorded, 80 were classified as Significant and one Serious event occurred in 2015 when one person was injured. The events that occurred during the 10 year period from 2014 through 2023 and shown in the table below, represent only 37% of all incidents in the last two decades, an indication that safety has improved (PHMSA2, 2024).

Radiological incidents

"Since 1990, hundreds of shipments have been made through Iowa. There have been no occurrences of a radiological incident in Iowa. Transportation accidents are the most common type of incident involving radioactive materials because of the sheer number of radioactive shipments" (Iowa B, 2023).

Probability

Probability for a hazardous materials spill in Keokuk County is 39 events/10 years = > 100%, Very likely.

One of these was a pipeline incident that occurred in 2019.

Climate trends

HazMat and weather: As temperatures rise, the length of tornado season may increase. Such an increase would statistically increase the risk that a tornado could impact a fixed chemical storage site or transportation vehicle. Some evidence suggests that 'Tornado Alley' – an area most favorable to tornado formation – is moving east, but the greatest effect of this is in the South. The likelihood of a tornado in any given part of Iowa has not significantly shifted.

Vulnerability and Impacts

Hazardous Materials Incidents: Affected Jurisdictions			
X	Delta	X	Richland
X	Gibson	X	Sigourney
X	Harper	X	South English
X	Hayesville	X	Thornburg
X	Hedrick	X	Webster
X	Keota	X	What Cheer
X	Keswick	X	Sigourney CSD
X	Kinross	X	Keota CSD
X	Martinsburg	X	Tri-County CSD
X	Ollie	X	Keokuk County (Unincorporated)

Affected Jurisdictions: All jurisdictions have the potential to be impacted by a Hazardous Materials release.

HAZARDOUS MATERIALS INCIDENTS	
All jurisdictions	
Vulnerability	According to FEMA, there are six types of injury that humans experience as a result of a hazardous materials incident: Thermal Harm, Radiological Harm, Asphyxiation, Chemical Harm, Etiological (Biological) Harm, and Mechanical Harm. (Hazardous Materials, 2019).
Impact	All of these threaten health and life, depending on the degree of exposure.
Keokuk County	
Vulnerability	Farm chemicals are frequently transported on local roads and highways, often at slow speeds on narrow roads
Impact	Conflicts between vehicles on the road or driver error can result in spills of hazardous materials
Vulnerability	In 2022 there were an estimated 172,000 Hogs and Pigs in Keokuk County. Most of these are in confinement facilities
Impact	Weather events such as tornados or power outages can result in livestock injury and manure spills at facilities

Impact	If live animals are exposed to severe weather events such as tornado, small farmers have a significant challenge to contain and protect the health of livestock and humans
Vulnerability	Transportation accidents can result in manure spills from tanks and containers during transport
Impact	Manure spills can contaminate water resources and cause adverse environmental impacts. Manure contains nutrients and pathogens, such as bacteria, viruses, and parasites that can infect humans and enter groundwater
City of Gibson	
Vulnerability	A fertilizer plant is adjacent to the city. This plant was recently enlarged
Impact	If a Hazardous Materials spill of fertilizer or components of fertilizer occurred, the population of Gibson could be exposed to toxic chemicals through the air and surface flow of stormwater

Impacts of Climate trends. Increased or decreased tornado activity would impact the security of hazardous materials stored at fixed sites or the transportation of hazardous materials. An increase or decrease in winter storms would also have positive or negative impacts on these. Additional precipitation intensity will likely result in higher levels of agricultural chemicals present in local streams and rivers.

Land use development. From FEMA regarding Land Use Policies:

"Proximity of these facilities to residential areas and businesses creates the potential for devastating impacts should a release or explosion occur. Jurisdictions should consider zoning and regulations to ensure that hazardous facilities are not located near residents, schools, and businesses and that future development is restricted within a certain distance of facilities that store hazardous materials" (HazMat, 2019) .

Population Patterns. An increase in population near HazMat storage or transportation routes would place more people at risk.

Case Study: Land Use Policy

On April 17, 2013, an explosion occurred at a facility located in the city of West, Texas, that was storing 30 tons of fertilizer-grade ammonium nitrate. It killed 15 and injured hundreds. Nearby homes and businesses were severely damaged, and many were destroyed.
Lack of effective zoning restrictions was one issue that led to the severity of this incident. The facility in West was built in an area of open fields in 1961, but the area did not have any regulations restricting encroachment. Over the subsequent 50 years, two schools, a playground, an apartment complex, and a nursing home were all built in proximity to the fertilizer facility. (HazMat, 2019)

Section C: Mitigation Strategy

C1. Capabilities Assessment

The ability of a community to respond and recover from disasters is a function of the capabilities and resources available. 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. In addition to reliance on the skills and abilities of staff, services may be acquired by contract for special skills such as grant writing or engineering.

For much of the year, schools are responsible for nearly every child in a community and employ many people. Schools, therefore, have a special interest in ensuring public safety from hazardous events. Other educational opportunities offered to a community can make pre-disaster planning and post-disaster management more effective.

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 tool and that the tool is currently in use.

Emergency Response Services

Various support agencies exist to respond to the many hazards that could occur within the County. These agencies include the Keokuk County Communications Center/E911, Keokuk County Emergency Management, Keokuk County EMS, the Keokuk County Health Center, the Keokuk County Sherriff's Office, the Sigourney Police Department, the Keota Police Department, the Southern Iowa Response Group (SIRG) Haz-Mat Team (out of Ottumwa), and 10 fire departments.

Law Enforcement

The Keokuk County Sheriff's office serves as the primary law enforcement agency for unincorporated Keokuk County, the smaller cities in the county and the Keokuk County Courthouse. The cities of Keota, Richland, and Sigourney each have their own police department.

Ambulance & Hospital

The ambulance service in Keokuk County operates out of the Keokuk County Health Center. The primary hospital is the Keokuk County Health Center, which is located in Sigourney and serves the residents of Keokuk County.

Fire Departments

Keokuk County supports the following fire departments: Delta, Hedrick, Keota, Keswick, Sigourney, Richland, What Cheer, and North Keokuk County (Webster) Fire Departments. These departments serve their associated cities and the rural and unincorporated areas of Keokuk County. Each department has mutual aid agreements with other nearby departments, to assist in response efforts.

Map of Emergency Services
Keokuk County, Iowa

Map features are representations of original data sources and do not replace or modify land surveys, deeds, or other legal instruments defining land ownership or use. There is no expressed or implied warranty of accuracy, quality, or completeness of any specific purpose or use.

Map prepared by Area 15 Regional Planning Commission
Sources: Iowa DNR & Iowa DOT - 2018 -

Miles
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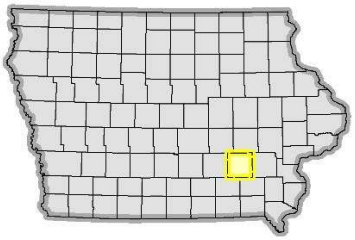
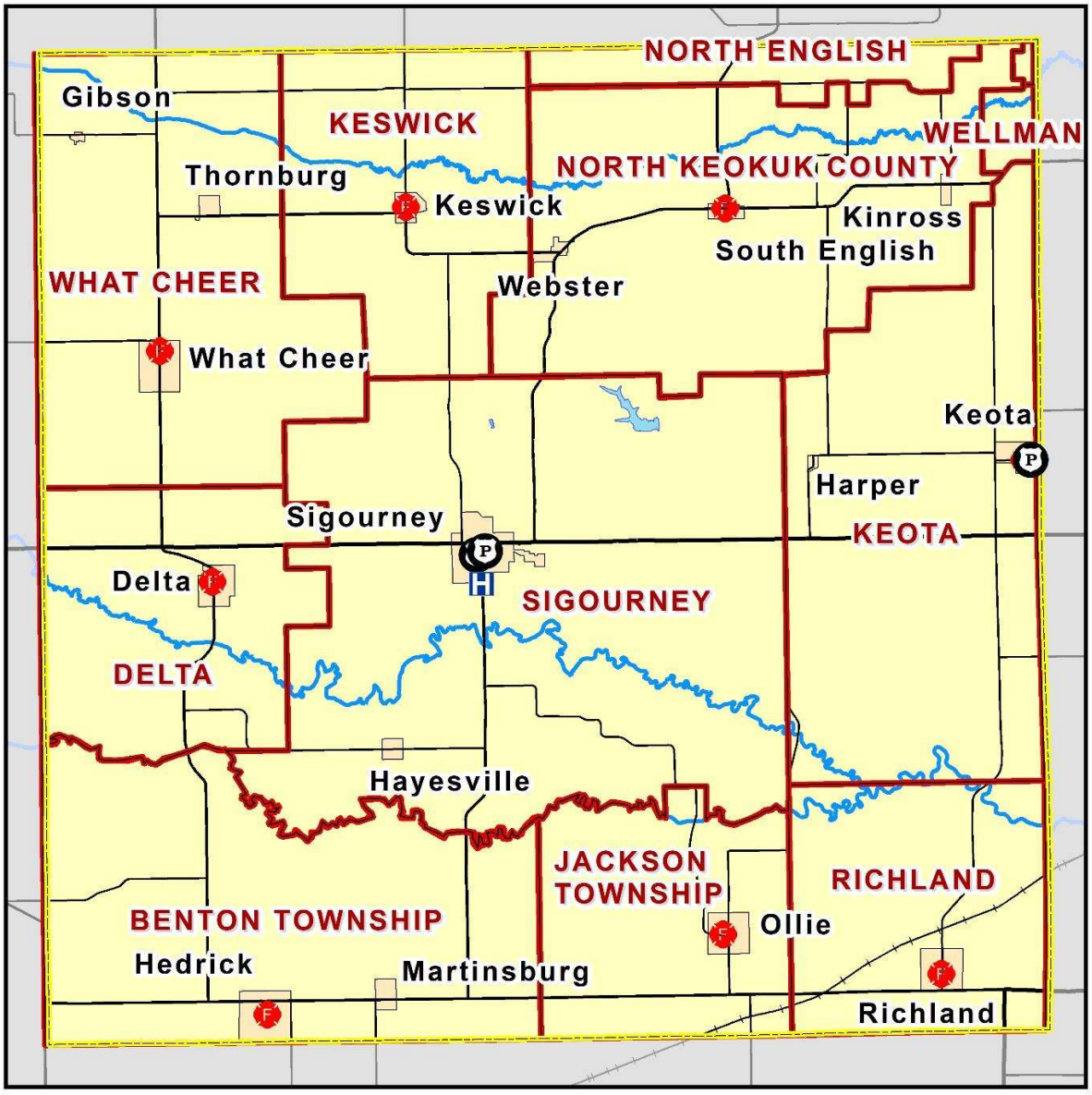
Legend

- Keokuk County
- Cities
- Fire Districts
- Firehouses
- Police Department
- Health Center

Road Type

- Principal Arterial
- Minor Arterial
- Major Collector
- Railroads
- Rivers
- Lakes





C1-a Existing Institutions, Plans, and Ordinances

CAPABILITY ASSESSMENT SMALL CITIES

Pop 300 or fewer	311	43	124	68	279	104	110	160	252	59	145
Existing Institutions, Plans, and Ordinances	Delta	Gibson	Harper	Hayes-ville	Keswick	Kinross	Martins-burg	Ollie	South English	Thorn-burg	Webster
Building Code & Permits	2024 update	No	YES	No	No	No	No	No	No	No	YES
Zoning Ordinance	No	No	No	No	No	No	No	No	No	No	YES
Subdivision Ordinance	No	No	No	No	No	No	No	No	No	No	No
Floodplain Ordinance	No	No	No	No	No	YES	No	No	No	No	No
Growth Management Ordinance	No	No	No	No	No	No	No	No	No	No	No
Site Plan Review Requirements	No	No	No	No	No	No	No	No	No	No	No
Comprehensive Plan	No	No	No	No	No	No	No	No	No	No	No
Capital Improvement Plan	No	No	No	No	No	No	No	No	No	No	No
Economic Development Plan	No	No	No	No	No	No	No	No	No	No	No
Emergency Operations Plan	No	No	No	No	No	No	No	No	Fire Dept	No	Water System
Post-Disaster Recovery Plan	No	No	No	No	No	No	No	No	No	No	No
Financial Capabilities											
Capital Improvements Project Funding	Limited	No	Limited	No	YES	No	Limited	Limited	YES	No	Limited
Authority to levy taxes/Local option sales tax	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Water, Sewer, Gas, or Electric service Fees	W,S	No	No	No	No	No	No	No	W,S	No	W,S
Incur fees for new development	No	No	No	No	No	No	No	No	No	No	No
Incur debt through GO funds or special tax bonds	No	No	No	No	No	No	No	No	No	No	No
CDBG Grants	YES	YES	No	YES	YES	YES	No	YES	YES	No	YES
Federal funding programs	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
State funding	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Administrative and Technical Capability											
Emergency Manager	K Co	K Co	K Co	K Co	K Co	K Co	K Co	K Co	K Co	K Co	K Co
Grant writers: Area-15 Planning Comm, Local, other	A-15	A-15	A-15	A-15	A-15	A-15	A-15	A-15	A-15	A-15	A15 & Local
Staff Planner or Engineer	No	No	No	No	No	No	No	No	No	No	No
Personnel skilled in GIS and/or HAZUS	No	No	No	No	No	No	No	No	No	No	No

Cities under 350 pop	Delta	Gibson	Harper	Hayes-ville	Keswick	Kinross	Martins-burg	Ollie	South English	Thorn-burg	Webster
City hall building & Condition	Good		Poor		Good	Good		Good	Good	Very Good	Good
Public Works Building/Maintenance shop	Good				Good		Good	Good			Good
City Police Department											
City Fire Departments	YES				YES						
Rural Fire Departments		W Cheer	Keota			N Keokuk	Hedrick		N Keokuk	W Cheer	N Keokuk
RWA Infrastructure		PWA	WRWA		WRWA	WRWA	WRWA	WRWA		PWA	
Water treatment plant & condition	Good										Good
City owned Water lines & condition	Good		Good		Updated 2018				Very Good		Very Good
City owned Water Tower & condition	Good										
Wastewater treatment plant	Ok	All septic	Russ		Russ	Russ	Russ	Russ		All septic	
Lift station and condition	Ok										
Sewer lagoons & condition	2028 upgrade								Good		
Electric Plant/Substation	No	No	No	No	No	No	No	No	No	No	No
Natural Gas Plant	No	No	No	No	No	No	No	No	No	No	No

Cell Towers / Radio Towers	No	No	No	No	No	No	No	No	No	No	No
Backup Generators	No	No	No	No	No	No	No	No	No	No	No
Sirens	No	No	No	No	No	No	No	No	1 Manual Op	No	No
Community Shelter	No	W Cheer	No	No	YES	No	No	No	No	YES	YES
Public Tornado shelter	No	No	No	No	No	No	No	No	No	No	No
Tie down ordinance for mobile homes	No	No	No	No	No	No	No	No	No	No	No
RV Park?	No	No	No	No	No	No	No	No	No	No	No
Sheriff's Department & Jail	Sigourney										
Keokuk County Hospitals & Clincs	Sigourney										
KCHC Clinics	Hedrick, Richland										
River Hills Community Health Cntr	Sigourney										
Iowa State Patrol District 13	Headquarters: Mount Pleasant Iowa										

CAPABILITY ASSESSMENT: Larger communities

Population greater than 300	10,033	813	883	497	1835	724
Existing Institutions, Plans, and Ordinances	Keokuk County	Hedrick	Keota	Richland	Sigourney	What Cheer
Building Code & Permits	No	YES	YES	YES	YES	YES
Zoning Ordinance	No	YES	YES	YES	YES	No
Subdivision Ordinance	No	YES	No	YES	YES	No
Floodplain Ordinance	No	No	YES	No	No	No
Growth Management Ordinance	No	No	No	No	No	No
Site Plan Review Requirements	No	No	No	No	No	No
Comprehensive Plan	2019	YES	2013	No	YES	No
Capital Improvement Plan	YES	No	No	No	No	No
Economic Development Plan	No	No	YES	No	YES	No
Emergency Operations Plan	YES	YES	No	YES	YES	No
Post-Disaster Recovery Plan	YES	No	No	No	No	No
Financial Capabilities						
Capital Improvements Project Funding	No	YES	YES	Limited	YES	Limited
Authority to levy taxes for specific purposes	YES	YES	YES	YES	YES	YES
Water, Sewer, Gas, or Electric service Fees	No	W,S	W,S	W,S	W,S	W,S
Incur fees for new development	No	No	No	YES	No	No
CDBG Grants	No	YES	YES	No	No	No
Federal funding programs	YES	YES	YES	YES	YES	YES
State funding	YES	YES	YES	YES	YES	YES
Administrative and Technical Capability						
Emergency Manager	YES	County	County	YES	YES	YES
Grant writers	A15 & Local	A15 & Local	A15 & Local	A15 & Local	A15 & Local	A15 & Local
Staff Planner or Engineer	YES	No	No	No	No	No
Personnel skilled in GIS and/or HAZUS	YES	No	No	YES	No	No

Cities over 350 pop	Keokuk County	Hedrick	Keota	Richland	Sigourney	What Cheer
City hall building & Condition	Courthouse	Good	Good	Good	Good	Good
Maintenance shop	Good	Good	Good	Good	Good	Good
City Police Department	No	No	No	No	YES until 7/1/2024	No
City Fire Departments	YES - 10	No	YES	YES	YES	YES
Rural Fire Departments	YES - 11	Independent			Independent	Independent
RWA Infrastructure	YES	WRWA				
Water tx plant & condition		WRWA	Good	Good	Good	Good

City owned Water lines & condition		Fair	Good	Good	Good	Good
City owned Water Tower & condition		New 2025	Good	Good	Good	Good
Wastewater treatment plant		Good	YES	YES	Good	Good
Lift station and condition		Good		YES	Good	Good
Sewer lagoons & condition		Good	YES	YES	Good	Good
Electric Plant/Substation	YES	No	No	No	No	No
Natural Gas Plant	YES	No	No	No	YES	YES
Cell Towers / Radio Towers, various locations	YES	YES	YES	YES	YES	YES
Backup Generators	No	4	2	YES	YES	YES
Sirens	YES	1 Automatic	1 Manual	1 Manual	YES	YES
Community Shelter	YES	YES			YES	No
Public Tornado shelter	YES	No	No	YES	No	No
Tie down ordinance mobile homes		YES	YES		No	No
RV Park	YES	No	2025	No	2	1
RV Park has shelter?	YES		YES		YES	YES
Sheriff's Department & Jail	Sigourney					
Keokuk County Hospitals & Clincs	Sigourney					
KCHC Clinics	Hedrick, Richland					
River Hills Community Health Center	Sigourney					
Iowa State Patrol District 13	Headquarters: Mount Pleasant Iowa					

CAPABILITY: School Districts

The three public school districts in Keokuk County (Keokuk, Sigourney and Tri-County) share similar capabilities for implementation of hazard mitigation activities. All districts have elected school boards officials, a superintendent, principals and vice principals for each school, teachers, and other administrative and support staff.

Schools

Does the school have this?	Keokuk CSD	Sigourney CSD	Tri-County CSD
Administrative Capability, sufficient staff	YES	YES	YES
Capital Improvement Plan (Fiscal planning)	YES	YES	YES
Designated emergency manager	YES	YES	YES
Emergency Management Plan (EOP)	YES	YES	YES
Post disaster recovery plan			YES
PTO/PTA/Booster Club	YES	YES	YES
Financial Capabilities	Keokuk CSD	Sigourney CSD	Tri-County CSD
CIP Funding		YES	YES
Authority to levy taxes	YES	YES	YES
Incur debt or Bonds	YES	YES	YES
CDBG Grant			
Federal funding programs	YES	YES	YES
State funding	YES	YES	YES
Public/Private partnerships, Corp donations	YES	YES	
Budget to raise match funds for mitigation grants		YES	
Other questions	Keokuk CSD	Sigourney CSD	Tri-County CSD
Has your District had positive response to Bond issues in the past?	YES	YES	YES
Is your District growing or declining in population?	Slow decline	Growing	Declining
Has the District taken measures to protect students from hazard events?	YES	YES	YES
Updated plans?		YES	
Conducted drills, or new types of drills?	YES	YES	YES
Any disaster education or weather science?		YES	

List any hazard events that have damaged your school in the last 10 years	
Keokuk CSD	No damage in the last ten years
Sigourney CSD	No damage from Hazards in the last ten years
Tri-County CSD	No damage from Hazards in the last ten years

Other School Capabilities

- School superintendents typically have the primary responsibility for grant writing, but also use outside services.
- Districts are partially funded through the statewide local option sales tax, which can be applied to hazard mitigation activities
- Districts are eligible to acquire funding through FEMA's Hazard Mitigation Assistance (HMA) grant program

C1-b Jurisdictions Can Build Upon Capabilities

Communities under 350 population (Delta, Gibson, Harper, Hayesville, Keswick, Kinross, Martinsburg, Ollie, South English, Thornburg and Webster) have little to no ability to expand capabilities, while communities over 350 (Keokuk County, Hedrick, Keota, Richland, Sigourney and What Cheer) have limited ability to expand capabilities. For more detailed information on small towns, see the detailed community profiles in Section G.

Jurisdictions can benefit from additional staff education in hazard vulnerability. Other educational and outreach capability could be improved with increased citizen involvement and ongoing public information programs.

Strategies that can be applied to improve capability include regular evaluation of existing regulations, the development, update and adoption of local plans, such as Comprehensive Plans, Economic Development plans and Capital Improvement Plans that include the mitigation strategies recommended in the 2024 Keokuk County Hazard Mitigation Plan for each locality.

Participation in the NFIP and adoption of floodplain regulations would reduce the risk from flood hazards (see Sec C2 below). Community programs such as StormReady, and increased public private partnerships are other ways to build capability.

Review of recommended mitigation strategies during the annual budget process may improve implementation. An Action Plan Summary Table included in Appendix G to provide an easy reference for that purpose. Specific communities affected are provided in a Table prefacing that Summary.

Listed in the table below are some specific suggestions to improve capability. Because there are 17 jurisdictions and 3 Schools, in the interests of readability, when the capability applies to all, they are not listed individually. When some entities are excluded, each jurisdiction will be listed. Reasons for exclusion include: The community is too small for the capability to be implemented, there is no political or public support for new regulations such as zoning, the community is not affected by SFHA flood hazard, and possibly other reasons.

Jurisdictions can improve capability	**Jurisdiction**	**Mitigation Actions that support this capability**
Improvements in funding for shelters and safe rooms	All jurisdictions	4
Installation of backup generators	All jurisdictions	3,22
Installation or upgrade of warning systems or sirens	All jurisdictions	21
Staff education	All jurisdictions	24
Hazard awareness education & outreach	All jurisdictions	18,19,24

Review Mitigation strategies during annual budget process for progress on implementation	All jurisdictions	1, 11,14,15
Update or adopt codes and regulations		
Building codes & permits	Keokuk County, Delta, Harper, Hedrick, Keota, Keswick, Richland, Sigourney South English, Webster, What Cheer	6
Floodplain management	Delta, Harper, Hayesville, Hedrick, Keota, Martinsburg, Ollie, Richland and South English	6
Develop, adopt and update local plans		
Comprehensive Plan	All Cities should have a comprehensive plan	
Economic development Plan	Hedrick, Keota, Richland, Sigourney, What Cheer	9
Capital improvement Plan	Hedrick, Keota, Richland, Sigourney, What Cheer	11
Continuity of government plan	Keokuk County, Delta, Harper, Hedrick, Keota, Keswick, Richland, Sigourney South English, Webster, What Cheer	8
Long term shelter plan	All jurisdictions	7
Post-disaster hazard analysis	All jurisdictions	
Public-private partnerships to improve public safety	All jurisdictions	
Continued public support for bond issues	Keota, Sigourney and Tri County School districts	

C2. Participation in the NFIP

Flood Insurance Rate Maps (FIRMs) show properties affected by floods that have at least a 1% chance of occurring in any given year. Generally, in Keokuk County these areas are adjacent to larger streams and the Skunk and English Rivers. Most of the SFHA floodplain is agricultural land, but a few residential and commercial structures are in the flood hazard area. See digital maps in Section B1, above.

Cities that do not intersect the Special Flood Hazard Area (SFHA) include Gibson, Thornburg and Webster. Webster has chosen to join the NFIP even though they are not in a Special Flood Hazard Area. While they do not have floodplain ordinances or issue permits, participation in the NFIP is a benefit to local property owners who wish to purchase flood insurance for their property.

Participation in the NFIP

Participation in the National Flood Insurance Program (NFIP) is voluntary. To join, the community must:

1. Complete an application
2. Adopt a resolution of intent to participate and cooperate with FEMA
3. Adopt and submit a floodplain management ordinance that meets or exceeds the minimum NFIP criteria. The floodplain management ordinance must also adopt any FIRM or FHBM for the community

Within participating communities, the Federal government makes flood insurance available throughout the community (NFIP Glossary, 2024).

Non-participating communities

Nine cities that are in the NFIP mapped SFHA floodplain do not participate in the NFIP. Participation is voluntary. Cities that have chosen not to participate in the NFIP are Delta, Harper, Hayesville, Hedrick, Keota, Martinsburg, Ollie, Richland and South English.

NOTE: The City of Sigourney joined the NFIP and adopted a FP Ordinance on June 19, 2014.

What happens if a community does not participate in the NFIP?

A community that does not join the NFIP after being identified for one year as floodprone, has withdrawn from the program, or is suspended from it, faces the following sanctions:

1. No resident will be able to purchase a flood insurance policy.
2. Existing flood insurance policies will not be renewed.
3. No Federal grants or loans for development may be made in identified flood hazard areas under programs administered by Federal agencies such as HUD, EPA, and SBA;
4. No Federal disaster assistance may be provided to repair insurable buildings located in identified flood hazard areas for damage caused by a flood.
5. No Federal mortgage insurance or loan guarantees may be provided in identified flood hazard areas. this includes policies written by FHA, VA, and others.
6. Federally insured or regulated lending institutions, such as banks and credit unions, must notify applicants seeking loans for insurable buildings in flood hazard areas that there is a flood hazard and that the property is not eligible for Federal disaster relief.

(NFIP Glossary, 2024)

NFIP NOTES: The County and all Cities in the planning area are in SFHAs with the exception of Gison, Thornburg and Webster.

NFIP Participating: Keokuk County, Kinross, Sigourney, What Cheer, (Webster participates even though they are not in a SFHA)
Non Participating: Delta, Harper, Haysville, Hedrick, Keota, Keswick, Martinsburg, Ollie, Richland, South English

Small Cities, pop below 350	Delta	Gibson	Harper	Hayes-ville	Keswick	Kinross	Martins-burg	Ollie	South English	Thorn-burg	Webster
NFIP Community?	No	No	No	No	No	Yes	No	No	No	No	Yes
Floodplain Manager		NSFHA				Yes				NSFHA	NSFHA
Date Adoption of FP Ord						8/16/2011					Joined NFIP 5/02/2023
Substantial damage or improvement assessment (See comments p 141)						Yes					
Determine Market Value						Assessed					
Total Cost of improvements						Total					
When cost exceeds 50%						Yes					

Cities with population greater than 350	Keokuk County	Hedrick	Keota	Richland	Sigourney	What Cheer
NFIP Community?	Yes	No	No	No	Yes	Yes
Designated Floodplain Manager	Yes				Yes	Yes
Date of Adoption of FP Ordinance. Permit required	5/01/2011				6/19/2014	8/9/2011
Substantial damage or improvement assessment; See p. 141	Yes				Yes	Yes
Determine Market Value	Assessed				Assessed	Assessed
Total Cost of improvements	Total				Total	Total
When cost exceeds 50%	Yes				Yes	Yes

Why communities do not participate in the NFIP:

Delta: The SFHA is at a lower elevation than the structures in the city. The city is on a hill. Cities of Harper, Hayesville, Martinsburg, Ollie, South English, Hedrick, Keota, Keswick and Richland: the SFHA is in a small and remote part of their city, and the community does not believe there is any threat to structures from flooding. See detail maps pages 49-56.

These cities will continue to consider NFIP participation and whether the benefits outweigh the costs for their individual communities.

Participating cities implement substantial improvement or substantial damage provisions of the NFIP:

When structures in the Special Flood Hazard Area (SFHA) are damaged or improved, National Flood Insurance Program (NFIP) participating communities have a responsibility to assess impacts before repairs can be made, no matter the cause of damage or reason for improvements. If the cost to repair or improve is 50% or more of the market value, the activity is considered “Substantial” and the structure must be brought into compliance with current local floodplain management standards (NFIP, 2023).

Each of the four NFIP participating jurisdictions with Zone A SFHAs in Keokuk County follows the method below to implement Substantial Improvement and Substantial damage regulations.

Determine Substantial improvements or Substantial damage

Market Value, Assessed Value: In Iowa, the assessor (or the Iowa Department of Revenue) estimates the value of each property. This is called the "assessed value." The assessed value is to be at actual or market value for most property taxes. For purposes of Substantial damage determination, the market value is for the structure only, excluding the value of the land.

Total costs for substantial damage: If the repairs needed to bring a structure to its pre-damage condition will equal or exceed 50% of the market value of the structure (not including the value of the land), the structure is considered to be Substantially Damaged. Likewise, if the proposed work to improve a structure will cost 50% or more of the value, the structure is considered to be Substantially Improved and must be brought into compliance with current local floodplain management standards.

A variety of factors must be included in the Cost of Repair calculations. Here are some examples:

a. Materials and labor cost (including donated or discounted materials and owner- or volunteer-completed labor)
b. Structural elements
c. Demolition and debris disposal
d. Contractor overhead or profit
e. Utility and service equipment
f. Elevation or floodproofing
g. Site preparations
h. Costs associated with complying with regulations or code requirements
i. Interior and exterior finishes

Determine percentage: Total costs/beginning value = percentage improvement

C3. Mitigation Goals

The purpose of mitigation is to protect life and reduce property damage. Mitigation is defined as any sustained action taken to reduce or eliminate long-term risk to life and property from a hazard event. Those concepts were found by the HMPC to be appropriate for Keokuk County.

Hazard Mitigation Goals	
Goal 1	Protect the health, safety and quality of life of citizens
Goal 2	Reduce or eliminate property loss, economic cost, and damage to the natural environment caused by a disaster
Goal 3	Ensure government operations, response, and recovery are not significantly disrupted by disaster events
Goal 4	Expand public awareness and support intergovernmental cooperation, coordination and communication to build a more resilient community

Objectives to support these Goals include

Objective 1: Update Plans and Regulations. Establish processes or regulatory measures that reduce local vulnerability to hazards and alleviate impacts such as death, injury, environmental damage, and property loss.

Objective 2: Structure and Infrastructure Projects. Encourage property protection measures and construction projects to prevent damage to life property and the environment.

Objective 3: Continuity of government. Provide for continued access to government and emergency services for all hazards and disaster events to preserve life and property.

Objective 4: Education and Awareness. Enhance public education to expand awareness and encourage intergovernmental cooperation, coordination, and communication to mitigate against all hazards.

Objective 5: Build capacity to prevent or reduce risks from all hazards for protection of citizens, property, and natural resources. Examples include installation and maintenance of sirens, backup generators and other relatively low cost safeguards.

Development of Action Steps

Mitigation can protect critical community facilities, reduce exposure to liability, and minimize disruption of community services. Examples of mitigation actions include land use planning, adoption of building codes, acquisition and demolition of structures in hazard-prone areas or ensuring that appropriate shelters are available. Mitigation actions should be cost-effective and environmentally sound.

C4-a Analysis of a comprehensive range of actions/projects

There are five mitigation action types:

- Structure/Infrastructure Projects: Modify or remove infrastructure to mitigate hazard
- Local Plans & Regulations: Using authorities, policies, codes to influence development
- Natural System Protection: Minimize damage by preserving natural system functions
- Education and Awareness Programs: Inform citizens on how to mitigate hazards
- 5% Projects: Actions not quantifiable by a Benefit Cost Analysis (sirens, generators, etc.)

Each jurisdiction considered options to reduce the impacts of hazards identified in the risk assessment including: take no action at this time, or take an action in one of the five mitigation action categories.

Mitigation Alternatives Considered

The Planning Committee evaluated mitigation alternatives. Actions recommended in this update include those that jurisdictions selected from the previous plan to be carried over, some new actions based on community needs and public comments, and suggestions selected or adapted from the 2013 publication *FEMA Mitigation Ideas*. The State of Iowa Hazard mitigation plan also provided useful guidance. Mitigation alternatives from other local plans were also included for consideration.

Some previously identified actions were deleted or slated for delay as detailed in a table in Section E.

Committee members discussed the mitigation needs of their respective communities and strategies that could be implemented in a five year time frame. Scoring based on community responses were used to prioritize potential actions that were recommended to the Board of Supervisors, City Councils and School Boards, who have the final authority over which actions to adopt.

C4-b. Compliance

For each of the hazards identified within the plan's risk assessment, at least one mitigation action is recommended for each affected jurisdiction. A scoring table in Appendix D tracks compliance with this requirement.

C5 Action plan

Section C5-a, below, outlines the method applied to prioritize each adopted action item, while Section C5-b displays a comprehensive action table that indicates how each activity meets FEMA requirements for hazard mitigation planning.

C5-a Prioritizing Mitigation Actions

The planning team agreed to use the scoring methodology described below to assist in prioritizing mitigation strategies. Costs and benefits were subjectively evaluated. The STAPLEE Method as shown in the table below was applied to each proposed action to help quantify benefits.

Local preference was given to the actions that mitigate hazards to new and existing buildings and infrastructure. Special consideration was also given to mitigation strategies that reduce hazards of greatest concern to the public. Surveys indicated that the top 3 concerns of the public are severe thunderstorms, tornados and winter weather. Dam Failure was uniformly the hazard of least concern.

Finally, each action was ranked in priority compared to the other mitigation actions by score.

Cost and Benefit	
1 point	Benefit expected to be equal to OR greater than cost
2 points	Benefit expected to be greater than cost AND ensure continuity of government
3 points	Benefit expected to be greater than cost AND mitigate multiple hazards
4 points	Benefit is expected to be greater than cost AND the action benefits underserved communities or socially vulnerable populations
5 points	Benefit expected to be significantly greater than cost OR the action is expected to prevent deaths or injuries

STAPLEE = 1 point for each category, up to 7	
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
Local emphasis = 1 point each	
1 point	Mitigates hazards to buildings and infrastructure
1 point	Mitigation for Severe storms (hail, high winds, lightning), Tornado, Winter weather
Total score = Priority	
10 or more	Priority A: High priority
6-9 points	Priority B: Medium priority
5 points or fewer	Priority C: Desirable if funding is available

C5-b Implementation and Funding

Each proposed activity is given a targeted implementation timeline in the table, based on a five-year plan. Jurisdictions will review potential mitigation opportunities during the annual budget process.

Any activity may be pursued at any time depending on the needs of the community or as funds become available. The variety of actions recommended provides each jurisdiction with opportunities to improve safety at all levels of financial ability.

Funding for Mitigation

The programs listed below are a sample of potential funding sources for mitigation activities.

For a comprehensive list of funding opportunities in the State of Iowa, the reader is referred to the excellent list of funding resources found in the 2023 Marion County Iowa Hazard Mitigation Plan at https://www.jeo.com/marioncounty-hmp published by JEO Consulting, under Marion County Hazard Mitigation Plan - Upfront and County Profile pages 231-256 Funding Guidebook.

FEMA Assistance Program	FED/LOCAL COST SHARE
Hazard Mitigation Grant Program (HMGP) project grant	75/25
Hazard Mitigation Grant Program Post Fire	75/25
Building Resilient Infrastructure and Communities (BRIC) project grant	75/25
BRIC – Economically Disadvantaged Rural Communities	Up to 90/10
Safeguarding Tomorrow Revolving Loan Fund Program	90/10
Flood Mitigation Assistance (FMA), FMA RL, FMA SRL	90/10
FMA – Socially Vulnerable Communities with a CDC Social Vulnerability Index (SVI) of 0.5 or greater	90/10

https://www.fema.gov/fact-sheet/summary-fema-hazard-mitigation-assistance-hma-programs

BRIC

In 2023, the Building Resilient Infrastructure and Communities (BRIC) program was authorized by the Biden Administration. BRIC is intended to shift the federal focus away from reactive disaster spending and toward research-supported, proactive investment in community resilience.

BRIC is focused on innovation, infrastructure projects benefitting disadvantaged communities, nature-based solutions, climate resilience and adaption and adopting hazard resistant building codes. A portion of the funding is allocated to Hazard Mitigation Planning.

Funding for Community Safe Rooms

Federal programs that provide funds for safe room construction include U.S. Department of Housing and Urban Development (HUD) Community Development Block Grant (CDBG) funds, Federal Housing Administration (FHA) mortgage insured financing, the FEMA Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation (PDM) grant program and Safe Schools 101.

Additionally, many states have developed initiatives for the construction of residential, public, and private safe rooms, including safe rooms in hospitals, emergency operations centers, first-responder facilities, schools, day care centers, manufactured home parks, private residences, community centers, senior centers, and campgrounds. For more information about safe room funding and initiatives, visit http://www.fema.gov/safe-rooms/public-and-community-safe-rooms

Action Plan Tables

Structure Infrastructure

Mitigation Action 1	**Improvements to infrastructure resilience**
Action description	Maintain, improve and protect public buildings, facilities, and utilities against all hazards. Apply protective film to windows, install lightning suppression devices, clean bridges and culverts, install protective materials with underground lines when the opportunity arises
Hazards addressed	Drought, Extreme heat, Expansive soils, Flood, High winds, Hail, Lightning, Sinkholes, Tornado, Wildfire, Winter storm
Jurisdiction affected	County, Cities, Schools
Responsible party	County EM & Supervisors, City & School Administrators
Goals	2,3
Score & Priority	12 A
Implementation timeline	12-60 months
Cost	Staff time; grant matching funds up to 25% of total project cost
Potential funding sources	HUD, CDBG, FHA, HMGP, BRIC Community Budget, Bonds, Safe schools 101, building maintenance fund

Mitigation Action 2	**Evaluate water redundancy and ensure water supply networks have reserve capacity and alternative supply paths**
Action description	Identify and maintain a backup water resource.
Hazards addressed	Drought
Jurisdiction affected	Thornburg, Webster
Responsible party	Public works officials

Goals	1,2,3
Score & Priority	11 A
Implementation timeline	36 months
Cost	To be determined
Potential funding sources	HMGP 5% Project, fundable under current operating budgets

Mitigation Action 3	**Equip critical facilities and community shelters to accept generators, by hard-wiring or install fixed generators**
Action description	Provide safe shelter for residents during power outages or when they are displaced from home by hazards
Hazards addressed	Extreme Heat, Severe storms (hail, high wind, lightning), Tornado, Winter storm
Jurisdiction affected	County, all Cities, Schools
Responsible party	County EM, City & Town Administrators, Superintendent of Schools
Goals	1,3
Score & Priority	11 A
Implementation timeline	12-24 months
Cost	$2000 per facility
Potential funding sources	HMGP, Community Budget

Mitigation Action 4	**Facilitate the funding, installation and improvement of handicap accessible community shelters and safe rooms**
Action description	Improve community shelters, apply for OEM/FEMA storm shelter assistance, OEM evaluation and Safe Schools 101
Hazards addressed	Extreme Heat, Severe storms (hail, high wind, lightning), Tornado, Winter storm
Jurisdiction affected	County, all Cities, Schools
Responsible party	County EM, City & Town Administrators, Superintendent of Schools
Goals	1,2,4
Score & Priority	10 A
Implementation timeline	12-60 months
Cost	Staff time; grant matching funds up to 25% of total project cost
Potential funding sources	HUD, CDBG, FHA, HMGP, BRIC Community Budget, Bonds, Safe schools 101

Plans & Regulations

Mitigation Action 5	Coordinate with State agencies to improve access to funding
Action description	All jurisdictions work together to develop a strategy to track funding opportunities and apply for hazard mitigation grants on an annual basis
Hazards addressed	All hazards
Jurisdiction affected	County, Cities, Schools, State agencies
Responsible party	County Supervisors, City Councils, School Administration, State agencies
Goal	1,3
Score & Priority 8 C	10 A
Implementation timeline	12-24 months
Cost	Area 15, Staff time or hire
Potential funding sources	General fund

Mitigation Action 6	Make use of effective codes and zoning tools to regulate construction in unsuitable areas
Action description	Update or Adopt new building regulations. Join NFIP
Hazards addressed	Expansive Soil, Flood, Sinkhole, Winter Storm, Dam Failure
Jurisdiction affected	County, Cities
Responsible party	County Commissioners, City Councils
Goals	1,2,4
Score & Priority	10 A
Implementation timeline	12-24 months
Cost	Staff time
Potential funding sources	General fund

Mitigation Action 7	Develop a long-term shelter plan.
Action description	Develop and adopt a long term shelter plan
Hazards addressed	Extreme Heat, Severe storms (hail, high wind, lightning), Tornado, Winter storm
Jurisdiction affected	Cities & Towns
Responsible party	County EM, City admin
Goals	1.4
Score & Priority	10 A
Implementation timeline	12-60 months
Cost	Staff Time
Potential funding sources	Annual budget, planning grant

Mitigation Action 8	Develop and implement a Continuity of Government plan
Action description	Develop and adopt a plan to facilitate continuity of government during hazard events
Hazards addressed	Severe storm, Tornado, Winter storm, Human Disease Epidemic
Jurisdiction affected	Cities & Towns
Responsible party	County Supervisors, City Administration

Goals	3,4
Score & Priority	9 B
Implementation timeline	12-60 months
Cost	Staff Time
Potential funding sources	Annual budget

Mitigation Action 9	**Assist businesses: create & maintain a disaster preparedness plan**
Action description	Work with local business to develop a plan for business retention after a disaster
Hazards addressed	Drought, Expansive soils, Flood, High winds, Hail, Lightning, Sinkholes, Tornado, Wildfire, Winter storm
Jurisdiction affected	Cities
Responsible party	Local Government
Goals	1,4
Score & Priority	9 B
Implementation timeline	12 to 36 months
Cost	Staff time
Potential funding sources	Current budget

Mitigation Action 10	**Develop a volunteer call list and procedure to contact elderly/disabled individuals that might need assistance during or after a major hazard event**
Action description	Appoint a volunteer group to organize and implement call list
Hazards addressed	Extreme heat, Hail, High wind, Lightning, Tornado, Winter weather
Jurisdiction affected	County & Cities
Responsible party	Volunteers
Goals	1
Score & Priority	9 B
Implementation timeline	12-24 months
Cost	County or City Staff support
Potential funding sources	Volunteers

Mitigation Action 11	**Assess vulnerability of critical facilities and infrastructure**
Action description	Inspect critical infrastructure annually to evaluate vulnerability to Hail, High wind, Lightning, Tornado and Winter weather.
Hazards addressed	Hail, High wind, Lightning, Tornado, Winter weather
Jurisdiction affected	County & Cities, Schools
Responsible party	Building maintenance personnel
Goals	1,2,3
Score & Priority	9 B
Implementation timeline	12 Months
Cost	Staff time
Potential funding sources	Current budget

Mitigation Action 12	Add information about expansive soils to building permit forms
Action description	Provide information about expansive soils and add a checkbox to building permits acknowledging receipt of same
Hazards addressed	Drought, Expansive soils, Flood
Jurisdiction affected	Delta, Harper, Hedrick, Keota, Richland, Sigourney, Webster, What Cheer
Responsible party	Building officials
Goals	2,4
Score & Priority	7 B
Implementation timeline	Implement in 12 months, then ongoing
Cost	Staff time
Potential funding sources	Current budget

Mitigation Action 13	Identify and monitor sinkholes and abandoned wells/mines
Action description	Monitor sinkhole areas and track changes. Report to DNR
Hazards addressed	Sinkholes
Jurisdiction affected	County & What Cheer
Responsible party	DNR, City of What Cheer, Private landowners
Goals	2,4
Score & Priority	7 B
Implementation timeline	Ongoing
Cost	NA
Potential funding sources	Staff time

Natural Systems

Mitigation Action 14	Conduct annual tree maintenance
Action description	Inspect trees in the right of way and and remove limbs, diseased or dying trees as necessary. Assist property owners with tree debris removal
Hazards addressed	High wind, Tornado, Wildfire, Winter storm, ACP Disease
Jurisdiction affected	County, Cities
Responsible party	Public Works Officials
Goals	3
Score & Priority	11 A
Implementation timeline	12-24 months
Cost	$5-10,000 / year
Potential funding sources	County & City maintenance budgets

Mitigation Action 15	Improve stormwater drainage capacity near public buildings
Action description	Improve drainage around buildings owned by the county, city, town or school. Direct stormwater to retention and infiltration areas
Hazards addressed	Flood, expansive soils
Jurisdiction affected	County, all Cities, Schools
Responsible party	Building maintenance personnel
Goals	2
Score & Priority	9 B
Implementation timeline	Ongoing
Cost	Variable depending on project
Potential funding sources	Building maintenance budget

Mitigation Action 16	Implement best practices for stormwater management in other affected areas
Action description	Monitor and correct stormwater surface flow problems in affected areas. Implement Best Practices and FEMA's Nature-based solutions.
Hazards addressed	Flood
Jurisdiction affected	County, all Cities, Schools
Responsible party	County Supervisors, City Public Works, Schools
Goals	2
Score & Priority	9 B
Implementation timeline	12-36 months
Cost	Varies depending on severity
Potential funding sources	Building maintenance budget

Mitigation Action 17	Acquire and remove any structures that remain in the SFHA floodplain
Action description	Identify any structures that remain in SFHA areas, acquire when the opportunity arises
Hazards addressed	Flood, Dam Failure
Jurisdiction affected	County, Cities of Delta, Harper, Hayesville, Hedrick, Keota, Martinsburg, Ollie, Richland, Sigourney and What Cheer
Responsible party	County Supervisors, City Councils
Goals	2
Score & Priority	6 C
Implementation timeline	Ongoing
Cost	Undetermined
Potential funding sources	FEMA: FMA, HMGP, & BRIC. Local General fund. Donated labor and equipment

Education & Awareness

Action Item 18	**Train emergency responders to handle transportation HazMat incidents**
Action description	Training, and conduct practice drills
Hazards addressed	HazMat Incident (Transportation)
Jurisdiction affected	County Cities, Schools
Responsible party	Emergency managers
Goal	1,3
Score & Priority	13 A
Implementation timeline	Ongoing
Cost	Staff time
Potential funding sources	Existing training funds

Action Item 19	**Conduct awareness programs for citizens and students to teach emergency preparedness**
Action description	Educate the public on a variety of Hazard topics
Hazards addressed	Extreme Heat, Flood, Hail, High wind, Lightning, Tornado, Wildfire, Winter Storm, HazMat Incident, Human disease epidemic
Jurisdiction affected	County Cities, Schools
Responsible party	County EM, City Administrators, School Administrators
Goals	1,4
Score & Priority	13 A
Implementation timeline	12-60 months
Cost	Negligible
Potential funding sources	Printing, Staff. Current operating budgets
Educational recommendations:	
Hail, High wind, Lightning, Tornado, Winter weather Educate the public regarding a) proper response to the sirens; b) tornado safe room locations; c) accessing watch and warning information; d) weather advisories and warnings by the National Weather Service; e) any additional relevant information	
Tornado, Winter weather, HazMat Incident: Educate the Public regarding a) creating a Family Disaster Plan	
Extreme heat	Educate the Public regarding a) what precautions to take during hot weather; b) providing sufficient shade and water for animals.
Flood	Educate the public regarding a) location of Flash flood hazard areas; b) precautions of hazards due to flood waters
Flood	Educate the public regarding a) location of special flood hazard areas; b) precautions of hazards due to flood waters; c) best practices for water retention on private property.
Wildfire	Educate the Public regarding a) fire safety and proper response to fire events and b) fire prevention
Winter weather	Educate the Public regarding a) information on precautions to take in the event of severe winter storms; b) dangerous routes and road closings

Winter weather	Educate the public on the potential dangers of alternative heat sources
Winter weather	Educate the Public regarding a) operating vehicles during severe weather conditions and b) precautions for boating and water sports safety
Human Epidemic	Educate public regarding existing diseases and best practices for prevention and care.
Human Epidemic	Inform the public regarding a) management of communicable diseases and outbreaks; b) immunization clinics and locations

5% Projects

Mitigation Action 21	**Install additional sirens and upgrade existing storm sirens with alternate power backups and remote activation**
Action description	Evaluate existing sirens and implement upgrade to the warning system
Hazards addressed	Severe storms, Tornado
Jurisdiction affected	County at Lake Belva Deer, All Cities
Responsible party	County Supervisors, City Administrators, Public works dept
Goals	1,4
Score & Priority	12 A
Implementation timeline	1-24 months
Cost	$ 25,000 new or $2000 upgrade or maintenance
Potential funding sources	Local Emergency management funding; or paid by facility or individual

Mitigation Action 22	**Purchase generators to power critical facilities**
Action description	Purchase generators to ensure continued operation of critical facilities in the event of a disaster
Hazards addressed	Tornado
Jurisdiction affected	County, Cities
Responsible party	County and City officials
Goals	1,3
Score & Priority	10 A
Implementation timeline	1-60 months, ongoing until complete
Cost	Depends on capabilities
Potential funding sources	HMGP 5% Project

Mitigation Action 23	**Obtain equipment to remove and dispose of storm & tree debris.**
Action description	Purchase equipment to manage tree limbs and brush, to reduce flammable material in the community
Hazards addressed	High wind, Tornado, Wildfire, Winter storm, ACP Disease
Jurisdiction affected	County, Cities
Responsible party	County EM, City Administrators
Goals	2
Score & Priority	10 A

Implementation timeline	12-36 months
Cost	$5,000 - $10,000
Potential funding sources	HMGP 5% Project

Mitigation Action 24	**Practice drills and train firefighters, responders, and community leaders on effective disaster response**
Action description	Prepare and adopt Standard Operating Procedures to prepare for and respond to hazards. Maintain database of damages by hazard event
Hazards addressed	Extreme heat, Expansive soils, Flood, High winds, Hail, Lightning, Sinkholes, Tornado, Wildfire, Winter storm, Dam Failure, Human epidemic, HazMat incident
Jurisdiction affected	County, Cities
Responsible party	County EM, City Administrators
Goals	1,3,4
Score & Priority	10 A
Implementation timeline	Ongoing
Cost	Staff time
Potential funding sources	Within current budgets

Mitigation Action 25	**Install, upgrade and maintain lightning protection systems for critical facilities**
Action description	Install lightning protection system to protect critical facilities
Hazards addressed	Lightning
Jurisdiction affected	County, all Cities, Schools
Responsible party	Building maintenance officials
Goals	2,3
Score & Priority	9 B
Implementation timeline	Initiate within 12 months, then ongoing
Cost	$ 2,000 per structure
Potential funding sources	Building fund

Mitigation Action 26	**Purchase and distribute NOAA weather radios**
Action description	Implement a program to purchase and distribute weather radios throughout the community
Hazards addressed	Drought, Extreme heat, Severe storms, Tornado, Winter storm
Jurisdiction affected	County
Responsible party	County EM
Goals	1,4
Score & Priority	9 B
Implementation timeline	Ongoing
Cost	$50 per radio
Potential funding sources	EM Budget, HSEMD, HMGP 5% Project

Mitigation Action 27	Purchase standby and portable pumps for flood protection
Action description	Purchase pumps to remove water
Hazards addressed	All Flood types
Jurisdiction affected	County, all Cities, Schools
Responsible party	Local Government, Public works
Goals	2
Score & Priority	8 B
Implementation timeline	Implement, then ongoing
Cost	$2000 per project
Potential funding sources	5% Grants, General fund

Mitigation Action 28	Provide/upgrade communications systems/backup systems.
Action description	Continue to upgrade and modernize communication equipment
Hazards addressed	All Hazards
Jurisdiction affected	County, Cities, Schools
Responsible party	Emergency Managers, City Administration, School Superintendents
Goals	1,2,3
Score & Priority	8 B
Implementation timeline	Ongoing
Cost	Varies by needs
Potential funding sources	5% Grants, Local IT budget

Section D: Plan Maintenance

Making the Plan Work

The Hazard Mitigation Plan is a guide for policy and decision-making regarding mitigation actions within Keokuk County. The Plan considers community background information, local trends and projections, current and future mitigation measures. The goals and objectives have been developed to reflect the consensus of the Hazard Mitigation Planning Committee (HMPC), the City Councils, the Board of Supervisors, and the citizens of Keokuk County.

Hazard Mitigation Planning Committee:

The Hazard Mitigation Planning Committee will be responsible for promoting and encouraging the implementation of the Hazard Mitigation Plan. The Committee will also serve as a resource to city councils and public agencies involved in Hazard Mitigation measures.

The responsibilities of the Committee will be to meet annually to monitor the plan, review the mitigation goals and action plan, discuss any change in risks posed by hazards and discuss mitigation strategies that have been initiated or completed. The committee will evaluate current resources being allocated to implement the plan, discuss the outcomes that have occurred from plan implementation, address any implementation problems that have occurred, and provide an annual progress report to the Keokuk County Emergency Management Commission on the implementation status.

D1-a Continuing Public participation

The success of this Plan will require the support of the residents and staff from each of the participating communities. All jurisdictions will keep the public informed by announcing and approving projects and activities at City Council meetings as implementation of a specific action is initiated. For structure and infrastructure projects, a press release may be issued to inform the public and request comments. As the process for the next update begins, a new round of public participation will be implemented, beginning with the annual HMPC meetings through Update adoption as described in Section D2-c, below.

D2-a Track the progress

Progress made on mitigation activities will be documented by the participating jurisdictions. The worksheets provided for that purpose are reproduced in Appendix F, *Worksheet 1 Annual Progress Report,* and *Worksheet 2, Project Report.* The person responsible for project management will submit the worksheets to the Keokuk County Emergency Manager upon completion of the project.

D2-b. Evaluate the plan for effectiveness

The Hazard Mitigation Planning Committee (HMPC) will monitor plan implementation, facilitate public input, and report to the governing bodies of each participating jurisdiction and the Keokuk County Emergency Management Commission (KCEMC) on an annual basis. Worksheets 1, 2 & 4 in Appendix F will be used to evaluate completed projects and assess risks.

Once the review forms are completed, they will be presented to the Keokuk County Emergency Management Commission, the Keokuk County Board of Supervisors, the City Councils and Mayors and to the public for comment and attached to the Hazard Mitigation Plan as an addendum.

The KCEMC is composed of elected members from communities throughout Keokuk County. That commission includes firefighters, law enforcement and public works professionals who will provide ongoing technical support to the HMPC.

D2-c Process to update the plan

This update represents a five year plan. Progress reports will be attached to the plan on an annual basis and shall be considered an addendum to the current plan in place. Updates will occur prior to plan expiration, to reflect changes to mitigation needs or progress made in the county.

As the five year cycle progresses, the HMPC will follow the guidelines below. The Keokuk County Emergency manager and HMPC members will report progress at local public meetings at intervals throughout the update process to keep citizens informed.
Referenced worksheets are in Appendix F.

Proposed schedule for future updates	**Time**
Planning Committee meets to review Projects and Risks: Worksheets 3 and 4	Annually
Apply for Planning funds from the state. Notice of Intent	2 years prior to plan expiration
Evaluate Planning team: Worksheet 2	14 months prior to Plan expiration
Receive funding award or authorize cost. Planner in place	1 year prior to Plan expiration
Begin Plan update, review and update Introduction and planning process chapters	1 year prior to Plan expiration
Complete the Capability assessment for each jurisdiction	11 months prior to plan expiration
Data collection and Hazard profiles	10 months prior to plan expiration
Vulnerability and Impacts for each jurisdiction	9 months prior to plan expiration
Evaluate previous mitigation action plan with each jurisdiction	8 months prior to plan expiration
Initiate public survey for risk assessment	8 months prior to plan expiration
Record and organize all public and jurisdiction comments	7 months prior to plan expiration
Draft new mitigation strategies and action tables	6 months prior to plan expiration
HMPC reviews all data, comments and drafts	5 months prior to plan expiration
HMPC reviews new action plan	4 months prior to plan expiration
Staff drafts, HMPC reviews maintenance section for update	3 months prior to plan expiration
HMPC approves final draft, County adopts to send to state	60 days prior to plan expiration
Final draft complete, submit to Iowa HSEMD	60 days prior to plan expiration
Receive FEMA approval	30 days prior to plan expiration
All jurisdictions adopt	Prior to previous plan expiration

D3 Integrating the Plan:

In Keokuk County, planning needs and capabilities of participating jurisdictions vary, and hazard mitigation will be integrated by appropriate means.

For example, the Cities of Keswick and Kinross do not have any other formal plans or building regulations, however, they may choose to implement mitigation strategies individually. These would be facilitated by resolution of the City Council.

The following steps describe ways in which this plan will be integrated into other planning mechanisms.

- As part of the annual review and evaluation process, the Hazard Mitigation Planning Committee will meet and discuss opportunities to integrate this Plan into other planning mechanisms. Participating jurisdictions will be represented on this committee.

- The annual assessment helps keep this Plan relevant as projects are completed, new needs become apparent and will be documented on the Annual Progress Report Worksheet 1 in Appendix F.
- Area 15 Regional Planning Commission (Area 15) and other regional planners provide planning services to Keokuk County communities that lack staffing and resources to produce local plans. Keokuk County communities will proactively seek out opportunities for integrating hazard mitigation, as plans are updated. One such plan is the Comprehensive Economic Development Strategies (CEDS) plan.
- All participating jurisdictions will review adopted mitigation measures during annual budgeting and dedicate funding as appropriate. The review and budgeting will be done by the City Council.
- Participating jurisdictions will review and consider ways to integrate this Mitigation Plan into Comprehensive Plans when those plans are being created or updated. Similarly, adopted hazard mitigation projects will be integrated into Capital Improvement Plans and other local plans as appropriate.
- Integration of this Plan into other planning mechanisms will adhere to the public input process required for those planning mechanisms.

Section E: Plan Update

E1-a Changes that increase or decrease vulnerability

Increased vulnerability. New Development: A fertilizer plant expansion has occurred at Gibson that may increase that community's exposure to Hazardous Materials incidents. Changes in development have not affected vulnerability in any other jurisdictions.

Climate trends also have the potential to increase vulnerability.

Decreased vulnerability. Mitigation: Several communities have acquired portable generators to support public services in the event of a major power failure. Delta updated building codes. See Section E2-c for a list of Mitigation activities since the previous plan.

E2. Changes in jurisdictional priorities

Priorities

The 2024 priorities as organized below were determined by the public survey responses and Planning Committee comments.

Priority	2018		Priority	2024
1	Thunderstorm/Lightning/Hail		**1**	Severe Storms (Hail, High Wind, Lightning)
2	Tornado/Windstorm		**2**	Tornado
3	Severe Winter Storm		**3**	Winter Storm
4	River Flood		**4**	Drought
5	Flash Flood		**5**	Extreme Heat
6	Earthquake		**6**	Flooding
7	Landslide		**7**	Wildfire
8	Sinkhole		**8**	Expansive Soils
9	Expansive Soils		**9**	Sinkhole
10	Extreme Heat		~~**10**~~	~~Earthquake~~
11	Drought		~~**11**~~	~~Landslide~~

E2-a How the plan was revised due to changes in community priorities

The top three hazards of concern are unchanged: Severe storms with Hail, High wind and Lightning, Tornado and Winter weather. Increased concerns about drought may reflect drought conditions present during 2023 when this update was initiated, as well as a growing public awareness of changing climate trends.

Animal, Crop and Plant Disease.

New concerns about the Emerald Ash Borer. Emma Hanigan, Iowa DNR urban forestry coordinator, reports that the U.S. Forest Service 2012 inventory indicated that there were 52 million woodland ash trees and 3.1 million urban ash trees in Iowa (Rodriguez, 2023).

Wildlife species range shifts and an increase in pests and pathogens are predicted.

Impacts of climate trends on the ecosystem raises new concerns about agricultural vulnerability. Planting windows may shift or crops may suffer if drought occurs or rain patterns do not coincide with crop needs. Rain events seem to have greater intensity.

Conservation best practices have evolved faster than funding opportunities. Lake Belva Deer recreational area would benefit from additional funding.

Mitigation Actions Added or Deleted

New actions include mitigation for expansive soils. There is increasing awareness that displaced underground water and sewer lines may be a result of the heaving of expansive soils. Problems that result include contamination of potable water and the environment, the cost of repair and the labor involved to restore service. Public surveys indicate a growing awareness of damages caused by expansive soil such as leaky basements and shifting concrete slabs.

Some action items from the previous plan were deleted due to the fact that they are not technically, in the category of Mitigation or are things over which local government has no authority.

Earthquakes and Landslides were eliminated as priorities for 2024. Wildfires were added due to concerns for local Fire Department safety and drought.

More concerns were expressed about Hazardous materials incidents and human Epidemic or pandemics, therefore more emphasis was placed on those hazards in this update than in the previous plan

E2-b Status update for mitigation actions identified in the previous mitigation plan

Of 27 proposed mitigation actions in the previous plan, the planning committee deleted 4, and 5 items were added. Reasons for deletion include that the action has been implemented, it is not under local control, does not qualify as mitigation or is no longer viewed as a priority. Some actions were edited and carried forward. New recommendations were based on public comments received. Mitigation actions were sorted into the categories in C4-a and prioritized within each category. See Appendix E for more information.

Mitigation Actions from Previous Plan

Previous (2018) Action Plan		
Mitigation Action		
P-01. Make use of effective codes and zoning tools to regulate construction in unsuitable areas.	Keep	Delta updated Building Code 2024
P-02. Install new and/or upgrade existing warning siren systems where needed. (SP01)	Keep	Yes - Hedrick has updated since 2018
P-03. Update and strengthen existing power lines.	Delete	Utility company
P-04. Identify sinkholes and abandoned wells/mines.	Keep	Ongoing Progress
P-05. Install drain tile in affected areas.	Keep, combined	Ongoing Progress
P-06. Survey affected areas during flood events, note repair needs, and maintain flood maps beyond those provided by FEMA.	Deleted	Changed priority
P-07. Assist businesses create and maintain a disaster preparedness plan to assist with business retention post-disaster.	Keep	Ongoing Progress
PP-01. Maintain, improve and protect public buildings, facilities, and utilities against all hazards. (SP03)	Keep	Ongoing Progress
PP-02. Encourage and continue compliance in the National Flood Insurance Program (NFIP).	Combined	Ongoing Progress

PP-03. Encouraging buyouts (acquisitions) of structures located in flood plains and/or repetitive loss properties.	Keep	Ongoing Progress
PEA-01. Encouraging the use of NOAA all hazards radios or technology of choice, such as Iowa Alert System.	Keep	Ongoing Progress
PEA-02. Practice drills and train firefighters, responders, and community leaders on preparedness for disasters.	Keep	Ongoing Progress
SP-01. Update and install warning sirens for all communities that have inadequate systems or those that have no warning systems. (P02)	Keep	Ongoing Progress
SP-02. Purchase and install backup generators where needed.	Keep	Ongoing Progress
SP-03. Maintain and improve bridges, culverts, ditches as needed. (PP01)	Keep	Ongoing Progress
SP-04. Improvements to existing storm water and sewer systems.	Keep	Ongoing Progress
SP-05. Encourage underground burial of power lines.	Delete	Ongoing Progress
SP-06. Maintain adequate equipment and manpower to keep streets clean and free of debris.	Keep	Ongoing Progress
SP-07. Pursue the construction of flood protection infrastructure in affected areas.	Delete	Updated to Best practices
ES-01. Designate or construct safe room and/or shelter sites with adequate supplies and overnight accommodations.	Keep	Ongoing Progress
ES-02. Develop emergency plans for all shelter sites.	Keep	Ongoing Progress
ES-03. Provide/upgrade communications systems/backup systems.	Keep	Ongoing
ES-04. Identify and maintain a backup water resource.	Keep	Ongoing
ES-05. Purchase standby and portable pumps for flood protection.	Keep	Ongoing
ES-06. Maintain at least current levels of service for training and equipment for firefighters and responders.	Delete	Not mitigation
ES-07. Gaining new and more fire equipment in order to respond to incidents.	Delete	Not mitigation
ES-08. Mass Casualty Incident Training for EMS and fire.	Keep	Not mitigation but needed. Keep

E2-c. How jurisdictions have integrated the mitigation plan

While most Keokuk County communities have not adopted new building codes or updated Comprehensive Plans since the previous HMP, some communities have adopted individual recommendations of the plan, such as the purchase of generators and implemented other actions as noted on the table above.

Special recognition: Webster. Floods can happen anywhere not just in special flood hazard areas. NFIP Flood insurance is a separate policy that can cover buildings, the contents in a building, or both and is only

available to property owners when the community participates in NFIP. While Webster is not in a special flood hazard area, the City has joined the NFIP. Most homeowners' insurance does not cover flood damage.

Keokuk County	County has gone to a cloud-based system for the ability to work offsite in an emergency
Delta	Updated building codes 2024
Gibson	Improved stormwater drainage
Harper	Demolition of unsafe structures
Hedrick	The City owns the property in flash flood areas, building is not permitted to occur there
	Updated Building code 2024
	Updated tornado siren since 2018
Keota	New RV Park will have bathhouse storm shelter
Keswick	Community volunteers respond to neighbor needs
Kinross	Community support for vulnerable people during hazard events
Sigourney	Joined the NFIP 3/05/2014
Webster	Joined the NFIP on 5/02/2023

Section F: Plan adoption

All participating jurisdictions will adopt a FEMA approved plan. Resolutions for formal adoption will be placed in Appendix G.

Section G: Community profiles

Community Profiles contain information specific to jurisdictions participating in the Keokuk County planning effort. Community Profiles were developed with the intention of highlighting each jurisdiction's unique characteristics that affect its risk to hazards. Community Profiles may serve as a reference of identified vulnerabilities and mitigation and strategic actions for a jurisdiction as they implement the mitigation plan. Information from individual jurisdictions was collected at public and personal meetings and used to establish the plan. Community Profiles include the following elements:

- Local Contact
- Demographics
- Employment and Economics
- Housing
- Public services
- Future Development Trends
- Hazard Prioritization
- Vulnerability and Impacts
- Mitigation Strategy
- Plan Maintenance

There is a discrepancy between two US Census products, not entirely explained by a difference in the year or margin of error. The 2020 number is the official population count, while the 2022 American Community Survey (ACS) is a 5-year estimate. Because of the difference, both are displayed here. Counts for 2023 are not yet available.

Community Population	2020 Decennial Census	2022 ACS Estimates
Delta	264	311
Gibson	63	43
Harper	118	124
Hayesville	41	68
Hedrick	728	813
Keota	897	883
Keswick	242	279
Kinross	80	104
Martinsburg	110	110
Ollie	201	160
Richland	542	497
Sigourney	2,004	1,835
South English	184	252
Thornburg	44	59
Webster	88	145
What Cheer	572	724

Delta

Demographics	
Total Population	311
Median Age	42.7
65 Years and Over	16%
Workforce	
Population over age 16	236
In Labor Force	132 (56%)
Not in Labor force	104 (44%)
Commute to Work	30 Mins
Households	
Median Household Income	$48,750
Per Capita Income	$25,495
Percent Poverty	14%
Average Household Size	2.5
Zero-vehicle households	7
Housing	
Total Housing Units	156
Occupied Housing Units	123
Vacant Housing Units	33
Mobile Homes	8
Median home value	$40,700
Year built	
Since 2000	5.1%
1970-1999	24.3%
1940-1969	7.1%
1939 or earlier	63.5%
Service	Provider
Electric	Alliant Energy
Natural Gas	None
Telephone	Windstream
Internet	Windstream
Water	Wapello Rural Water Assc
Sewage Treatment	City of Delta
Fire Protection	Delta Vol Fire Dept
Police/Law Enforcement	Keokuk Co Sheriff
Ambulance	Keokuk County

Planning Committee representative:

Sheri Walker, City Clerk

Hazards that affect the community:

	Delta
X	Drought
X	Extreme heat
X	Expansive soils
	Flash Flood
X	Flood SFHA & Stormwater
X	High winds
X	Hail
X	Lightning
	Sinkholes
X	Tornado
	Wildfire
X	Winter storm
X	Animal or Plant Disease
	Dam Failure
X	HazMat Incident
X	Human Epidemic

Hazard Prioritization

The Delta hazard risk assessment and the public survey were used to evaluate special concerns of the city and its residents.

Delta Risk Assessment	
1	Severe storm
2	Winter storm
3	Tornado
4	Extreme heat
5	Drought

Gibson

Demographics	
Total Population	43
Median Age	49.8
65 Years and Over	2%
Workforce	
Population over age 16	34
In Labor Force	23 (68%)
Not in Labor force	11 (32%)
Commute to Work	27 Mins
Households	
Median Household Income	$51,528
Per Capita Income	$30,079
Percent Poverty	7%
Average Household Size	1.59
Zero-vehicle households	7
Housing	
Total Housing Units	31
Occupied Housing Units	27
Vacant Housing Units	4
Mobile Homes	0
Median home value	$76,600
Year built	
Since 2000	0.0%
1970-1999	45.2%
1940-1969	29.0%
1939 or earlier	25.8%
Service	Provider
Electric	Alliant Energy
Natural Gas	None
Telephone	Windstream
Internet	Windstream
Water	Poweshiek Rural Water Assc
Sewage Treatment	Septic systems
Fire Protection	What Cheer Fire Dept
Police/Law Enforcement	Keokuk Co Sheriff
Ambulance	Keokuk County

Planning Committee Representative:

Steve Van Zee, Mayor

Hazards that affect Gibson include:

	Gibson
X	Drought
X	Extreme heat
X	Expansive soils
	Flash Flood
X	Flood (Stormwater)
X	High winds
X	Hail
X	Lightning
	Sinkholes
X	Tornado
	Wildfire
X	Winter storm
X	Animal or Plant Disease
	Dam Failure
X	HazMat Incident
X	Human Epidemic

The Gibson hazard risk assessment and public survey were used to evaluate special concerns of the city and its residents.

Gibson Risk Assessment	
1	Tornado
2	Severe storm
3	Winter storm
4	Drought

Harper

Demographics	
Total Population	124
Median Age	22.2
65 Years and Over	2%
Workforce	
Population over age 16	81
In Labor Force	63 (78%)
Not in Labor force	18 (22%)
Commute to Work	25 Mins
Households	
Median Household Income	$70,000
Per Capita Income	$20,652
Percent Poverty	4%
Average Household Size	3.9
Zero-vehicle households	0
Housing	
Total Housing Units	32
Occupied Housing Units	32
Vacant Housing Units	0
Mobile Homes	0
Median home value	$89,000
Year built	
Since 2000	3.1%
1970-1999	3.1%
1940-1969	56.3%
1939 or earlier	38%
Service	Provider
Electric	Alliant Energy
Natural Gas	Alliant Energy
Telephone	Windstream
Internet	Windstream, Cloudburst 9
Water	Wapello Rural Water Assc
Sewage Treatment	RUSS-Regional Utility Service
Fire Protection	Keota Vol Fire Dept.
Police/Law Enforcement	Keokuk Co Sheriff
Ambulance	Keokuk County

Planning Committee Representative:

Dawn Minard, Clerk

Hazards that affect Harper include:

	Harper
X	Drought
X	Extreme heat
X	Expansive soils
	Flash Flood
X	Flood SFHA & Stormwater
X	High winds
X	Hail
X	Lightning
	Sinkholes
X	Tornado
	Wildfire
X	Winter storm
X	Animal or Plant Disease
	Dam Failure
X	HazMat Incident
X	Human Epidemic

The Harper hazard risk assessment and public survey were used to evaluate special concerns of the city and its residents.

Harper Risk Assessment	
1	Severe storm
2	Tornado
3	Drought
4	Winter storm
5	Extreme heat
6	Flood

Hayesville

Demographics	
Total Population	68
Median Age	66.5
65 Years and Over	51%
Workforce	
Population over age 16	64
In Labor Force	28 (44%)
Not in Labor force	36 (56%)
Commute to Work	11 Mins
Households	
Median Household Income	$38,750
Per Capita Income	$29,669
Percent Poverty	35%
Average Household Size	1.9
Zero-vehicle households	1
Housing	
Total Housing Units	49
Occupied Housing Units	36
Vacant Housing Units	13
Mobile Homes	0
Median home value	$58,900
Year built	
Since 2000	4.1%
1970-1999	26.5%
1940-1969	10.2%
1939 or earlier	59.2%
Service	Provider
Electric	Alliant Energy
Natural Gas	None
Telephone	Windstream
Internet	Windstream
Water	Wapello Rural Water Assc
Sewage Treatment	Private Septic
Fire Protection	Sigourney Fire Dept.
Police/Law Enforcement	Keokuk Co Sheriff
Ambulance	Keokuk County

Planning Committee Representative:

Chris Gammack, Mayor

Hazards that affect Hayesville include:

Hayesville	
X	Drought
X	Extreme heat
X	Expansive soils
X	Flash Flood
X	Flood SFHA & Stormwater
X	High winds
X	Hail
X	Lightning
	Sinkholes
X	Tornado
	Wildfire
X	Winter storm
X	Animal or Plant Disease
	Dam Failure
X	HazMat Incident
X	Human Epidemic

The Hayesville hazard risk assessment and public survey were used to evaluate special concerns of the city and its residents.

Hayesville Risk Assessment	
1	Tornado
2	Severe storm
3	Winter storm

Hedrick

Demographics	
Total Population	813
Median Age	38.5
65 Years and Over	21%
Workforce	
Population over age 16	660
In Labor Force	333 (50%)
Not in Labor force	327 (49%)
Commute to Work	28 Mins
Households	
Median Household Income	$59,375
Per Capita Income	$24,073
Percent Poverty	25%
Average Household Size	3.1
Zero-vehicle households	8
Housing	
Total Housing Units	309
Occupied Housing Units	260
Vacant Housing Units	49
Mobile Homes	10
Median home value	$76,800
Year built	
Since 2000	7.8%
1970-1999	23.9%
1940-1969	19.7%
1939 or earlier	49%
Service	Provider
Electric	Alliant Energy
Natural Gas	MidAmerican Eng
Telephone	Windstream
Internet	Windstream, Rise Broadband
Water	Wapello Rural Water Assc
Sewage Treatment	City of Hedrick
Fire Protection	City of Hedrick FD
Police/Law Enforcement	Keokuk Co Sheriff
Ambulance	City of Hedrick

Planning Committee Representative:

Ashley Olinger, City Clerk

Hazards that affect Hedrick include:

Hedrick	
X	Drought
X	Extreme heat
X	Expansive soils
	Flash Flood
X	Flood SFHA & Stormwater
X	High winds
X	Hail
X	Lightning
	Sinkholes
X	Tornado
	Wildfire
X	Winter storm
X	Animal or Plant Disease
	Dam Failure
X	HazMat Incident
X	Human Epidemic

The Hedrick hazard risk assessment and public survey were used to evaluate special concerns of the city and its residents.

Hedrick Risk Assessment	
1	Tornado
2	Severe storm
3	Winter storm
4	Drought
5	Extreme heat
6	Wildfire
7	Flood

Keota

Demographics	
Total Population	883
Median Age	38.5
65 Years and Over	21%
Workforce	
Population over age 16	680
In Labor Force	486 (71%)
Not in Labor force	194 (29%)
Commute to Work	28 Mins
Households	
Median Household Income	$67,917
Per Capita Income	$32,315
Percent Poverty	7%
Average Household Size	2.3
Zero-vehicle households	5
Housing	
Total Housing Units	422
Occupied Housing Units	392
Vacant Housing Units	30
Mobile Homes	15
Median home value	$93,200
Year built	
Since 2000	2.4%
1970-1999	31.7%
1940-1969	31.2%
1939 or earlier	34.6%
Service	Provider
Electric	Alliant Energy
Natural Gas	Alliant Energy
Telephone	Windstream
Internet	Windstream & Cloudburst9
Water	City of Keota
Sewage Treatment	City of Keota
Fire Protection	Keota Vol Fire Dept
Police/Law Enforcement	Keokuk Co Sheriff
Ambulance	Keota QRS, Keokuk County, Washington County

Planning Committee Representative:

Alycia Horras, City Clerk

Hazards that affect Keota include:

Keota	
X	Drought
X	Extreme heat
X	Expansive soils
	Flash Flood
X	Flood SFHA & Stormwater
X	High winds
X	Hail
X	Lightning
	Sinkholes
X	Tornado
	Wildfire
X	Winter storm
X	Animal or Plant Disease
	Dam Failure
X	HazMat Incident
X	Human Epidemic

The Keota hazard risk assessment and public survey were used to evaluate special concerns of the city and its residents.

Keota Risk Assessment	
1	Severe storm
2	Winter storm
3	Drought
4	Tornado
5	Extreme heat

Keswick

Demographics	
Total Population	279
Median Age	35.8
65 Years and Over	18%
Workforce	
Population over age 16	210
In Labor Force	116 (55%)
Not in Labor force	94 (45%)
Commute to Work	30 Mins
Households	
Median Household Income	$55,694
Per Capita Income	$26,548
Percent Poverty	5%
Average Household Size	2.9
Zero-vehicle households	2
Housing	
Total Housing Units	112
Occupied Housing Units	97
Vacant Housing Units	15
Mobile Homes	0
Median home value	$75,900
Year built	
Since 2000	11.6%
1970-1999	14.3%
1940-1969	10.8%
1939 or earlier	63.4%
Service	Provider
Electric	Alliant Energy
Natural Gas	Multi County Oil
Telephone	Modern Co-Op
Internet	Modern Co-Op
Water	Wapello Rural Water Assc
Sewage Treatment	RUSS-Regional Utility Service
Fire Protection	Keswick Vol Fire Dept
Police/Law Enforcement	Keokuk Co Sheriff
Ambulance	Volunteer EMT, City of Sigourney

Planning Committee Representative:

Mark Zittergruen, Mayor

Hazards that affect Keswick include:

	Keswick
X	Drought
X	Extreme heat
X	Expansive soils
X	Flash Flood
X	Flood SFHA & Stormwater
X	High winds
X	Hail
X	Lightning
	Sinkholes
X	Tornado
	Wildfire
X	Winter storm
X	Animal or Plant Disease
	Dam Failure
X	HazMat Incident
X	Human Epidemic

The Keswick hazard risk assessment and public survey were used to evaluate special concerns of the city and its residents.

Keswick Risk Assessment	
1	Tornado
2	Winter storm
3	Severe storm
4	Drought
5	Flood
6	Extreme heat
7	Expansive soils

Kinross

Demographics	
Total Population	104
Median Age	31.8
65 Years and Over	21%
Workforce	
Population over age 16	65
In Labor Force	34 (52%)
Not in Labor force	31 (48%)
Commute to Work	38 Mins
Households	
Median Household Income	?
Per Capita Income	$18,480
Percent Poverty	13%
Average Household Size	3.1
Zero-vehicle households	0
Housing	
Total Housing Units	40
Occupied Housing Units	34
Vacant Housing Units	6
Mobile Homes	0
Median home value	$52,500
Year built	
Since 2000	0.0%
1970-1999	12.5%
1940-1969	15.0%
1939 or earlier	72.5%
Service	Provider
Electric	Alliant Energy
Natural Gas	None
Telephone	Modern Co-Op
Internet	Modern Co-Op
Water	Wapello Rural Water Assc
Sewage Treatment	RUSS-Regional Utility Service
Fire Protection	North Keokuk Fire Dept
Police/Law Enforcement	Keokuk Co Sheriff
Ambulance	North Keokuk First Responders

Planning Committee Representative:

Ben Mast, Mayor

Hazards that affect Kinross include:

	Kinross
X	Drought
X	Extreme heat
X	Expansive soils
X	Flash Flood
X	Flood SFHA & Stormwater
X	High winds
X	Hail
X	Lightning
	Sinkholes
X	Tornado
	Wildfire
X	Winter storm
X	Animal or Plant Disease
	Dam Failure
X	HazMat Incident
X	Human Epidemic

The Kinross hazard risk assessment and public survey were used to evaluate special concerns of the city and its residents.

Kinross Risk Assessment	
1	Tornado
2	Severe storm
3	Winter storm
4	Drought
5	Heat

Martinsburg

Demographics	
Total Population	110
Median Age	47
65 Years and Over	23%
Workforce	
Population over age 16	95
In Labor Force	55 (58%)
Not in Labor force	40 (42%)
Commute to Work	21 Mins
Households	
Median Household Income	$41,071
Per Capita Income	$27,281
Percent Poverty	29%
Average Household Size	2.3
Zero-vehicle households	3
Housing	
Total Housing Units	50
Occupied Housing Units	48
Vacant Housing Units	2
Mobile Homes	8
Median home value	$71,300
Year built	
Since 2000	10.0%
1970-1999	40.0%
1940-1969	14.0%
1939 or earlier	36%
Service	Provider
Electric	Alliant Energy
Natural Gas	MidAmerican Eng
Telephone	Windstream
Internet	Windstream
Water	Wapello Rural Water Assc
Sewage Treatment	RUSS-Regional Utility Service
Fire Protection	Hedrick Volunteer FD
Police/Law Enforcement	Keokuk Co Sheriff
Ambulance	Hedrick First Responders

Planning Committee Representative:

Mike Jasper, Mayor

Hazards that affect Martinsburg include:

	Martinsburg
X	Drought
X	Extreme heat
X	Expansive soils
	Flash Flood
X	Flood SFHA & Stormwater
X	High winds
X	Hail
X	Lightning
	Sinkholes
X	Tornado
	Wildfire
X	Winter storm
X	Animal or Plant Disease
	Dam Failure
X	HazMat Incident
X	Human Epidemic

The Martinsburg hazard risk assessment and public survey were used to evaluate special concerns of the city and its residents.

Martinsburg Risk Assessment	
1	Severe storm
2	Winter storm
3	Flood
4	Tornado

Ollie

Demographics	
Total Population	160
Median Age	37.5
65 Years and Over	28%
Workforce	
Population over age 16	122
In Labor Force	64 (52%)
Not in Labor force	58 (48%)
Commute to Work	29 Mins
Households	
Median Household Income	$52,500
Per Capita Income	$23,923
Percent Poverty	19%
Average Household Size	2.6
Zero-vehicle households	0
Housing	
Total Housing Units	92
Occupied Housing Units	62
Vacant Housing Units	30
Mobile Homes	I7
Median home value	$82,500
Year built	
Since 2000	2.2%
1970-1999	18.5%
1940-1969	31.5%
1939 or earlier	47.8%
Service	Provider
Electric	Alliant Energy
Natural Gas	None
Telephone	Windstream
Internet	Windstream
Water	Wapello Rural Water Assc
Sewage Treatment	RUSS-Regional Utility Service
Fire Protection	Jackson Township FD
Police/Law Enforcement	Keokuk Co Sherriff
Ambulance	Keokuk County

Planning Committee Representative:

Scott Vetter, Mayor

Hazards that affect Ollie include:

	Ollie
X	Drought
X	Extreme heat
X	Expansive soils
	Flash Flood
X	Flood SFHA & Stormwater
X	High winds
X	Hail
X	Lightning
	Sinkholes
X	Tornado
	Wildfire
X	Winter storm
X	Animal or Plant Disease
	Dam Failure
X	HazMat Incident
X	Human Epidemic

The Ollie hazard risk assessment and public survey were used to evaluate special concerns of the city and its residents.

Ollie Risk Assessment	
1	Severe storm
2	Tornado
3	Winter storm
4	Expansive soils

Richland

Demographics	
Total Population	497
Median Age	40.9
65 Years and Over	15%
Workforce	
Population over age 16	374
In Labor Force	246 (66%)
Not in Labor force	128 (34%)
Commute to Work	24 Mins
Households	
Median Household Income	$52,344
Per Capita Income	$27,712
Percent Poverty	11%
Average Household Size	2.5
Zero-vehicle households	7
Housing	
Total Housing Units	227
Occupied Housing Units	199
Vacant Housing Units	28
Mobile Homes	26
Median home value	$114,700
Year built	
Since 2000	3.5%
1970-1999	38.8%
1940-1969	22.1%
1939 or earlier	35.7%
Service	**Provider**
Electric	Alliant Energy
Natural Gas	None
Telephone	Windstream
Internet	Windstream, Natel, Farmers Telephone
Water	City of Richland
Sewage Treatment	City of Richland
Fire Protection	Richland Vol Fire Dept
Police/Law Enforcement	Keokuk Co Sheriff
Ambulance	Keokuk County

Planning Committee Representative:

Michael Hadley Jr., City Council

Hazards that affect Richland include:

Richland	
X	Drought
X	Extreme heat
X	Expansive soils
	Flash Flood
X	Flood SFHA & Stormwater
X	High winds
X	Hail
X	Lightning
	Sinkholes
X	Tornado
	Wildfire
X	Winter storm
X	Animal or Plant Disease
	Dam Failure
X	HazMat Incident
X	Human Epidemic

The Richland hazard risk assessment and public survey were used to evaluate special concerns of the city and its residents.

Richland Risk Assessment	
1	Severe storms
2	Tornado
3	Extreme heat
4	Winter storm

Sigourney

Demographics	
Total Population	1835
Median Age	50.5
65 Years and Over	33%
Workforce	
Population over age 16	1,600
In Labor Force	819 (51%)
Not in Labor force	781 (49%)
Commute to Work	20 Mins
Households	
Median Household Income	$48,688
Per Capita Income	$31,823
Percent Poverty	13%
Average Household Size	2.1
Zero-vehicle households	39
Housing	
Total Housing Units	1,022
Occupied Housing Units	873
Vacant Housing Units	149
Mobile Homes	6
Median home value	$105,700
Year built	
Since 2000	10.1%
1970-1999	22.5%
1940-1969	25.7%
1939 or earlier	41.8%
Service	Provider
Electric	Alliant Energy
Natural Gas	Alliant Energy
Telephone	Windstream, Mediacom
Internet	Windstream, Mediacom, LISCO
Water	City of Sigourney
Sewage Treatment	City of Sigourney
Fire Protection	Sigourney Volunteer FD
Police/Law Enforcement	City of Sigourney
Ambulance	Keokuk County

Planning Committee Representative:

Angela Alderson, City Clerk

Hazards that affect Sigourney include:

Sigourney	
X	Drought
X	Extreme heat
X	Expansive soils
X	Flash Flood
X	Flood SFHA & Stormwater
X	High winds
X	Hail
X	Lightning
	Sinkholes
X	Tornado
	Wildfire
X	Winter storm
X	Animal or Plant Disease
	Dam Failure
X	HazMat Incident
X	Human Epidemic

The Sigourney hazard risk assessment and public survey were used to evaluate special concerns of the city and its residents.

Sigourney Risk Assessment	
1	Severe storm
2	Tornado
3	Winter storm
4	Drought
5	Extreme heat
6	Flood
7	Expansive soils

South English

Demographics	
Total Population	252
Median Age	40
65 Years and Over	18%
Workforce	
Population over age 16	217
In Labor Force	142 (65%)
Not in Labor force	75 (35%)
Commute to Work	29 Mins
Households	
Median Household Income	$50,833
Per Capita Income	$30,633
Percent Poverty	17%
Average Household Size	2.3
Zero-vehicle households	0
Housing	
Total Housing Units	127
Occupied Housing Units	112
Vacant Housing Units	15
Mobile Homes	1
Median home value	$80,000
Year built	
Since 2000	.8%
1970-1999	43.2%
1940-1969	15.8%
1939 or earlier	40.2%
Service	Provider
Electric	Alliant Energy
Natural Gas	Alliant Energy
Telephone	Modern Co-Op
Internet	Modern Co-Op
Water	Wapello Rural Water Assc
Sewage Treatment	City of South English
Fire Protection	North Keokuk Co FD
Police/Law Enforcement	Keokuk Co Sheriff
Ambulance	Keokuk County and South English QRS

Planning Committee Representative:

Cameron Miller, City Council

Hazards that affect South English include:

South English	
X	Drought
X	Extreme heat
X	Expansive soils
	Flash Flood
X	Flood SFHA & Stormwater
X	High winds
X	Hail
X	Lightning
	Sinkholes
X	Tornado
	Wildfire
X	Winter storm
X	Animal or Plant Disease
	Dam Failure
X	HazMat Incident
X	Human Epidemic

The South English hazard risk assessment and public survey were used to evaluate special concerns of the city and its residents.

South English Risk Assessment	
1	Severe storm
2	Drought
3	Extreme heat
4	Winter storm
5	Tornado

Thornburg

Demographics	
Total Population	59
Median Age	60.4
65 Years and Over	39%
Workforce	
Population over age 16	58
In Labor Force	30 (52%)
Not in Labor force	28 (48%)
Commute to Work	37 Mins
Households	
Median Household Income	$50,417
Per Capita Income	$29,839
Percent Poverty	9%
Average Household Size	1.9
Zero-vehicle households	0
Housing	
Total Housing Units	31
Occupied Housing Units	31
Vacant Housing Units	0
Mobile Homes	0
Median home value	$22,500
Year built	
Since 2000	0.0%
1970-1999	12.9%
1940-1969	3.2%
1939 or earlier	83.9%
Service	Provider
Electric	Alliant Energy
Natural Gas	None
Telephone	Windstream
Internet	Windstream
Water	Poweshiek Rural Water Ass
Sewage Treatment	None
Fire Protection	What Cheer Volunteer FD
Police/Law Enforcement	Keokuk Co Sheriff
Ambulance	Keokuk County

Planning Committee Representative:

Jeannie Bos,Clerk

Hazards that affect Thornburg include:

	Thornburg
X	Drought
X	Extreme heat
X	Expansive soils
X	Flash Flood
X	Flood (Stormwater)
X	High winds
X	Hail
X	Lightning
	Sinkholes
X	Tornado
	Wildfire
X	Winter storm
X	Animal or Plant Disease
	Dam Failure
X	HazMat Incident
X	Human Epidemic

The Thornburg hazard risk assessment and public survey were used to evaluate special concerns of the city and its residents.

Thornburg Risk Assessment	
1	Tornado
2	Severe storm
3	Winter storm
4	Drought
5	Heat

Webster

Demographics	
Total Population	145
Median Age	27.9
65 Years and Over	12%
Workforce	
Population over age 16	101
In Labor Force	65 (64%)
Not in Labor force	36 (36%)
Commute to Work	32 Mins
Households	
Median Household Income	$31,985
Per Capita Income	$19,959
Percent Poverty	7%
Average Household Size	2.5
Zero-vehicle households	0
Housing	
Total Housing Units	65
Occupied Housing Units	57
Vacant Housing Units	8
Mobile Homes	10
Median home value	$72,500
Year built	
Since 2000	1.5%
1970-1999	21.5%
1940-1969	16.9%
1939 or earlier	60%
Service	Provider
Electric	Alliant Energy
Natural Gas	None
Telephone	Modern Co-Op
Internet	Mediacom & Modern Co-Op
Water	City of Webster
Sewage Treatment	RUSS-Regional Utility Service System
Fire Protection	North Keokuk County FD
Police/Law Enforcement	Keokuk County Sheriff
Ambulance	Keokuk County

Planning Committee Representative:

Bryan Lee, Myor

	Webster
X	Drought
X	Extreme heat
X	Expansive soils
	Flash Flood
X	Flood (Stormwater)
X	High winds
X	Hail
X	Lightning
	Sinkholes
X	Tornado
	Wildfire
X	Winter storm
X	Animal or Plant Disease
	Dam Failure
X	HazMat Incident
X	Human Epidemic

The Webster hazard risk assessment and public survey were used to evaluate special concerns of the city and its residents.

Webster Risk Assessment	
1	Tornado
2	Severe storm
3	Winter storm
4	Drought
5	Heat

What Cheer

Demographics	
Total Population	724
Median Age	34.8
65 Years and Over	17%
Workforce	
Population over age 16	515
In Labor Force	294 (57%)
Not in Labor force	221 (43%)
Commute to Work	26 Mins
Households	
Median Household Income	$45,500
Per Capita Income	$23,933
Percent Poverty	26%
Average Household Size	2.8
Zero-vehicle households	16
Housing	
Total Housing Units	335
Occupied Housing Units	262
Vacant Housing Units	73
Mobile Homes	27
Median home value	$43,300
Year built	
Since 2000	4.2%
1970-1999	22.1%
1940-1969	9.3%
1939 or earlier	64.5%
Service	Provider
Electric	Alliant Energy
Natural Gas	Alliant Energy
Telephone	Windstream, Mediacom
Internet	Windstream, Mediacom
Water	Wapello Rural Water Assc
Sewage Treatment	City of What Cheer
Fire Protection	What Cheer Volunteer FD
Police/Law Enforcement	Keokuk Co Sheriff
Ambulance	Keokuk County

Planning Committee Representative:

Christine Howard, City Council

Hazards that affect What Cheer include:

What Cheer	
X	Drought
X	Extreme heat
X	Expansive soils
	Flash Flood
X	Flood SFHA & Stormwater
X	High winds
X	Hail
X	Lightning
X	Sinkholes
X	Tornado
X	Wildfire
X	Winter storm
X	Animal or Plant Disease
	Dam Failure
X	HazMat Incident
X	Human Epidemic

The What Cheer hazard risk assessment and public survey were used to evaluate special concerns of the city and its residents.

What Cheer Risk Assessment	
1	Severe storm
2	Winter storm
3	Tornado
4	Drought
5	Extreme heat
6	Flood
7	Wildfire
8	Expansive soils

Schools

School District	Location	Enrollment
Keota	Keota	346
Sigourney	Sigourney	564
Tri-County	Thornburg	257

Hazards that affect schools

Schools	
X	Extreme heat
X	Expansive soils
X	Flood (Surface flow)
X	High winds
X	Hail
X	Lightning
X	Tornado
X	Wildfire
X	Winter storm
X	HazMat Incident
X	Human Epidemic

Mitigation actions for schools can be viewed in the Table in Appendix G.

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Appendices

Appendix A – Hazards profiled for Iowa

The following information is directly quoted from the 2023 State of Iowa HMP Section 3, pages 3-1 and 3-2.

> The 2018 Iowa Hazard Mitigation Plan identified 20 hazards that pose a measure of risk to Iowa. Of those, 13 are considered natural hazards, meaning they "are a source of harm or difficulty created by a meteorological, environmental, or geological phenomenon or combination of phenomena"1. By this definition, "natural" does not include biological hazards, such as disease. To comply with 44 CFR 201.4 (c) (2), this plan must contain an "overview of the type and location of all natural hazards that can affect the state." In section 3.3 profiles, or overviews, of each of the following natural hazards determined to be able to affect the state of Iowa will be presented:
>
> 1. Drought
> 2. Tornadoes and other High Wind Events (including derechos)
> 3. Flooding-River
> 4. Flooding-Flash
> 5. Severe Winter Storms
> 6. Hail and Lightning storms
> 7. Excessive Heat
> 8. Dam and Levee failure (relates to natural hazard of flooding)
> 9. Landslides
> 10. Earthquake
> 11. Wildfire, including Grass Fire
> 12. Sinkholes
> 13. Expansive Soils
>
> The natural hazard profiles include information on the nature of each natural hazard, the locations or areas where they are found, and information on previous occurrences of hazard events. Using best available information, the probability of future hazard events is also provided for each natural hazard profiled in section 3.3.
>
> Section 3.4 includes a brief overview of several "non-natural" hazards that affect Iowa, namely:
>
> 1. Animal/Crop/Plant Disease
> 2. Pandemic Human Disease
> 3. Hazardous Materials
> 4. Infrastructure Failure
> 5. Radiological Incident
> 6. Terrorism
> 7. Transportation Incident
>
> These seven hazards plus the thirteen natural hazards are the same 20 hazards used in the Threat and Hazard Identification and Risk Assessment (THIRA) for Iowa.

Appendix B – Animal Plant Crop Disease Costs

The Des Moines Register

Published 8:04 a.m. CT July 27, 2021 Updated 12:16 p.m. CT July 27, 2021

By Donnelle Eller

Iowa farmers absorbed $243 million in losses from last year's devastating drought, derecho, new tally says

The derecho and drought that hammered Iowa last year destroyed $802 million in corn, soybeans and pastures, a new report shows, with farmers absorbing nearly one-third of the losses.

The American Farm Bureau Federation, which is lobbying congressional leaders to provide additional disaster aid for U.S. growers, says crop insurance covered nearly $560 million of the losses that Iowa farmers faced following the devastating drought and the derecho. The state's farmers were responsible for covering $243 million out of pocket.

Nationwide, natural disasters caused $6.5 billion in damage to crops, pasture and rangeland, according to the Farm Bureau. Federal crop insurance is covering $2.9 billion in losses, leaving U.S. growers to cover $3.6 billion of the total hit.

Damage from natural disasters, including hurricanes, wildfires and Tornados, drought and derechos, extended beyond just agricultural land: Nearly $99 billion in damages was reported to homes, businesses, farms and other property last year.

It was the fourth-most expensive year of natural disasters since 1980, according to the National Oceanic and Atmospheric Administration.

The natural disasters killed 262 people last year, NOAA reported, including three Iowans who died in the derecho.

The derecho's straight-line winds reached 140 mph on Aug. 10 as it traveled 770 miles across eight states from South Dakota to Ohio. Total damages to homes, businesses and farms — much of it centered in Iowa and Illinois — reached $11.5 billion, NOAA reported, up from a $7.5 billion estimate made last fall.

It was the most costly thunderstorm in U.S. history, according to NOAA.

The storm ripped through cities and towns across Iowa, including Des Moines, Marshalltown and Cedar Rapids, leaving about 400,000 people without power. Many of Cedar Rapids' 132,000 residents were without power for days, stretching past two weeks for some.

The derecho's damage to Iowa corn, soybeans and other crops reached $490.8 million, with federal crop insurance covering $343.3 million of those losses and farmers picking up the remaining $147.5 million in costs, said Daniel Munch, the Farm Bureau associate economist who wrote the report, released earlier this month.

The drought caused $308.2 million in damage to Iowa crops, with $214.5 million covered by insurance, the report shows. An estimated $93.7 million in losses were uncovered.

Munch said last year's drought, which has continued this year, contributed to the derecho damage, potentially weakening plants. Experts also say the storm's timing — hitting shortly before crops were harvested — contributed to damage by snapping tall corn.

The storm damaged crops on an estimated 6 million farm acres as it swept across the central third of Iowa. Farm Bureau's crop damage estimate doesn't include other ag losses, such as twisted grain bins on farms

and at elevators, loss of livestock or the additional equipment, time and other costs that farmers experienced when harvesting thousands of acres of fallen corn and soybeans, Munch said.

The report also indicated the drought and derecho damaged about $3.1 million of Iowa pasture and rangeland, with nearly $2 million of losses uncovered.

Last year, Iowa farmers insured about 95% of the state's total corn and soybean acres, U.S. Department of Agriculture data shows. The insured crops represented $12 billion of value. Taxpayers subsidized about half of the state's crop insurance costs; farmers paid the remainder.

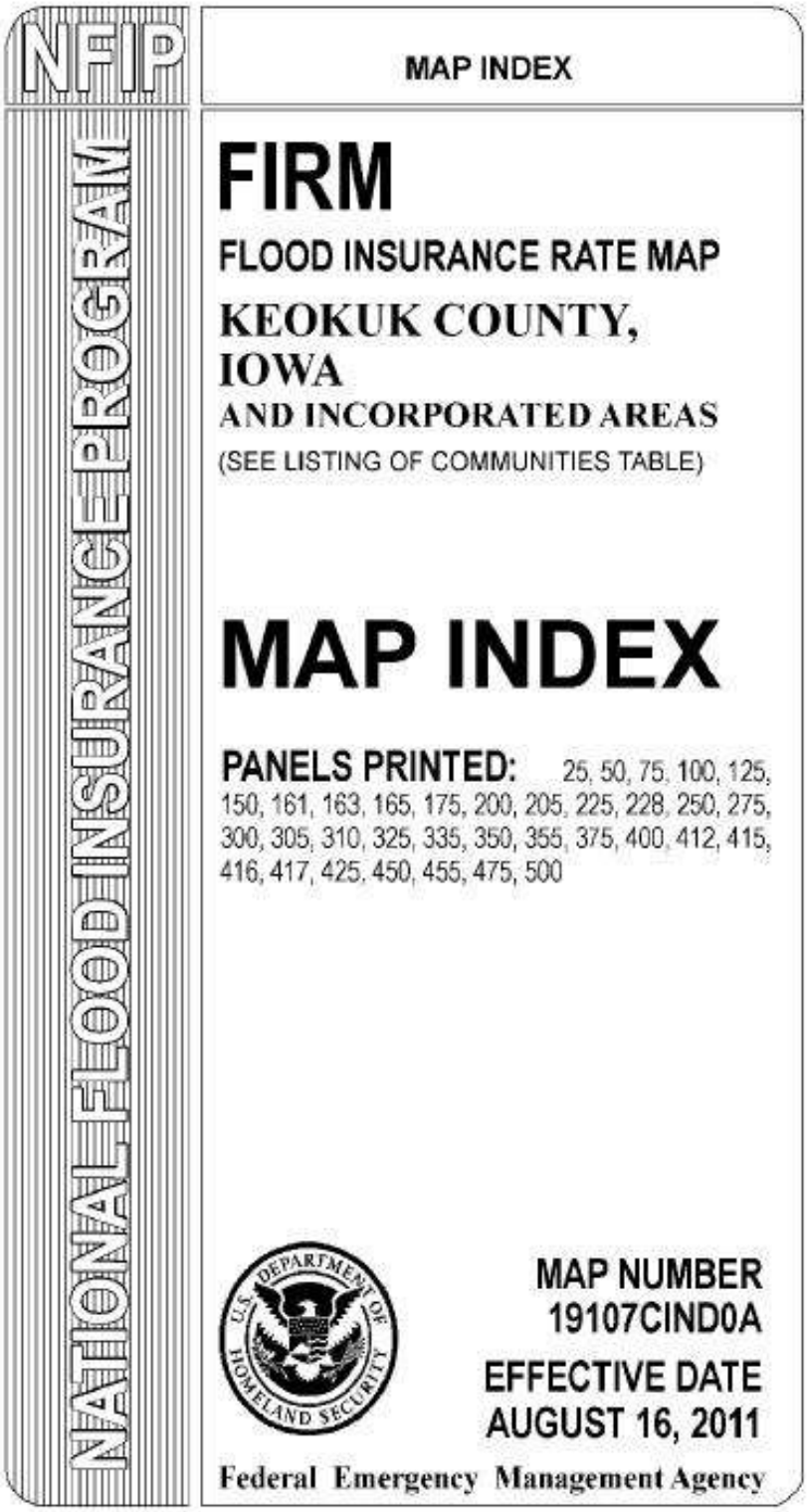
Congress and the former Trump administration made about $4 billion available to farmers to help cover natural disaster costs in 2018 and 2019. It was part of a larger $19.1 billion disaster package for Americans.

U.S. Reps. Randy Feenstra, R-Iowa, and Cindy Axne, D-Iowa, voted to provide coverage for the derecho and other high wind-events in an $8.5 billion disaster bill that the House agriculture committee approved Tuesday. The bill would provide assistance to farmers and ranchers seeking natural disaster assistance for last year and 2021.

Donnelle Eller covers agriculture, the environment and energy for the Register. Reach her at deller@registermedia.com or 515-284-8457

Appendix C – Flood Index, Communities in Keokuk County

No Flood Insurance Study (FIS) has been published for Keokuk County.



Community Name	Community Number	Panel Numbers	Initial NFIP Map Date	Effective FIRM Date
Keokuk County (Unincorporated)	109883		August 23, 1977	August 16, 2011
Delta	190962	0300	August 16, 2011	August 16, 2011
***Gibson**	190964	0150	NSFHA	NSFHA
Harper	190741	0335	August 16, 2011	August 16, 2011
Hayesville	190966	0300, 0325	August 16, 2011	August 16, 2011
Hedrick	190592	0412, 0416	August 16, 2011	August 16, 2011
Keota	190435	0355	August 16, 2011	August 16, 2011
Keswick	190750	0200	August 16, 2011	August 16, 2011
Kinross	190436	0228	August 13, 1976	August 16, 2011
Martinsburg	190969	0417, 0450	August 16, 2011	August 16, 2011
Ollie	190790	0455	August 16, 2011	August 16, 2011
Richland	190647	0475, 0500	August 16, 2011	August 16, 2011
Sigourney	190178	0305, 0310	August 16, 2011	August 16, 2011
South English	190806	0205	August 16, 2011	August 16, 2011
***Thornburg**	190975	0175	NSFHA	NSFHA
***Webster**	190976	0200	NSFHA	NSFHA
What Cheer	190179	0161, 0163	August 16, 2011	August 16, 2011
***No SFHA Identified**				

FLOOD AND STORMWATER MANAGEMENT

From FEMA Flood Risk Reduction Guide Part 12 B.5.

https://www.fema.gov/grants/mitigation/guide/part-12/b/5

Flood diversion and storage projects are climate resilient mitigation actions.

While there may be many different types of localized flood risk reduction projects, stormwater management projects are some of the most common to the HMA programs. Stormwater management is defined as efforts to reduce the impact of increased runoff that results from new development in a watershed. Stormwater management also encompasses many aspects of water quality and includes efforts to reduce erosion and the entry of sediment and pollutants into receiving streams.

The objective of this activity is to prevent future development from increasing flood hazards to existing development, to protect existing hydrologic functions within the watershed, and to maintain and improve water quality. Unmanaged stormwater runoff from new development and redevelopment throughout a watershed increases flood hazards by causing more frequent flooding, greater flood depths and longer-lasting floods. As forests, fields and farms are covered by impermeable surfaces such as streets, rooftops and parking lots, more of the rain runs off, and at a faster rate. When an area is urbanized, the rate and volume of runoff can increase fivefold or more. Communities are affected by development that takes place upstream in their watershed, and the community's own development can have an impact on downstream communities. Communities are encouraged to cooperate with adjacent communities to manage stormwater. Stormwater management regulations regulate development on a case-by-case basis to ensure the peak flow and

volume of stormwater runoff from each site will be no greater than the runoff from the site before it was developed or redeveloped.

Stormwater management

Stormwater management practices can be grouped loosely into the following categories:

Infiltration: These approaches manage stormwater by infiltrating it into the ground. These methods are considered pollutant-reducing. Some examples include porous pavement, subsurface infiltration and bioinfiltration.

Slow release: These approaches detain and slowly release stormwater over time. An example is a detention/retention pond.

Pollutant-reducing: These approaches incorporate pollutant-reducing practices. They may include infiltration practices and some slow-release practices.

Vegetated: These approaches use vegetation as a significant component within the storage area. Examples include bioretention basins, ponds and wet basins, green roofs, and vegetated media filters.

Non-vegetated: These approaches do not have a significant vegetation component. They include but are not limited to porous pavements, blue roofs, media filters, cisterns, and subsurface storage and conveyance methods (Flood Risk Reduction, 2024).

Many flood diversion and storage projects are currently eligible for HMA as flood risk reduction activities. The HMA Guide focuses on flood diversion and storage projects implemented using green infrastructure methods as much as possible to address drought mitigation and climate change resilience in addition to reducing flood risk. Green infrastructure methods involve diverting the water into appropriately sized bioretention or biodetention basins. Smaller projects can provide localized flood reduction by channeling the diverted water into a bioswale, rain garden, stormwater tree trench or smaller bioretention or biodetention basin.

Appendix D – Compliance, Mitigation Actions

Scoring

Cost and Benefit	
1 point	Benefit expected to be equal to OR greater than cost
2 points	Benefit expected to be greater than cost AND ensure continuity of government
3 points	Benefit expected to be greater than cost AND mitigate multiple hazards
4 points	Benefit is expected to be greater than cost AND the action benefits underserved communities or socially vulnerable populations
5 points	Benefit expected to be significantly greater than cost OR the action is expected to prevent deaths or injuries
STAPLEE = 1 point for each category, up to 7	
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
Local emphasis = 1 point each	
1 point	Mitigates hazards to buildings and infrastructure
1 point	Mitigation for Severe storms (hail, high winds & lightning), Tornado, Winter weather
Total score = Priority	
10 or more	Priority A: High priority
7-9 points	Priority B: Medium priority
6 points or fewer	Priority C: Desirable if funding is available

Scoring Table

Item #	Action	Category	GOALS	STAPLEE	STAP SCORE	COST BENEFIT	LOCAL EMPHASIS	TOTAL	PRIORITY
1	Improvements to infrastructure resilience. M	Structure/infrastructure	2,3	STAPEE	6	4	2	12	A
2	Evaluate water redundancy and ensure wate	Structure/infrastructure	1,2,3	STAP Ec	5	5	1	11	A
3	Equip critical facilities and community shelte	Structure/infrastructure	1,3	STAPL Ec	6	4	1	11	A
4	Facilitate the funding, installation and impro	P&R	1,2,4	STAP Ec	5	4	1	10	A
5	Coordinate with State agencies to improve a	P&R, NEW	1,3	STAPL Ec	6	3	1	10	A
6	Make use of effective codes and zoning tools	P&R	1,2,4	STAPL Ec	6	3	1	10	A
7	Develop a long-term shelter plan	P&R	1,4	STAPL	5	4	1	10	A
8	Develop and implement a Continuity of Gove	P&R, NEW	3,4	STAPL	5	2	2	9	B
9	Assist businesses create and maintain a disas	P&R	1,4	STAP Ec	5	3	1	9	B
10	Develop a voluteer call list and procedure to	P&R, NEW	1	STAP	4	4	1	9	B
11	Assess vulnerability of critical facilities and in	P&R	1,2,3	STAP Ec	5	3	1	9	B
12	Add information about expansive soils to buil	P&R, NEW	2,4	STAP Ec	5	1	1	7	B
13	Identify sinkholes and abandoned wells/mine	P&R	2,4	STAP Ec	5	1	1	7	B
14	Conduct annual tree maintenance	NS		STAPLEE	7	3	1	11	A
15	Improve stormwater drainage capacity, rete	NS	2	STAPLEE	7	1	1	9	B
16	Implement best practices for stormwater ma	NS, NEW	2	STAPLEE	7	1	1	9	B
17	Acquire and remove any structures that rem	P&R	2	TAL Env	4	1	1	6	C
18	Train emergency responders to handle trans	E&A	1,3	STAPLEE	7	5	1	13	A
19	Conduct awareness programs for citizens an	E&A, NEW	1,4	STAPLEE	7	5	1	13	A
20	Provide Flood Insurance Rate Maps and expa	E&A	2	STAPL Env	6	1	1	8	B
21	Install additional sirens and upgrade existing	0.05	1,4	STAPL Ec	6	5	1	12	A
22	Purchase generators to power critical faciliti	0.05	1,3	STAP Ec	5	4	1	10	B
23	Obtain equipment to remove and dispose of	0.05	2,	STAPL Env	6	3	1	10	A
24	Practice drills and train firefighters, responde	P&R	1,3,4	STAP	4	5	1	10	A
25	Provide Personal Protective Equipment (PPE)	5% NEW	1,3	STAP	4	5	1	10	A
26	Install, upgrade and maintain lightning prote	5% NEW	2,3	STAPLE	6	2	1	9	B
27	Purchase and distribute NOAA weather radio	0.05	1,4	STA	3	5	1	9	B
28	Purchase standby and portable pumps for flo	0.05	2	STAPL Ec	6	1	1	8	B

C4-b At least one mitigation action for each hazard per affected jurisdiction. Additional action items are also recommended in the Mitigation Action Tables.

HAZARD	Schools Action	County & Cities Action
Drought	NA	1
Extreme heat	7	22
Expansive soils	15	6
Flood	15	16
High winds	19	11
Hail	26	23
Lightning	26	26
Sinkholes	NA	13 (Co & W Cheer only)
Tornado	7	8
Wildfire	19	1
Winter storm	3	14
Dam Failure	NA	27
Animal/Crop/Plant Disease	NA	23
Hazardous Material spill	19	19
Human epidemic	19	24

Appendix E – Public Survey comments

The top 3 weather concerns of the Public are Severe storms (with Hail High Wind and Lightning), Tornados and Winter weather. Topics of least concern were Sinkholes and Dam failure.

2024	Priority
Severe Storms (Hail, High Wind, Lightning)	1
Tornado	2
Winter Storm	3
Drought	4
Extreme Heat	5
Flooding	6
Wildfire	7
Expansive Soils	8
Sinkhole	9
Dam Failure	10

Public comments received are summarized by the comments below. Duplicate ideas were deleted.

COMMUNITY COMMENTS, PUBLIC COMMENTS	CATEGORY
Build a community rec center with generator backup that can be used as a storm shelter, cooling and or warming center	Structure
Community Shelters	Structure
Improvements to infrastructure resiliency	Structure
Emergency response plan, continuity of government	P & R
More control of run off chemicals in our water system.	P & R
Having the funding to provide assistance to residents	P & R
Support for elderly or disabled during emergency	P & R
Designated storm shelters, public plan	P & R
Expansive soils	P & R
Safety for elderly	P & R
Funding to implement solutions	P & R
Trees around power lines trimmed or removed	P & R
Keeping the bridges cleaned of debris underneath to reduce flooding	NS
Drainage improvements for towns	NS
Be personally prepared, better preparedness	Education
Family plan for shelter & emergency supplies	Education
Reduce fossil fuel consumption	Education
Sirens (remote activation)	5%
Generators, utility back up	5%
Better Communication, Warnings including rural	5%
More snow removal equipment	5%
More tree removal equipment	5%
Support QRS & Fire departments	FD

Appendix F – Plan Review Worksheets

The following worksheets are used to report and evaluate projects, review the planning committee and risk assessments, and guide plan revisions.

Keokuk County Hazard Mitigation Planning

Worksheet 1 – Annual Progress Report

Date _____

Progress report period from Date: _____ to _____

Which jurisdictions initiated or completed Hazard Mitigation activity this period?
Attach Project Report (Worksheet 1) for each project, County Town or School.

Project 1	Entity
	Project
	Contact person
	Email or phone
Project 2	Entity
	Project
	Contact person
	Email or phone
Project 3	Entity
	Project
	Contact person
	Email or phone
Project 4	Entity
	Project
	Contact person
	Email or phone

Comments:

Worksheet 2 – Project Report

Community name: _____

Contact person: _____ Phone _____ Email _____

Project name: _____

Total project cost: _____

Funding sources: _____

Hazard(s) Mitigated: _____

Project Location and description:

Actual or expected date of completion _____-_

Which of the following Goals does the project support:

Protect life Protect property Protect the environment

Increased public preparedness for disasters

Was there public or political support for the project? _____

Was the project successfully completed? _____

Within the proposed budget? _____

Within the proposed timeframe? _____

Please attach any supporting photos or other pertinent information.

Comments:

Worksheet 3 – Process to update the plan

As the five year cycle progresses, the Hazard Mitigation Planning Committee (HMPC) will follow the guidelines below.

Prep for 5 year Update:

Evaluate the Planning Team

Local staffing changes that require a new team member?

Unrepresented stakeholders that should be invited to the team?

Are there ways to gain more diverse and widespread participation?

Are there new or unused methods of funding that we should pursue?

Who will research funding by contacting State Emergency Management, FEMA, DNR, USDA, and other communities that have achieved successful projects?

_____

Check with all Jurisdictions for changes to Building codes, permits, comp plans, projects planned, completed or underway, school hazard mitigation activities, or other Hazard Mitigation measures taken since the adoption date of last HMP (use and attach worksheets 1 & 2).

Proposed schedule for future updates	**Time**
Apply for planning funds from the state. Notice of Intent	2 years prior to plan expiration
Evaluate Planning team:	14 months prior to Plan expiration
Receive funding award or authorize cost. Planner in place	1 year prior to Plan expiration
Begin Plan update, refresh community information	1 year prior to Plan expiration
Complete the capability assessment for each jurisdiction	11 months prior to plan expiration
Begin data collection and hazard profiles	10 months prior to plan expiration
Initiate public survey for risk assessment	9 months prior to plan expiration
Vulnerability and Impacts for each jurisdiction	8 months prior to plan expiration
Review previous mitigation action plan with each jurisdiction	8 months prior to plan expiration
Record and organize all public and jurisdiction comments	7 months prior to plan expiration
HMPC reviews all data, comments and drafts	6 months prior to plan expiration
Draft new mitigation strategies and action tables	5 months prior to plan expiration
HMPC reviews new action plan	4 months prior to plan expiration
Staff drafts, HMPC reviews maintenance section for update	3 months prior to plan expiration
HMPC approves final draft, county adopts to send to state	60 days prior to plan expiration
Final draft complete, submit to Iowa HSEMD	60 days prior to plan expiration
Receive FEMA approval	30 days prior to plan expiration
All jurisdictions adopt	Prior to previous plan expiration

Worksheet 4 Risk Assessment

Hazard Mitigation Planning 2024

Public Opinion Survey

Hazards of concern for this Plan:

Natural Hazards
Dam Failure
Drought
Earthquake
Expansive soils
Extreme Heat
Flood
Severe storms
(Hail, High Wind, Lightning)
Tornado
Wildfire
Winter Storm

Flip for Page 2

Thank you!

Please return surveys to your local City Hall, or email comments to Gail Thomas at grthomasplans@gmail.com

Hazard Mitigation Planning 2024

What hazards affect your community most often? (Most frequent)

#1
#2
#3
#4

What Hazards are you most concerned about? (Most dangerous)

#1
#2
#3
#4

When these things happen, what would be the most serious effects?

Do you have frequent power outages, and what problems does that cause?

What should be done to reduce the impacts of hazards on your community?

Thank you!

Please return surveys to your local City Hall, or email comments to
Gail Thomas at grthomasplans@gmail.com

Appendix G – Adoption Resolutions

Appendix G – Summary Action Plan

Reference guide for Mitigation Actions for each community:

Action item # for the County	Action item # for Schools	Action items for ALL Cities	Actions for specific Jurisdictions
1	1	1	
			2: Thornburg, Webster (water supply)
3	3	3	
4	4	4	
5			5: Keokuk County Only
6		6	
7	7	7	
8		8	
9		9	
10		10	
11	11	11	
			12: Cities with Building permits
13			13: County & What Cheer
14		14	
15	15	15	
16	16	16	
17			17: County & Cities with SFHAs
18			18: County & Fire Departments
19	19	19	
20		20	
21		21	
22	22	22	
23		23	
24			24: Keokuk County only
25	25	25	
26			26: Keokuk County only
27	27	27	
28	28	28	

See full tables in Section C5-b. Pages 146 – 155

#	Structure Infrastructure	HAZARDS MITIGATED	PRIORITY	JURISDICTIONS
1	Improvements to infrastructure resilience	Drought, Expansive soils, Flood, High winds, Hail, Lightning, Sinkholes, Tornado, Wildfire, Winter storm	12 A	County, Cities & Schools
2	Evaluate water redundancy and ensure water supply networks have sufficient reserve capacity and alternative supply paths	Drought	11 A	Thornburg, Webster
3	Equip critical facilities and community shelters to accept generators, by hard-wiring or install fixed generators	Hail, High wind, Lightning, Tornado, Winter weather	11 A	County, Cities & Schools
4	Facilitate the funding, installation and improvement of handicap accessible community shelters and safe rooms	Hail, High wind, Lightning, Tornado, Winter weather	10 A	County, Cities & Schools
	Plans & Regulations			
5	Coordinate with State agencies to improve access to funding	All Hazards	10 A	County
6	Make use of effective codes and zoning tools to regulate construction in unsuitable areas	Expansive soils, Floods	10 A	County & Cities
7	Develop a long-term shelter plan.	Extreme heat, Hail, High wind, Lightning, Tornado, Winter weather	10 A	County, Cities & Schools
8	Develop and implement a Continuity of Government plan	Hail, High wind, Lightning, Tornado, Winter weather, Human epidemic	9 B	County & Cities
9	Assist businesses create and maintain a disaster preparedness plan	Drought, Flood, High winds, Hail, Lightning, Sinkholes, Tornado, Wildfire, Winter storm	9 B	County & Cities
10	Develop a voluteer call list and procedure to contact elderly/disabled individuals that might need assistance during or after a major hazard event	Hail, High wind, Lightning, Tornado, Winter weather	9 B	County & Cities
11	Assess vulnerability of critical facilities and infrastructure	Hail, High wind, Lightning, Tornado, Winter weather	9 B	County, Cities & Schools
12	Add information about expansive soils to building permit forms	Expansive soils	7 B	Delta, Harper, Hedrick, Keota, Richland, Sigourney, Webster, What Cheer
13	Identify sinkholes and abandoned wells/mines	Sinkhole	7 B	County & What Cheer

	Natural Systems			
14	Conduct annual tree maintenance	Hail, High wind, Lightning, Tornado, Winter weather, APC Disease	11 A	County & Cities
15	Improve stormwater drainage capacity near public buildings	Flood (Surface flow), Expansive soils	9 B	County, Cities & Schools
16	Implement best practices for stormwater management in other affected areas	Flood (SFHA, Flash, Surface flow), Expansive soils	9 B	County, Cities & Schools
17	Acquire and remove any structures that remain in the SFHA floodplain	Flood (SFHA), Dam failure	6 C	County & Cities with SFHA
	Education & Awareness			
18	Train emergency responders to handle transportation HazMat incidents	HazMat	13 A	County & Fire Departments
19	Conduct awareness programs for citizens and students to teach emergency preparedness	Extreme Heat, Flood, Hail, High wind, Lightning, Tornado, Wildfire, Winter Storm, HazMat Incident, Human disease epidemic	13 A	County, Cities & Schools
20	Provide Flood Insurance Rate Maps and expansive soil maps to the public	Flood (SFHA), Expansive soils	8 B	County & Cities
	5% Projects			
21	Install additional sirens and upgrade existing storm sirens with alternate power backups and remote activation	Hail, High wind, Lightning, Tornado	12 A	County & Cities
22	Purchase generators to power critical facilities	Extreme heat, Hail, High wind, Lightning, Tornado, Winter weather	10 A	County, Cities & Schools
23	Obtain equipment to remove and dispose of storm and tree debris	Hail, High wind, Lightning, Tornado, Winter weather, ACP Disease	10 A	County & Cities
24	Practice drills and train firefighters, responders, and community leaders on effective disaster response	Hail, High wind, Lightning, Tornado, Wildfire, Winter weather, Human epidemic, HazMat	10 A	County & Cities, Fire Departments
25	Install, upgrade and maintain lightning protection systems for critical facilities	Lightning	9 B	County, Cities & Schools
26	Purchase and distribute NOAA weather radios	Natural Hazards, Dam Failure	9 B	County
27	Purchase standby and portable pumps for flood protection.	Flood (SFHA, Flash< Surface flow)	8 B	County, Cities & Schools
28	Provide/upgrade communications systems/backup systems.	All Hazards	6 C	County, Cities & Schools

See full tables in Section C5-b. Pages 146 – 155 for more information.