3 RISK ASSESSMENT

44 CFR Requirement §201.6(c)(2): [The plan shall include] A risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

The risk assessment process identifies and profiles relevant hazards and assesses the exposure of lives, property, and infrastructure within Cedar County, Iowa to these hazards. The goal of the risk assessment is to estimate the potential loss in the planning area, including loss of life, personal injury, property damage, and economic loss, from a hazard event. The risk assessment process allows communities in the planning area to better understand their potential risk to the identified hazards and provides a framework for developing and prioritizing mitigation actions to reduce risk from future hazard events.

The risk assessment for Cedar County and participating jurisdictions followed the methodology described in the 2013 FEMA *Local Mitigation planning Handbook*, which includes a four-step process:

Step 1—Describe Hazards
Step 2—Identify Community Assets
Step 3—Analyze Risks
Step 4—Summarize Vulnerability

This chapter is divided into six main parts:

- **Section 3.1 Hazard Identification** identifies the hazards that threaten the planning area and the methodology utilized to score or rank the hazards;
- **Section 3.2 Assets at Risk** provides the planning area's total exposure to natural hazards, considering critical facilities and other community assets at risk;
- **Section 3.3 Development Since 2011 Plan Update** discusses what changes in development have occurred since the previous Hazard Mitigation Plan;
- **Section 3.4 Future Land Use and Development** discusses areas of planned future development;
- **Section 3.5 Hazard Profiles and Vulnerability** for each hazard, this section is divided into two parts: 1) Hazard Profile discusses the threat to the planning area, the geographic location/extent at risk, previous occurrences of hazard events, and probability of future occurrence; and 2) Vulnerability Assessment further defines and quantifies populations, buildings, critical facilities, and other community assets at risk to natural hazards;
- **Section 3.6 Hazard Analysis Summary** provides a tabular summary of the hazard ranking for each jurisdiction in the planning area.

3.1 Hazard Identification

Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the type…of all natural hazards that can affect the jurisdiction.

The 16 hazards identified for this plan update are listed below in alphabetical order

- Dam Failure*
- Drought
- Earthquakes
- Expansive Soils
- Extreme Heat
- Flash Flood
- Grass/Wildland Fire
- Hazardous Materials Incident*
- Radiological Incident*
- River Flood
- Severe Winter Storm
- Sinkholes
- Terrorism*
- Thunderstorm/Lightning/Hail
- Tornado/Windstorm
- Transportation Incident

*denotes hazards added to this plan update that were not included in the 2011 *Cedar County Multi-jurisdictional Hazard Mitigation Plan*.

Sections 3.1.1 through 3.1.3 describe how these hazards were identified for this plan update.

3.1.1 Review of Existing Mitigation Plans

Prior to 2011, Hazard Mitigation Planning in Cedar County was accomplished on a jurisdictional basis. In January 2010, the unincorporated county and incorporated municipalities came together to coordinate multi-jurisdictional mitigation planning for the entire Cedar County planning area. This coordinated effort resulted in the *Cedar County, Iowa Multi-jurisdictional Hazard Mitigation Plan*, approved by FEMA in January 2011. To identify hazards to include in the Risk Assessment update, a comparison was performed of the hazard identification in the *2013 Iowa State Hazard Mitigation Plan*, and the *2011 Cedar County Multi-jurisdictional Hazard Mitigation Plan*. **Table 3.1** provides the details of the comparison.

Table 3.1. Hazard Comparison Chart

2013 Iowa State Hazard Mitigation Plan Hazards	*2011 Cedar County Hazard Mitigation Plan* Hazards
River Flooding	Flooding (Riverine and Flash)
Flash Flood	
Tornado/Windstorm	Tornadoes
Thunderstorm/Lightning/Hail	Severe Thunderstorms (Windstorms/Hailstorms/Thunder and Lightning)
Severe Winter Storm	Sever Winter Storm
Levee/Dam Failure	Not Included
Terrorism	Not Included
Animal/Plant/Crop Disease	Not Included
HAZMAT Incident	Not Included
Radiological Incident	Not Included
Drought	Drought
Human Disease	Not Included
Transportation Incident	Interstate/Highway Transportation Incident
	Railway Transportation Incident
Infrastructure Failure	Not Included
Extreme Heat	Extreme Heat
Grass/Wild Land Fire	Wildfires
Sinkholes	Sinkholes
Landslide	Not Included
Earthquake	Earthquake
Expansive Soils	Expansive Soils

After a review of the hazards, it was agreed that the hazards/hazard naming for this update will be consistent with the 2013 State Plan with the following exceptions:

- Levee Failure will not be included because there are no levees in Cedar County other than private agricultural levees that are not inventoried.
- Dam Failure will be included as a separate hazard. Although there are no high or moderate hazard dams within the county boundaries, there are dams upstream that could impact Cedar County in the unlikely event of failure. Therefore, this hazard has been added to address the upstream dams.
- Animal/Plant/Crop Disease will not be included. The agricultural community works with animal/plant/crop disease specialists routinely to address preventative steps that can be taken. This hazard is adequately addressed through other planning mechanisms.
- Human Disease will not be included. The County Health Department has a Public Health Plan that addresses this hazard.
- Infrastructure Failure will not be included as a separate hazard. The failure to infrastructure that can occur as a result of natural hazards will be discussed under each hazard.

Infrastructure failure as a result of human causes is not required for inclusion in Hazard Mitigation Plans.

- Landslide will not be included. The planning committee determined there have been no instances of landslides as a result of natural causes in the planning area.

3.1.2 Review Disaster Declaration History

Information utilized to identify hazards relevant for Cedar County was obtained by examining events that triggered federal disaster declarations. Federal and/or state declarations may be granted when the severity and magnitude of an event surpasses the ability of the local government to respond and recover. Disaster assistance is supplemental and sequential. When the local government's capacity has been surpassed, a state disaster declaration may be issued, allowing for the provision of state assistance. If the disaster is so severe that both the local and state governments' capacities are exceeded; a federal emergency or disaster declaration may be issued allowing for the provision of federal assistance.

FEMA also issues emergency declarations, which are more limited in scope and do not include the long-term federal recovery programs of major disaster declarations. Determinations for declaration type are based on scale and type of damages and institutions or industrial sectors affected.

Table 3.2 lists federal disaster declarations that included Cedar County for the period from 1969 to 2013.

Table 3.2. FEMA Disaster Declarations that included Cedar County, Iowa, 1998-2014

Number	Declared	Incident Period	Description
4187	8/5/2014	6/26 to 7/7/2014	Severe Storms, Tornadoes, Straight-line Winds, and Flooding
4135	07/31/2013	06/21 to 06/28/2013	Severe Storms, Tornadoes, and Flooding
4119	05/31/2013	04/17 to 04/30/2013	Severe Storms, Straight-line Winds, and Flooding
1763	5/27/2008	5/25 to 8/13/2008	Severe Storms, Tornadoes and Flooding
1737	01/04/2008	12/10 to 12/11/2007	Severe Winter Storms
1688	03/14/2007	2/23 to 3/2/2007	Severe Winter Storms
1518	05/25/2004	5/19 to 6/24/2004	Severe Storms, Tornadoes, and Flooding

Source: Federal Emergency Management Agency, www.fema.gov/

U.S. Department of Agriculture's Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans (EM) to producers suffering losses in those counties and in counties that are contiguous to a designated county. In addition to EM eligibility, other emergency assistance programs, such as Farm Service Agency (FSA) disaster assistance programs, have historically used disaster designations as an eligibility requirement trigger.

Table 3.3 provides the USDA Secretarial disaster declarations that included Cedar County in 2012 and 2013. Cedar County was also included in Secretarial disaster declarations in 2008, 2009, 2010, and 2011. However, details of cause were not available for these declarations.

Table 3.3. USDA Secretarial Disaster Declarations Including Cedar Co. (2012-2013)

Number	Date	Cause					
		Drought	High Winds	Fire, Wildfire	Heat	Insects	Frost, Freeze
S361	2013	x	x	x	x	x	
S362	2012						x
S331	2012	x	x	x	x	x	

Source: U.S. Department of Agriculture

3.1.3 Research Additional Sources

Additional data on locations and past impacts of hazards in the planning area was collected from the following sources:

- Cedar County Digital Flood Insurance Rate Map, FEMA
- Cedar County Emergency Management
- Cedar County Flood Insurance Study, FEMA
- *Cedar County Multi-jurisdictional Hazard Mitigation Plan* (January 2011);
- Data Collection Guides completed by each jurisdiction
- Environmental Protection Agency
- Federal Emergency Management Agency (FEMA);
- Flood Insurance Administration
- Hazards US (HAZUS)
- Iowa Department of Agriculture and Land Stewardship, Division of Soil Conservation
- Iowa Department of Education, Bureau of Information and Analysis Services
- Iowa Department of Natural Resources;
- Iowa Department of Public Safety
- Iowa Department of Transportation, Office of Traffic and Safety
- Iowa Flood Center
- Iowa State Fire Marshal Division
- *Iowa State Hazard Mitigation Plan* (September 2013);
- Iowa Utilities Board
- National Drought Mitigation Center Drought Reporter;
- National Fire Incident Reporting System (NFIRS)
- National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center;
- Pipeline and Hazardous Materials Safety Administration
- SILVIS Lab, Department of Forest Ecology and Management, University of Wisconsin
- U.S. Army Corps of Engineers
- U.S. Department of Agriculture's (USDA) Risk Management Agency Crop Insurance Statistics;
- U.S. Department of Transportation
- United States Geological Survey
- Various articles and publications available on the internet (sources are indicated where data is cited).

3.1.4 Hazards Identified

Through the hazard identification review process, 16 natural and human-caused/technological hazards that have the potential to significantly affect the planning area were chosen for further analysis in the risk assessment. The hazards identified for this plan update are listed below in alphabetical order

- Dam Failure*
- Drought
- Earthquakes
- Expansive Soils
- Extreme Heat
- Flash Flood
- Grass/Wildland Fire
- Hazardous Materials Incident*
- Radiological Incident*
- River Flood
- Severe Winter Storm
- Sinkholes
- Terrorism*
- Thunderstorm/Lightning/Hail
- Tornado/Windstorm
- Transportation Incident

*denotes hazards added to this plan update that were not included in the 2011 *Cedar County Multi-jurisdictional Hazard Mitigation Plan*.

Although 16 hazards with the potential to significantly affect the planning area were identified and selected for additional analysis, not all hazards impact every jurisdiction. **Table 3.4** provides a summary of the jurisdictions impacted by each hazard. An “x” indicates the jurisdiction is impacted by the hazard. A "-" indicates the hazard is not applicable to that jurisdiction.

Table 3.4. Hazards Identified for Each Jurisdiction

Jurisdiction	Dam Failure	Drought	Earthquakes	Expansive Soils	Extreme Heat	Flash Flood	Grass/Wildland Fire	Hazardous Materials Incident	Radiological Incident	River Flood	Severe Winter Storm	Sinkholes	Terrorism	Thunderstorm/Lightning/Hail	Tornado/Windstorm	Transportation Incident
Cedar County	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
City of Bennett	-	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
City of Clarence	-	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x
City of Durant	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
City of Lowden	-	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
City of Mechanicsville	-	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x
City of Stanwood	-	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x
City of Tipton	-	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
City of West Branch	-	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Bennett School District, #603	-	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x
Durant School District, #1926	-	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x
North Cedar School District, #3691	-	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x
Tipton School District #6408	-	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x
West Branch School District #6930	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x

3.1.5 Multi-Jurisdictional Risk Assessment

For this multi-jurisdictional plan, the risks are assessed for each jurisdiction where they deviate from the risks facing the entire planning area. The planning area is fairly uniform in terms of climate and topography as well as building construction characteristics. Accordingly, the geographic areas of occurrence for weather-related hazards do not vary greatly across the planning area for most hazards. The more urbanized areas within the planning area have more assets that are vulnerable to the weather-related hazards and varied development trends impact the future vulnerability. Similarly, more rural areas have more assets (crops/livestock) that are vulnerable to drought. These differences are discussed in greater detail in the vulnerability sections of each hazard.

The hazards that have the potential to vary across the planning area in terms of geographic areas at risk include dam failure, hazardous materials incident, flash flood, grass or wildland fire, radiological incident, and river flood.

Bi-county Cities

There are several cities within Cedar County that have portions of their city limits in adjacent counties. These cities are treated in one of two ways for purposes of participation in this plan:

1) Official Plan Participants: The following cities are bi-county/multiple-county cities that have the majority of their corporate limits in Cedar County. These cities will be invited as official plan participants in the Cedar County plan. The Risk Assessment will include incorporation of analysis of building exposure/critical facilities of the entire city limits for these jurisdictions:

- City of Durant (portions in Muscatine and Scott Counties)
- City of West Branch (portions in Johnson County)

2) Stakeholder Participants: To provide a comprehensive analysis, the Risk Assessment includes incorporated areas of the City of Wilton which has a portion of their city limits in Cedar County, but is considered an official city of adjacent Muscatine County. The Risk Assessment will include analysis of building exposure/critical facilities ONLY for the portion of the incorporated area that is within the Cedar County boundary. Although this city is not an official participant of the *Cedar County Multi-jurisdictional Hazard Mitigation Plan*, they are stakeholders in the planning process and as such, were invited to planning meetings and to comment on plan drafts.

3.1.6 Hazard Scoring Methodology

To maintain reporting format consistent with the *2013 Iowa State Hazard Mitigation Plan*, the Cedar County Hazard Mitigation Planning Committee (HMPC) used the same methodology to score and prioritize the hazards. This prioritization was based on a hazard scoring system that considers four elements of risk: probability, magnitude/severity, warning time, and duration. **Table 3.5** provides definitions for each of the four elements along with associated rating levels.

Table 3.5. Hazard Score Element Definitions and Rating Scales

Element/Score	Definitions
Probability: Reflects the likelihood of the hazard occurring again in the future, considering both the hazard's historical occurrence and the projected likelihood of the hazard occurring in any given year	
1—Unlikely	Less than 10% probability in any given year (up to 1 in 10 chance of occurring), history of events is less than 10% likely or the event is unlikely but there is a possibility of its occurrence.
2—Occasional	Between 10% and 20% probability in any given year (up to 1 in 5 chance of occurring), history of events is greater than 10% but less than 20% or the event could possibly occur.
3—Likely	Between 20% and 33% probability in any given year (up to 1 in 3 chance of occurring), history of events is greater than 20% but less than 33% or the event is likely to occur.
4—Highly Likely	More than 33% probability in any given year (event has up to a 1 in 1 chance of occurring), history of events is greater than 33% likely or the event is highly likely to occur.
Magnitude / Severity: Assessment of severity in terms of injuries and fatalities, personal property, and infrastructure and the degree and extent with which the hazard affects the jurisdiction.	
1—Negligible	Less than 10% of property severely damaged, shutdown of facilities and services for less than 24 hours, and/or injuries /illnesses treatable with first aid.
2—Limited	10% to 25% of property severely damaged, shutdown of facilities and services for more than a week, and/or injuries/illnesses that do not result in permanent disability.
3—Critical	25% to 50% of property severely damaged, shutdown of facilities and services for at least 2 weeks, and/or injuries/illnesses that result in permanent disability.
4—Catastrophic	More than 50% of property severely damaged, shutdown of facilities and services for more than 30 days, and/or multiple deaths.
Warning Time: Rating of the potential amount of warning time that is available before the hazard occurs. This should be taken as an average warning time.	
1	More than 24 hours warning time
2	12 to 24 hours warning time
3	6 to 12 hours warning time
4	Minimal or no warning time (up to 6 hours warning)
Duration: A measure of the duration of time that the hazard will affect the jurisdiction.	
1	Less than 6 hours
2	Less than 1 day
3	Less than 1 week
4	More than one week

Using the rating scales described in the table above, the formula used to determine each hazard's score, including weighting factors, is provided below:

(Probability x .45) + (Magnitude/Severity x .30) + (Warning Time x .15) + (Duration x .10) = SCORE

Based on the hazard's overall weighted score, the hazards are categorized as follows: High (3.0-4.0), Moderate (2.0-2.9), and Low (1.0-1.9).

These terms relate to the level of planning analysis to be given to the particular hazard in the risk assessment process and are not meant to suggest that a hazard would have only limited impact. In order to focus on the most critical hazards, those assigned a level of high or moderate were given more extensive attention in the remainder of the risk assessment (e.g., quantitative analysis or loss estimation), while those with a low planning significance were addressed in more general or qualitative ways.

The HMPC determined overview hazard ranking scores for the planning area as a whole. The results of this overview are provided below in **Table 3.6**. Additionally, the hazard ranking overview is provided at the beginning of each hazard profile and vulnerability section. A detailed hazard summary by jurisdiction is provided at the conclusion of each hazard profile and vulnerability section to provide a summary of how the hazard varies by jurisdiction.

Table 3.6. Cedar County Planning Area Hazard Ranking Results

Hazard	Probability	Magnitude	Warning Time	Duration	Weighted Score	Level
Tornado/Windstorm	4	3	3	1	3.25	High
River Flood	4	3	1	4	3.25	High
Severe Winter Storm	4	2	3	3	3.15	High
Hazardous Materials Incident	4	2	4	1	3.10	High
Transportation Incident	4	2	4	1	3.10	High
Flash Flood	4	2	2	1	2.80	Moderate
Thunderstorm/Lightning/Hail	4	1	3	1	2.65	Moderate
Drought	3	2	1	4	2.50	Moderate
Grass/Wildland Fire	4	1	1	1	2.35	Moderate
Radiological Incident	1	3	4	4	2.35	Moderate
Terrorism	1	3	4	1	2.05	Moderate
Extreme Heat	2	2	1	3	1.95	Low
Dam Failure	1	1	4	1	1.45	Low
Earthquakes	1	1	4	1	1.45	Low
Sinkholes	1	1	4	1	1.45	Low
Expansive Soils	1	1	1	1	1.00	Low

3.2 Assets at Risk

This section assesses the population, structures, critical facilities and infrastructure, and other important assets in the planning area that may be at risk to hazards.

3.2.1 Total Exposure of Population and Structures

3.2.1.1 Unincorporated County and Incorporated Cities

Table 3.7 shows the total population, building count, estimated value of buildings, estimated value of contents and estimated total exposure to parcels for the unincorporated county and each incorporated city. A recognized data limitation associated with utilizing parcel data with assessed values is the exclusion of tax exempt properties in the planning area. There are 556 parcels throughout the planning area that are tax exempt. The number of exempt parcels is also broken down by jurisdiction. However, structure values are not available for these properties.

Table 3.8 provides the building/improvement counts for the county and each city in the planning area broken down by usage type. Finally, **Table 3.9** provides the building/improvement dollar values for the county and each city in the planning area broken out by building usage types (residential, commercial, industrial, and agricultural).

The methodology employed to extract the summary of building/improvement counts and values from the parcel data is provided below:

- Parcel values that had an associated dwelling or improvement value were used as the structure file. Since building footprints and/or building counts per parcel were not available, the parcels with dwelling or improvement value were counted as one building/improvement;
- Parcel polygons were converted to points; and
- Parcel points were spatially joined to the political area (jurisdiction).

Population data is based on the 2013 population estimate from the Iowa State University of Science and Technology, Iowa Community Indicators Program. Building counts and building exposure values are based on parcel data provided by the Cedar County GIS Department, Johnson County GIS Department, Muscatine County GIS Department, and Scott County GIS Department. The contents exposure values were calculated by factoring a multiplier to the building exposure values based on usage type. The contents multipliers were derived from the HAZUS MH 2.1 and are defined below the table. Land values have been purposely excluded from the tables because land remains following disasters, and subsequent market devaluations are frequently short term and difficult to quantify. Additionally, state and federal disaster assistance programs generally do not address loss of land or its associated value (other than crop insurance). The assessed land value of parcels that do not have any associated structures (primarily agricultural) is $679,334,850. The assessed land value of parcels containing at least one structure is $322,530,144.

Table 3.7. Population and Building Exposure by Jurisdiction-Unincorporated County and Incorporated Cities

Jurisdiction	2013 Population Estimate	Exempt Parcels	Building Count	Building Exposure ($)	Contents Exposure ($)	Total Exposure ($)
Unincorporated County	7,097	292	3,906	$422,049,350	$317,725,085	$739,774,435
City of Bennett	396	16	170	$10,455,940	$5,662,435	$16,118,375
City of Clarence	961	27	462	$35,047,570	$20,982,280	$56,029,850
City of Durant*	1,832	20	774	$94,971,006	$65,306,966	$160,277,972
City of Lowden	780	27	400	$27,227,056	$15,339,926	$42,566,981
City of Mechanicsville	1,129	33	483	$39,365,410	$21,676,010	$61,041,420
City of Stanwood	673	30	330	$23,475,106	$14,536,271	$38,011,377
City of Tipton	3,199	54	1,397	$133,371,010	$85,004,280	$218,375,290
City of West Branch*	2,326	56	764	$141,927,556	$107,371,461	$249,299,017
City of Wilton**	N/A	1	1	$124,240	$62,120	$186,360
Total	**18,393**	**556**	**8,687**	**$928,014,244**	**$653,666,834**	**$1,581,681,078**

Sources: Population Estimate, Iowa State University of Science and Technology, Iowa Community Indicators Program; Exempt Parcels, Building/Improvement Count and Exposure, Cedar County GIS Department. Durant data is combination of data from Cedar, Muscatine, and Scott County GIS Departments and West Branch data is combination of data from Cedar and Johnson County GIS Departments; Contents Exposure derived by applying multiplier to Building Exposure based on HAZUS MH 2.1 standard contents multipliers per usage type as follows: Residential (50%), Commercial (100%), Industrial (150%), Agricultural (100%).

*Data is for entire incorporated area, including portion(s) in adjacent counties.

**Data is for Cedar County portion of incorporated area only.

Table 3.8. Building/Improvement Counts by Usage Type

Jurisdiction	Agricultural	Commercial	Industrial	Residential	Total
Unincorporated County	1,933	95	10	1,868	3,906
City of Bennett	0	19	1	150	170
City of Clarence	3	66	2	391	462
City of Durant*	2	87	14	671	774
City of Lowden	3	59	0	338	400
City of Mechanicsville	3	48	0	432	483
City of Stanwood	3	54	2	271	330
City of Tipton	9	221	13	1,154	1,397
City of West Branch*	6	113	8	637	764
City of Wilton**	0	0	0	1	1
Total	**1,962**	**762**	**50**	**5,913**	**8,687**

Source: Cedar County GIS Department. Durant data is combination of data from Cedar, Muscatine, and Scott County GIS Departments and West Branch data is combination of data from Cedar and Johnson County GIS Departments;
*Data is for entire incorporated area, including portion(s) in adjacent counties.
**Data is for Cedar County portion of incorporated area only.

Table 3.9. Building/Improvement and Contents Values by Usage Type

Jurisdiction	Agricultural Building/ Improvements ($)	Agricultural Contents ($)	Commercial Building/ Improvements ($)	Commercial Contents ($)	Industrial Building /Improvements ($)	Industrial Contents ($)	Residential Building/ Improvements ($)	Residential Contents ($)	Total Building /Improvements ($)	Total Contents ($)	Total Exposure ($)
Unincorporated County	$171,318,890	$171,318,890	$17,038,970	$17,038,970	$12,521,480	$18,782,220	$221,170,010	$110,585,005	$422,049,350	$317,725,085	$739,774,435
City of Bennett	$0	$0	$848,870	$848,870	$10,030	$15,045	$9,597,040	$4,798,520	$10,455,940	$5,662,435	$16,118,375
City of Clarence	$309,760	$309,760	$4,436,010	$4,436,010	$1,085,610	$1,628,415	$29,216,190	$14,608,095	$35,047,570	$20,982,280	$56,029,850
City of Durant*	$22,080	$22,080	$8,714,746	$8,714,746	$13,453,050	$20,179,575	$72,781,130	$36,390,565	$94,971,006	$65,306,966	$160,277,972
City of Lowden	$122,120	$122,120	$3,330,676	$3,330,676	$0	$0	$23,774,260	$11,887,130	$27,227,056	$15,339,926	$42,566,981
City of Mechanicsville	$25,430	$25,430	$3,961,180	$3,961,180	$0	$0	$35,378,800	$17,689,400	$39,365,410	$21,676,010	$61,041,420
City of Stanwood	$15,670	$15,670	$3,280,266	$3,280,266	$1,150,750	$1,726,125	$19,028,420	$9,514,210	$23,475,106	$14,536,271	$38,011,377
City of Tipton	$224,250	$224,250	$23,008,820	$23,008,820	$6,702,240	$10,053,360	$103,435,700	$51,717,850	$133,371,010	$85,004,280	$218,375,290
City of West Branch*	$156,350	$156,350	$42,415,776	$42,415,776	$15,121,620	$22,682,430	$84,233,810	$42,116,905	$141,927,556	$107,371,461	$249,299,017
City of Wilton**	$0	$0	$0	$0	$0	$0	$124,240	$62,120	$124,240	$62,120	$186,360
Total	**$172,194,550**	**$172,194,550**	**$107,035,314**	**$107,035,314**	**$50,044,780**	**$75,067,170**	**$598,739,600**	**$299,369,800**	**$928,014,244**	**$653,666,834**	**$1,581,681,078**

Source: Cedar County GIS Department. Durant data is combination of data from Cedar, Muscatine, and Scott County GIS Departments and West Branch data is combination of data from Cedar and Johnson County GIS Departments;

*Data is for entire incorporated area, including portion(s) in adjacent counties.

**Data is for Cedar County portion of incorporated area only.

3.2.1.2 Public School Districts

The enrolled number of students at the participating public school districts is provided in **Table 3.10** as well as the number of buildings, building values (building exposure) and contents value (contents exposure).

Table 3.10. Enrollment and Building Exposure by Jurisdiction-Public School Districts

Public School District	Enrollment	Building Count	Building Exposure ($)	Contents Exposure ($)	Total Exposure ($)
Bennett Community School	77	1 School Building 1 Garage	$8,940,626 $48,529	$1,328,051	$10,317,206
Durant Community Schools	717	3 School Buildings	$25,693,160	$3,701,557	$29,394,717
North Cedar CSD	837	4 School Buildings	$36,452,576	$4,537,187	$40,989,763
Tipton Community Schools	950	3 School Buildings	$29,000,000	$4,000,000	$33,000,000
West Branch Community Schools	868	3 School Buildings 1 Bus Barn/Maint	$17,600,000 $750,000	$5,300,000 $1,000,000	$24,650,000

Source: Enrollment Statistics from 2012-2013 Iowa Public School PreK-12 Enrollments by District – Iowa Department of Education, Bureau of Information and Analysis Services; Building Count and Exposure from Data Collection Guides from Public School Districts.; Exposure values from Data Collection Guides

3.2.2 Critical and Essential Facilities and Infrastructure

As part of the update to the *Cedar County Multi-jurisdictional Hazard Mitigation Plan*, participating jurisdictions assessed the vulnerability of the following types of facilities below:

- **Critical Facilities**: Those facilities that are essential in providing utility or direction either during the response to an emergency or during the recovery operation.
- **Essential Facilities**: Those facilities that if damaged, would have devastating impacts on disaster response and/or recovery.
- **High Potential Loss Facilities**: Those facilities that would have a high loss or impact on the community.
- **Transportation and Lifeline Facilities**: Those facilities and infrastructure that are critical to transportation, communications, and necessary utilities.

Table 3.11 is a summary of the inventory of xxx critical and essential facilities and infrastructure in the planning area. This list was compiled from an inventory of critical facilities that was developed by the County and incorporated cities as part of the 2011 Hazard Mitigation Plan. This inventory was revised with updates from the planning committee and an updated inventory of Tier II chemical facilities from the Iowa Department of Natural Resources.

At Meeting #2, each jurisdiction was provided with the inventory of their jurisdiction's critical and essential facilities for validation. Additions/deletions, and corrections were then noted by the individual jurisdictions and Cedar County GIS incorporated the changes in the inventory. The validated critical facility inventory for all jurisdictions was then utilized in analysis of geographic hazards, such as riverine flooding and fixed chemical facilities. The full list of critical and essential facilities, as well as tables indicating critical and essential facilities to the 1-percent annual chance floodplain and within ½ mile of chemical facilities, is provided in Appendix E.

The Critical Facility Inventory is “For Official Use Only”. To obtain access, contact the Cedar County Emergency Manager.

Table 3.11. Inventory of Critical/Essential Facilities and Infrastructure by Jurisdiction

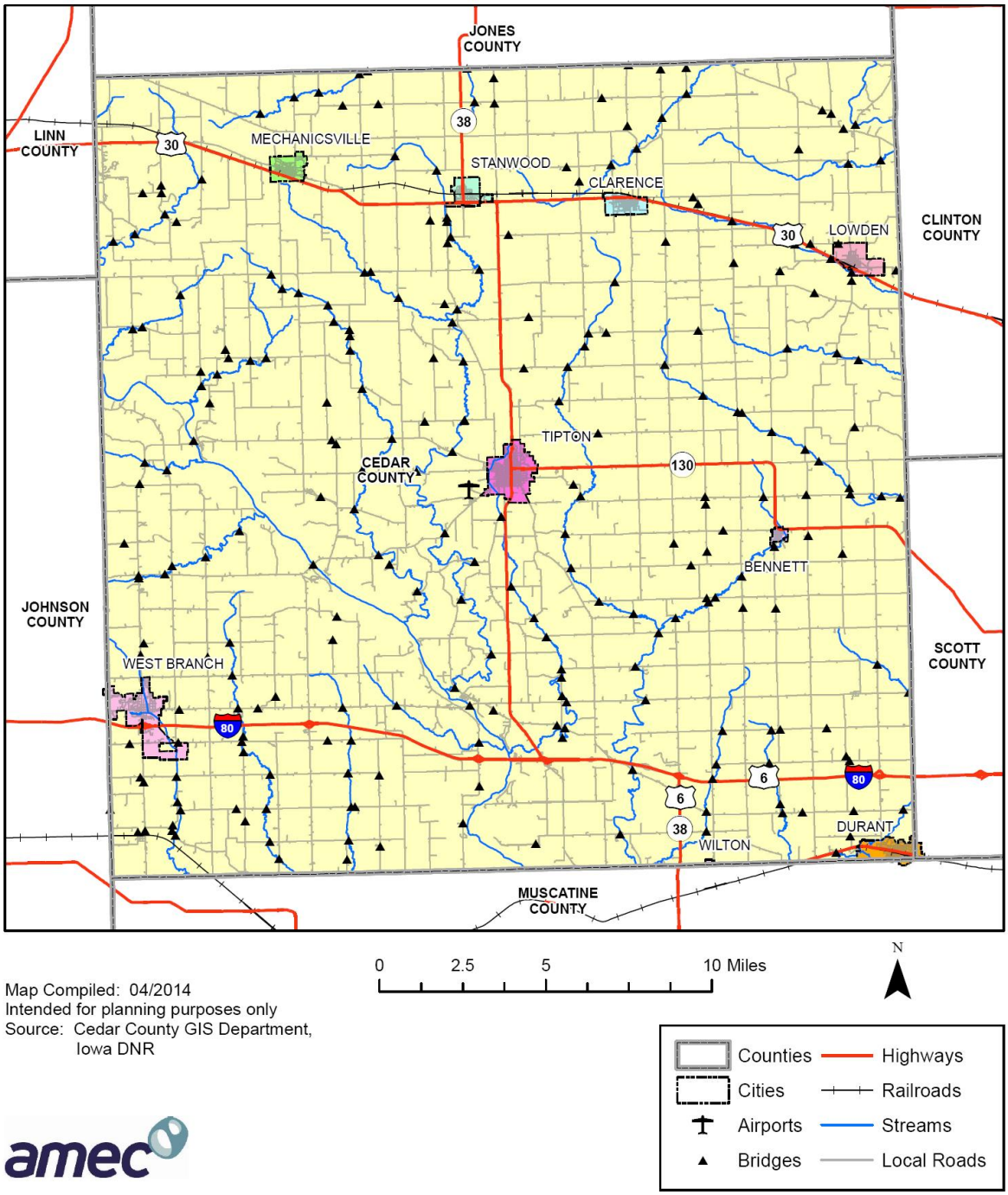
Jurisdiction	Facility Type	Facility Count
Bennett	Agricultural	1
	Ambulance	1
	Church	2
	Commercial	1
	Communications	2
	Community Group	1
	Fire Department	1
	Fuel	1
	Government	3
	Recreation	1
	School	1
	Wastewater	1
	Water	1
	Total	**17**
Clarence	Ambulance	1
	Chemical	1
	Church	2
	Communications	1
	Community Group	1
	Electrical	1
	Fire Department/Government	1
	Fuel	1
	Government	3
	Medical	1
	Nursing Home/Vulnerable Needs	2
	Recreation	1
	School	1
	Water	2
	Total	**19**
Durant	Ambulance	1
	Church	2
	Community Group	1
	Electrical	1
	Fire Department	1
	Fuel	2
	Government	2
	Medical	2
	Nursing Home/Vulnerable Needs	3
	Police Department/Public Works	1
	Recreation	4
	School	3
	Wastewater	2
	Water	4
	Total	**29**
Lowden	Chemical	1
	Church	2
	Communications	1
	Community Group	1
	Fire Department	1
	Fuel	3
	Government	5
	Nursing Home/Vulnerable Needs	2
	Recreation	2

Jurisdiction	Facility Type	Facility Count
	Wastewater	1
	Water	1
	Total	**20**
Mechanicsville	Chemical	1
	Communications	2
	Economic	1
	Electrical	1
	Fire Department	1
	Fire Department/Government	1
	Fuel	2
	Government	3
	Nursing Home/Vulnerable Needs	1
	School	1
	Transportation	1
	Wastewater	1
	Water	2
	Total	**18**
Stanwood	Agricultural	2
	Chemical	1
	Communications	2
	Electrical	1
	Fire Department/Government	1
	Fuel	6
	School	1
	Water	3
	Total	**17**
Tipton	Ambulance	1
	Chemical	6
	Communications	1
	Electrical	1
	Fire Department	1
	Fuel	1
	Government	2
	Medical	2
	Nursing Home/Vulnerable Needs	2
	Police Department	1
	School	1
	Water	4
	Total	**23**
West Branch	Chemical	2
	Fire Department/Police Department	1
	Government	2
	Nursing Home/Vulnerable Needs	1
	School	3
	Wastewater	2
	Water	5
	Total	**16**
Cedar County	Chemical	17
	Fuel	4
	Wastewater	3
	Total	**24**
Muscatine County	Wastewater*	1
	Total	**1**
	Grand Total	**184**

Source: Cedar County GIS Department

Figure 3.1 shows the locations of bridges in the planning area included in the National Bridge Inventory data set within HAZUS MH 2.1. For additional information on scour critical bridges, see **Section 3.5.6**, Flash Flooding.

Figure 3.1. Cedar County Bridges



3.2.3 Other Assets

Assessing the vulnerability of the planning area to disaster also involves inventorying the natural, historic, cultural, and economic assets of the area. This is important for the following reasons:

- The plan participants may decide that these types of resources warrant a greater degree of protection due to their unique and irreplaceable nature and contribution to the overall economy.
- If these resources are impacted by a disaster, knowing about them ahead of time allows for more prudent care in the immediate aftermath, when the potential for additional impacts is higher.
- The rules for reconstruction, restoration, rehabilitation, and/or replacement are often different for these types of designated resources.
- Natural resources can have beneficial functions that reduce the impacts of natural hazards, such as wetlands and riparian habitat, which help absorb and attenuate floodwaters.
- Losses to economic assets (e.g., major employers or primary economic sectors) could have severe impacts on a community and its ability to recover from disaster.

In the planning area, specific assets include the following:

Threatened and Endangered Species: **Table 3.12** includes Federally Threatened, Endangered, Proposed and Candidate Species in Cedar County, Iowa.

Table 3.12. Threatened and Endangered Species in Cedar County

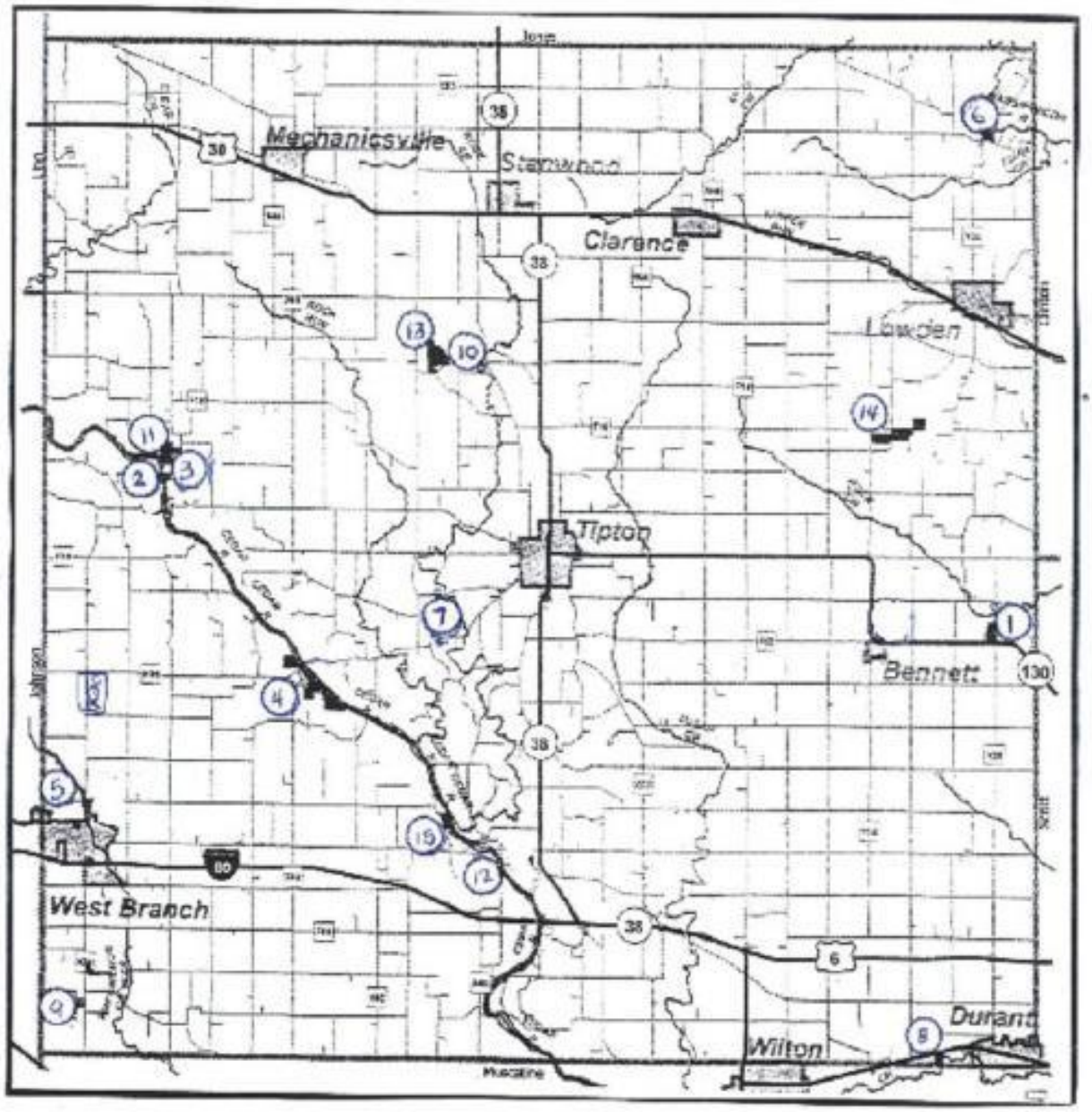
Common Name	Scientific Name	Status
Indiana bat	Myotis sodalis	Endangered
Northern long-eared bat	Myotis septentrionalis	Proposed as Endangered
Prairie bush clover	Lespedeza leptostachya	Threatened
Western prairie fringed orchid	Platanthera praeclara	Threatened

Source: U.S. Fish and Wildlife Service, http://www.fws.gov/midwest/endangered/lists/iowa_cty.html

Natural Resources: The Cedar County Conservation Board manages six parks and nine wildlife areas throughout the county. The parks and wildlife areas in Cedar County are listed below and shown in the map in **Figure 3.2**.

1. Bennett Park
2. Cedar Bluff Access
3. Cedar Bluff Wildlife Area
4. Cedar Valley Park
5. Hoover Nature Trail
6. Massillon Park
7. Mitzner Property
8. Norton Nature Area
9. Pioneer Park
10. Red Oak
11. River Valley Wetland
12. Rochester Park
13. Rock Creek Timber
14. Townsend Wildlife Area
15. West Rochester Sand Pit

Figure 3.2. Cedar County Parks and Natural Areas



Source: Cedar County Conservation board Website, http://cedarccb.org/Parks.html, accessed 4/2/2014

Historic Resources: The National Register of Historic Places is the official list of the Nation's cultural resources worthy of preservation. Authorized under the National Historic Preservation Act of 1966, the National Register is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect our historic and archeological resources. The National Register is administered by the National Park Service under the Secretary of the Interior. Properties listed in the National Register include districts, sites, buildings, structures and objects that are significant in American history, architecture, archeology, engineering, and

culture. The properties in Cedar County that are on the National Register of Historic Places are identified in **Table 3.13.**

Table 3.13. Cedar County, Iowa Properties on the National Register of Historic Places

Location	Site Name	Address	Year Listed	Resource
Buchanan	Hall Hannah Morse Fowler House	Address Restricted	1998	Building
Clarence	Mill Creek Bridge	Plum St over Mill Creek	1998	Structure
Downey	Downey Savings Bank	Front St.	1976	Building
Durant	St. Paul's Episcopal Church and Parish Hall (St. Paul's Church)	206 6th Ave	1985	Building
Lowden	Kreinbring Phillips 66 Gas Station	200 Main St	2000	Building
Lowden	Cedar Lincoln Hotel	408 Main St.	1996	Building
Rochester	Green William House (Anderson Hall)	1709 Madison St	1999	Building
Tipton	Cedar County Sheriff's House and Jail	118 W. 4th St.	2003	Building
Tipton	John Christian and Bertha Landrock Reichert House	508 E. Fourth St.	1991	Building
Tipton	Tipton State Bank	501 Cedar St.	2000	Building
Tipton	Cedar Floral Hall	W of Tipton on Cedar County Fair Grounds.	1976	Building
Tipton	Hotel Tipton	524-527 Cedar St.	1998	Building
Tipton vicinity	Red Oak Grove Presbyterian Church & Cemetery	751 King Ave	2010	Building
West Branch	Herbert Hoover National Historic Site	Off I-80	1966	Building
West Branch	Gruwell and Crew General Store	109 W. Main St	1982	Building
West Branch	West Branch Commercial Historic District	W. Main & N. Downey Streets	1987-1995	District

Source: State Historical Society of Iowa, http://www.iowahistory.org/historic-preservation/national-register-of-historic-places/properties-in-iowa.html

Agriculture and the Economy: Agriculture plays an important role in the Cedar County economy. **Table 3.14** provides a summary of the agriculture-related jobs in Cedar County.

Table 3.14. Agriculture-Related Jobs in Cedar County

Activity	Jobs
Crop and livestock production	1,695
Ag processing	206
Ag support	25
Total Agricultural-related Jobs	**1,926**

Source: Iowa State University Extension, 2009, http://www.extension.iastate.edu/Publications/Pm2023-16.pdf

For additional information on the Cedar County economy, see Chapter 2.

3.3 Development Since 2011 Plan Update

This section provides information on development that has occurred since the 2011 Cedar County Multi-jurisdictional Hazard Mitigation Plan Update. Narrative development data is from the Cedar County Economic Development Council. Building permit data is from the U.S. Census Bureau (http://censtats.census.gov/bldg/bldgprmt.shtml).

2014

- Expansion of Sinclair Tractor in Durant: 156 by 55 foot addition expanded shop and office space, allowing additional space to hire more employees, 2375 Yankee Avenue, Durant
- Lowden Housing Addition: The City of Lowden approved preliminary plans for Fitzgerald, a new housing addition planned to be directly east of Schwarz Addition on 5th St. Place. The new housing addition will include 12 lots with cul-de-sac next to Yankee Avenue.
- Stanwood received a Community Development Block Grant to replace the existing dilapidated water main to eliminate water main breaks and provide a reliable supply of water to meet state standards.
- New Business in Tipton: In May, the City Council approved a resolution supporting an Iowa High Quality Jobs Program application for a manufacturing facility for David's Famous Gourmet Frozen Custard. If constructed, the facility would employ up to 35 people. A former agricultural implement building on West South Street in Tipton is the planned site for the new facility.
- 5 Building Permits Issued Jan-August 2014: 5 single family permits were issued county-wide during this period.
    - Bennett-0
    - Clarence-0
    - Durant-1
    - Lowden-0
    - Mechanicsville-0
    - Stanwood-0
    - Tipton-0
    - West Branch-0
    - Unincorporated Cedar County-4

2013

- New Sports Complex in Tipton: Heartland Sports Complex was constructed in Tipton at the southeast corner of Spruce and South Streets. The 100 by 176 foot building contains 2 full basketball courts, 4 volleyball courts, 2 batting cages, golf nets and a walking track.
- 43 Building Permits Issued: 42 single family and 1 two-family permits were issued county-wide during 2013.
    - Bennett-0
    - Clarence-2
    - Durant-1
    - Lowden-0
    - Mechanicsville-2
    - Stanwood-0
    - Tipton-7
    - West Branch-9
    - Unincorporated Cedar County-22

2012

- Wind Turbines Installed: ACCIONA Windpower installed two wind turbines in the County near Mechanicsville.
- 29 Building Permits Issued: 29 single family permits were issued county-wide during 2012.
    - Bennett-0
    - Clarence-1
    - Durant-2
    - Lowden-1
    - Mechanicsville-2
    - Stanwood-0
    - Tipton-6
    - West Branch-4
    - Unincorporated Cedar County-13

2011

- 28 Building Permits Issued: 28 single family permits were issued county-wide during 2011.
    - Bennett-0
    - Clarence-0
    - Durant-1
    - Lowden-0
    - Mechanicsville-0
    - Stanwood-0
    - Tipton-5
    - West Branch-8
    - Unincorporated Cedar County-14

3.4 Future Land Use and Development

According to the U.S. Census Bureau, the Cedar County population increased 1.13 percent from 2000 to 2013. **Table 3.15** provides the population growth statistics for all cities in Cedar County as well as the county as a whole. The unincorporated areas population was determined by subtracting the populations of the incorporated areas from the overall county population. As a result, the unincorporated county populations are not completely accurate since portions of some of the incorporated areas overlap into adjacent counties.

Table 3.15. Cedar County Population Growth, 2000-2012

Jurisdiction	2000 Population	2010 Population	2013 Population Estimates	# Change 2000-2013	% Change 2000-2013
Iowa	2,926,324	3,046,355	3,090,416	164,092	5.61%
Cedar County	18,187	18,499	18,393	206	1.13%
Bennett	395	405	396	1	0.25%
Clarence	1,008	974	961	-47	-4.66%
Durant*	1,677	1,832	1,832	155	9.24%
Lowden	794	789	780	-14	-1.76%
Mechanicsville	1,173	1,146	1,129	-44	-3.75%
Stanwood	680	684	673	-7	-1.03%
Tipton	3,155	3,221	3,199	44	1.39%
West Branch*	2,188	2,322	2,326	138	6.31%
Unincorporated areas (est.)	7,117	7,126	7,097	-20	-0.28%

Source: U.S. Bureau of the Census, 2000 and 2010 data is from the Decennial Census, 2013 populating estimate data is from the Iowa State University of Science and Technology, Iowa Community Indicators Program; *population includes the portions of these cities in adjacent counties

Table 3.16 provides the change in numbers of housing units in the planning area from 2000 to 2010.

Table 3.16. Change in Housing Units, 2000-2010

Jurisdiction	Housing Units 2010	Housing Units 2000	2000-2010 # Change	2000-2010 % change
Iowa	1,336,417	1,232,511	103,906	8.4%
Cedar County, Iowa	8,064	7,570	494	6.5%
Bennett city, Iowa	172	163	9	5.5%
Clarence city, Iowa	455	453	2	0.4%
Durant city, Iowa	783	702	81	11.5%
Lowden city, Iowa	371	359	12	3.3%
Mechanicsville city, Iowa	496	479	17	3.5%
Stanwood city, Iowa	295	297	-2	-0.7%
Tipton city, Iowa	1,510	1,404	106	7.5%
West Branch city, Iowa	990	876	114	13.0%

Source: U.S. Bureau of the Census, Decennial Census; Population Statistics are for entire incorporated areas as reported by the U.S. Census Bureau

The following sections provide details regarding future growth, land use and development. The information in this section comes from information provided by each of the participating jurisdictions as well as other sources, cited throughout. Where available, maps are provided to facilitate consideration of hazard areas in future development plans as well as potential growth area.

Cedar County

The 1980 Cedar County Comprehensive Plan was updated by combining the 2006 Cedar County, Iowa Land Use Plan with the County's 1994 Builder Plan, the 2000 Housing Needs Assessment, the 2001 Hazard Mitigation, the 2005 Pre-Disaster Mitigation Plan, and other County reports and data. These combined documents act as the Comprehensive Plan for Cedar County and are used as the official guidelines in making decisions and recommendations for rural development (2006 Cedar County, Iowa Land Use Plan, pg. 7).

According to the population projections for Cedar County between 2005 and 2030 the population is expected to have an average increase of 1.67 percent. See **Table 3.17**.

Table 3.17. Cedar County Population Projection, 2000-2030

2000	2005	2010	2015	2020	2025	2030
18,217	18,361	18,636	18,968	19,333	19,786	20,259
	+0.08%	+1.50%	+1.78%	+1.92%	+2.34%	+2.39%

Source: 2005 State Profile: Iowa, State Data Center of Iowa, Woods & Poole Economics, Inc.

Future Land Use Map Areas (see **Figure 3.3**)

1. Agricultural Area--The Agricultural Area is established for agricultural activities such as the various types of farming, as well as directly related commercial and industrial activities that support the farming community. The Agricultural Area covers the majority of the Land Use Map and reflects Cedar County's primary natural resource and economy.

2. Residential Area--The Residential Area is established to indicate generally suitable locations for residential development. The Residential Areas are located near incorporated cities, some rural unincorporated communities, and certain rural areas that have developed over time due to their location.

3. Commercial Area--The Commercial Area is established to indicate generally suitable locations for various types of commercial activities. The Commercial Areas are primarily located near a few cities and several key interchanges along Interstate 80.

4. Industrial Area--The Industrial Area is established to indicate generally suitable locations for industrial and manufacturing activities, and supporting activities such as warehousing and

trucking facilities. The industrial Areas are primarily located near cities and several key interchanges along Interstate 80.

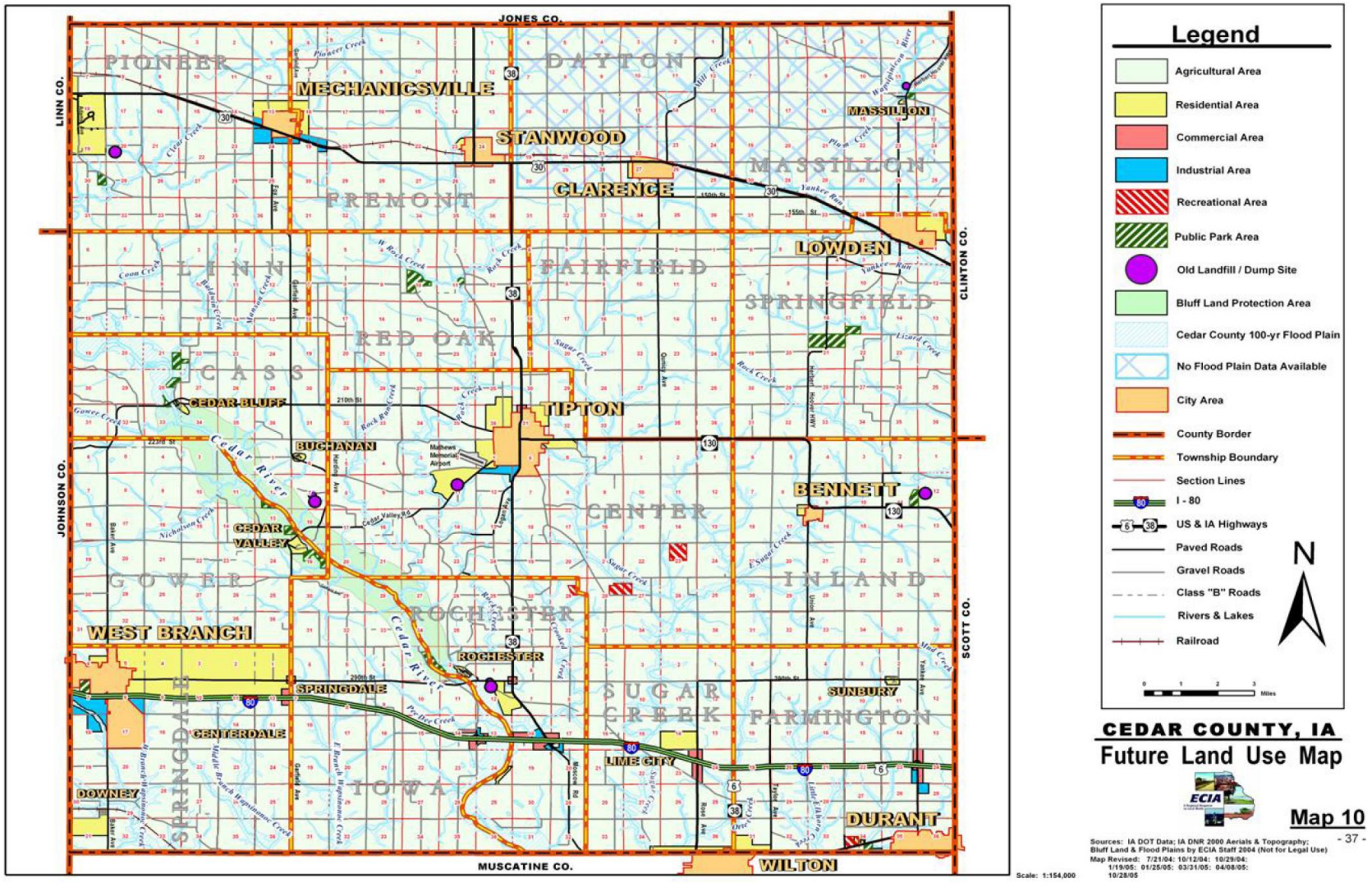
5. Recreational Area--The Recreational Area is established to indicate generally suitable locations for private recreational facilities such as golf courses. The Recreational Areas may be found in various locations across the County.

6. Public Park Area--The Public Park Area is established to indicate generally suitable locations for public parks. The Public Park Areas may be found in various locations across the County.

7. Bluff Land Protection Area--The Bluff Land Protection Area is established to indicate areas providing unique environmental character that require special protection in order to be preserved. Development is allowed within the Bluff Land Protection Area, but the location, height, or site improvement of such development may be limited. The Bluff Land Protection Area is located along the Cedar River between the unincorporated communities of Cedar Bluff and Rochester.

Other areas are also shown on the Future Land Use Map in the unincorporated areas of the County. These areas indicate Old Landfill / Dump sites and the 100-Year Flood Plain. Such areas are to be considered as constraints on future development and are to be avoided.

Figure 3.3. Cedar County Future Land Use Map



Source: Cedar County Land Use Plan, 2006

City of Bennett

The City of Bennett did not report any development trends or expected general growth areas. The City is planning to construct a new fire station in the near future.

City of Clarence

A new residential housing addition is planned at 11th Avenue and Bill Street. This addition will be called the Robinson Housing Addition.

City of Durant

The city of Durant has planned construction of a new water tower on the northeast side of the wastewater treatment facility as well as future stormwater system improvements.

City of Lowden

The City of Lowden did not report any development trends or expected general growth areas. However, there is potential for improvements of the wastewater treatment plant at an existing location east of the City.

City of Mechanicsville

The City of Mechanicsville did not report any development trends or expected general growth areas. However, there are discussions of projects to line the sewer pipes to reduce infiltration and inflow as well as replace water mains.

City of Stanwood

The City of Stanwood did not report any development trends or expected general growth areas. However, a new park shelter is planned for construction to replace the existing shelter.

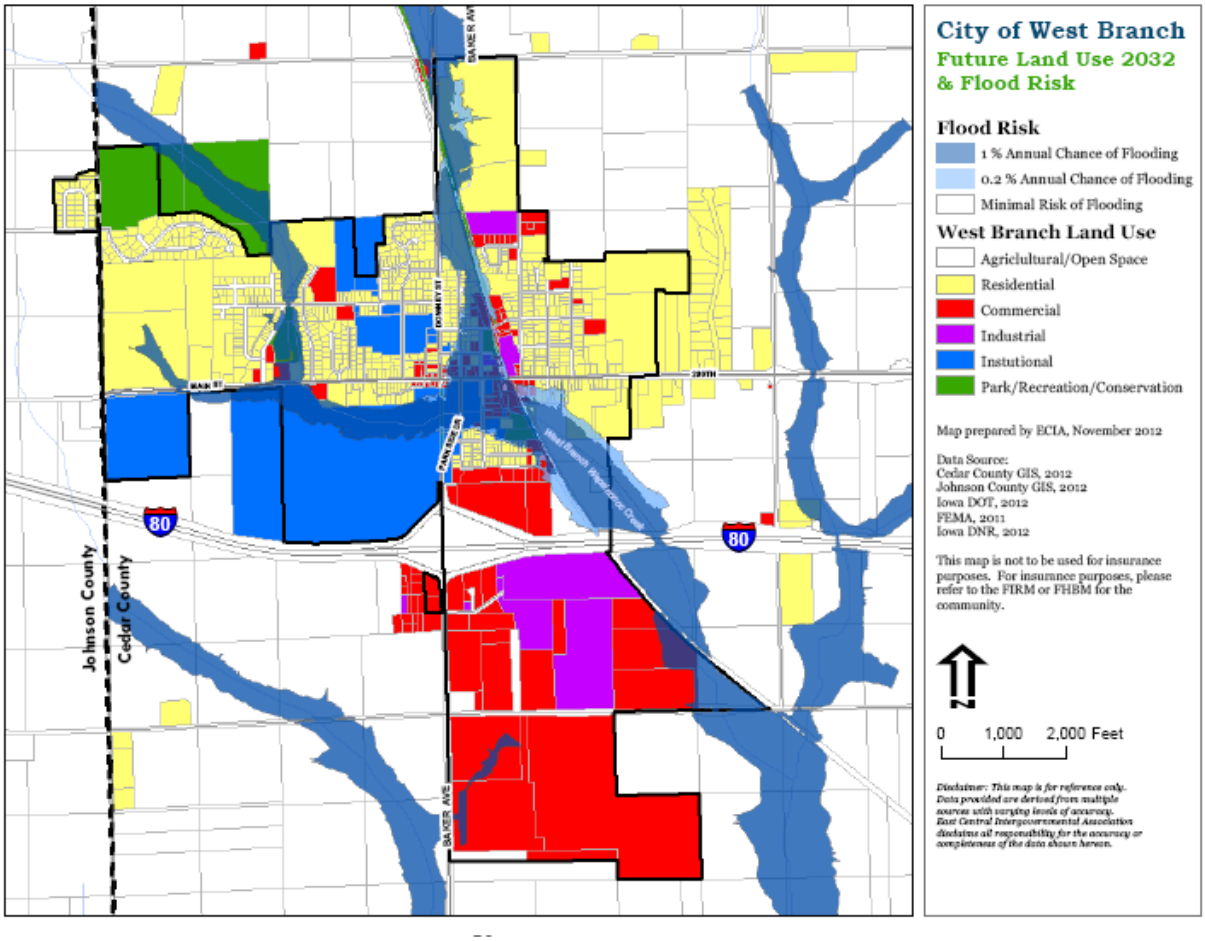
City of Tipton

The City of Tipton reports slight growth in non flood-prone areas of the City. Infrastructure improvements are also planned.

City of West Branch

The April 1, 2013 West Branch Comprehensive Plan details the City's plan for growth. Chapter 10 of the Comprehensive Plan is dedicated to discussion of Hazard Mitigation. The summary statement on land use states" there is adequate land outside of natural-hazard areas for development". Selected specific actions from the Hazard Mitigation Plan are detailed in the Comprehensive plan as a way of integrating these two plans. (See page 50 of the Comprehensive Plan). The map in **Figure 3.4** provides a comparison of future land use with the FEMA 2011 floodplain map.

Figure 3.4. West Branch Future Land Use with Flood Risk



Source: West Branch Comprehensive Plan, April 1, 2013

School Districts' Future Development

This section summarizes future development for the participating school districts:

Bennett School District

School enrollment is expected to remain about the same over the next five years. No planned future development reported.

Durant School District

School enrollment is expected decrease 10 to 15 percent over the next five years. Plans are in place to replace the middle and elementary school windows.

North Cedar School District

No planned future development reported.

Tipton School District

School enrollment is expected to increase by about 5 percent over the next five years. No planned future development reported.

West Branch School District

School enrollment is expected to remain about the same over the next five years. The school district has a comprehensive 15-year facilities improvement plan in place. The district is moving through Phase I of the 5-phase plan.

3.5 Hazard Profiles and Vulnerability

Hazard Profiles

Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

Each hazard identified in Section **3.1.4** is profiled individually in this section in alphabetical order.

The level of information presented in the profiles varies by hazard based on the information available. With each update of this plan, new information will be incorporated to provide for better evaluation and prioritization of the hazards that affect the planning area. Detailed profiles for each of the identified hazards include information categorized as follows:

Hazard Description

This section consists of a general description of the hazard and the types of impacts it may have on a community. It also includes the ratings assigned to the hazard relative to typical warning times and duration of hazard events as described in **Table 3.5**.

Geographic Location/Extent

This section describes the geographic location of the hazard in the planning area. Where available, maps are utilized to indicate the specific locations of the planning area that are vulnerable to the subject hazard. This section also provides information as to the extent of the hazard (i.e. the size or degree of impacts).

Previous Occurrences

This section includes information on historic incidents and their impacts.

Probability of Future Occurrence

The frequency of past events is used to gauge the likelihood of future occurrences. Where possible, the probability or chance of occurrence was calculated based on historical data. Probability was determined by dividing the number of events observed by the number of years and multiplying by 100. This gives the percent chance of the event happening in any given year. An example would be three droughts occurring over a 30-year period, which suggests a 10 percent chance of a drought occurring in any given year. For each hazard, the probability is assigned a rating as defined in **Table 3.5**.

Vulnerability Assessments

Requirement §201.6(c)(2)(ii) :[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.

Requirement §201.6(c)(2)(ii)(A) :The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas.

Requirement §201.6(c)(2)(ii)(B) :[The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.

Requirement §201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

Requirement §201.6(c)(2)(ii): (As of October 1, 2008) [The risk assessment] must also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged in floods.

Following the hazard profile for each hazard is the vulnerability assessment. The vulnerability assessment further defines and quantifies populations, buildings, critical facilities, and other community assets at risk to natural hazards. The vulnerability assessments were conducted based on the best available data and the significance of the hazard. Data to support the vulnerability assessments was collected from the following sources:

- Available GIS data sets such as DFIRM, parcel data, critical facilities, etc (all sourced when used);
- FEMA's HAZUS-MH loss estimation software;
- Written descriptions of assets and risks provided by participating jurisdictions;
- Existing plans and reports;
- Personal interviews with planning committee members and other stakeholders; and
- Other sources as cited.

Detailed profiles for each of the identified hazards include information categorized as follows:

Vulnerability Overview

This section consists of a general overview narrative of the planning area's vulnerability to the hazard. Within this section, the magnitude/severity of the hazard is discussed. The magnitude of the impact of a hazard event (past and perceived) is related directly to the vulnerability of the people, property, and the environment it affects. This is a function of when the event occurs, the

location affected, the resilience of the community, and the effectiveness of the emergency response and disaster recovery efforts.

For each hazard, the magnitude/severity is assigned a rating as defined in **Table 3.5**.

Potential Losses to Existing Development

This section provides the potential losses to existing development. Where data is available, this section provides estimated financial losses as well as the methodology used. For hazards with an overall "Low" rating, potential losses may not be discussed.

Future Development

This section provides information on how vulnerability to this hazard will be impacted by planned future development as well as information for jurisdictions to consider in planning future development.

Hazard Summary by Jurisdiction

For hazards that vary by jurisdiction, this section will provide an overview of how the hazard varies, followed by a table indicating the probability, magnitude, warning time, and duration rankings for each jurisdiction with the resulting hazard score and level.

3.5.1 Dam Failure

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
1	1	4	1	1.45	Low

Profile

Hazard Description

Many of Iowa's community settlements were founded along rivers and streams due to their reliance on water resources. Often, these streams or rivers later needed a dam for flood control or a reservoir for a constant water source. A dam is defined as a barrier constructed across a watercourse for the purpose of storage, control, or diversion of water. Dams are typically constructed of earth, rock, concrete, or mine tailings. Dam failure is the uncontrolled release of impounded water resulting in downstream flooding, affecting both life and property. Dam failure can be caused by any of the following: flooding; earthquakes; flow blockages; landslides; lack of maintenance; improper operation; poor construction; vandalism; or terrorism.

The thresholds for when a dam falls under State regulation are outlined in Iowa Administrative Code 567-71.3 and are listed below. The thresholds are primarily based on both dam height and water storage volumes. State regulated dams are those dams that meet the following:

In rural areas:

a. *Any dam designed to provide a sum of permanent and temporary storage exceeding 50 acre-feet at the top of dam elevation, or 25 acre-feet if the dam does not have an emergency spillway, and which has a height of 5 feet or more.*

b. *Any dam designed to provide permanent storage in excess of 18 acre-feet and which has a height of 5 feet or more.*

c. *Any dam across a stream draining more than 10 square miles.*

d. *Any dam located within 1 mile of an incorporated municipality, if the dam has a height of 10 feet or more, stores 10 acre-feet or more at the top of dam elevation, and is situated such that the discharge from the dam will flow through the incorporated area.*

In urban areas:

Any dam which exceeds the thresholds in 71.3 (1) "a", "b", or "d".

Low head dams:

Any low head dam on a stream draining 2 or more square miles in an urban area, or 10 or more square miles in a rural area.

Dams are classified by the State of Iowa into three categories based on the potential risk to people and property in the event of failure (see **Table 3.18**). The classification can change over

time due to changes in development downstream from the dam. In addition, older dams may not have been built to the standards of their updated classification when this occurs. The Iowa Department of Natural Resources performs annual inspections on all high hazard dams in the State.

Table 3.18. Dam Hazard Classification Definitions

Hazard Class	Definition
High	A structure shall be classified as high hazard if located in an area where failure may create a serious threat of loss of human life or result in serious damage to residential, industrial, or commercial areas, important public utilities, public buildings, or major transportation facilities.
Moderate (Significant)*	A structure shall be classified as moderate hazard if located in an area where failure may damage isolated homes or cabins, industrial or commercial buildings, moderately traveled roads or railroads, interrupt major utility services, but without substantial risk of loss of human life. In addition, structures where the dam and its impoundment are of 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, shall be considered moderate hazard for design and regulatory purposes unless a higher hazard class is warranted by downstream conditions.
Low	A structure shall be classified as low hazard if located in an area where damages from a failure would be limited to loss of the dam, loss of livestock, damages to farm outbuildings, agricultural lands, and lesser used roads, and where loss of human live is considered unlikely.

Source: Iowa Department of Natural Resources; *the term "moderate" is used by the Iowa Department of Natural Resources. However, the National Inventory of Dams uses the term "significant" to identify the same general hazard classification

Warning Time Score: 4—Minimal or no warning (up to 6 hrs. warning)

Duration Score: 1—Less than 6 hours

Geographic Location/Extent

Dams in Planning Area

There are only 2 regulated dams inside the county boundaries of Cedar County. Both state-regulated dams in the County are low-hazard dams.

- Bennett Lake Dam—owned by Cedar County Conservation Board
- Worrel Dam—privately owned

Dams Upstream of Planning Area

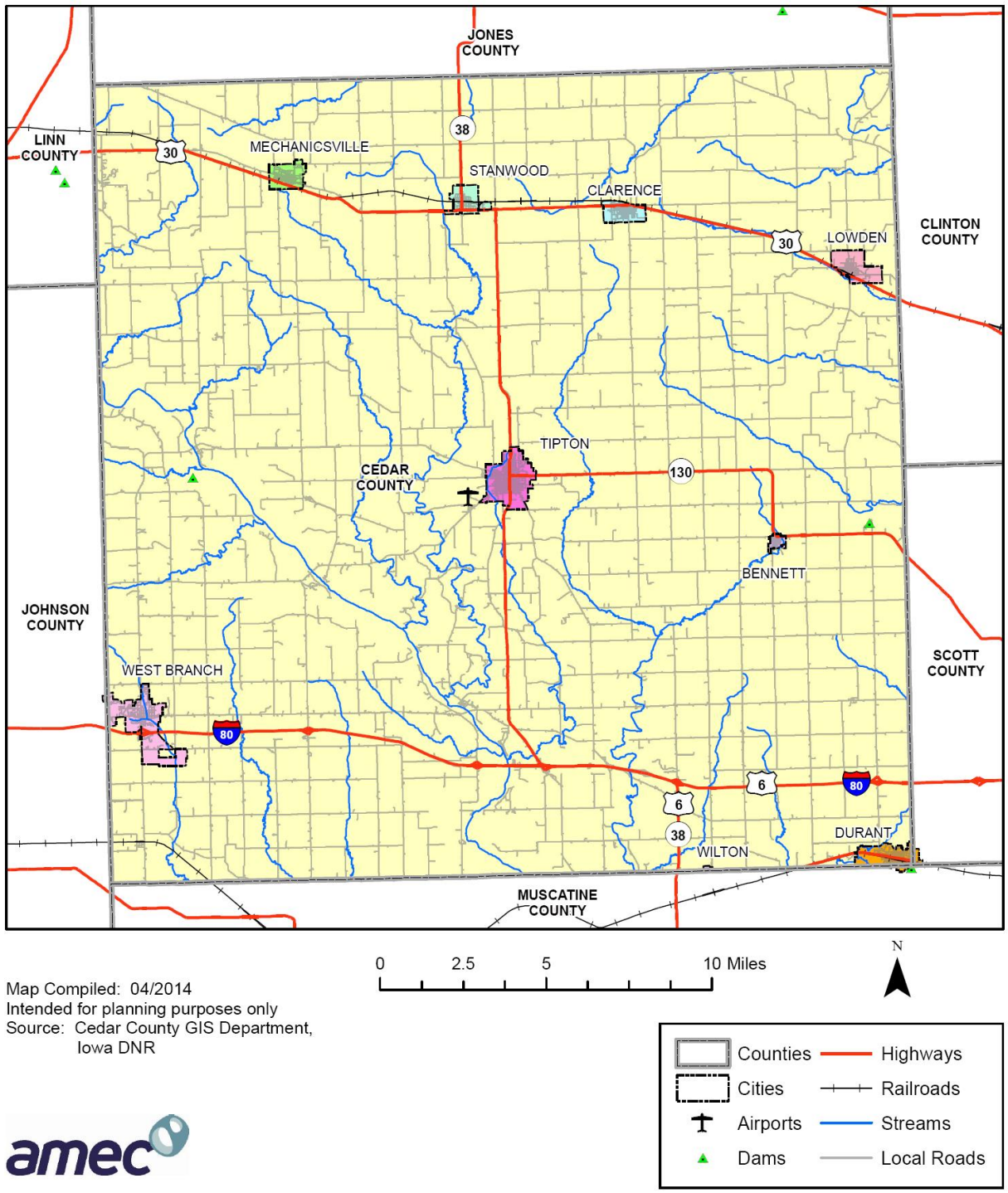
Dams upstream of the planning area were also considered as failure could potentially impact portions of Cedar County.

State-Regulated Dams: There are two dams located on a tributary of Spring Creek and one dam on the Wapsipinicon River that could potentially impact portions of the planning area in the unlikely event of failure. These three dams are also low-hazard dams indicating that failure would not pose risk to people or property other than agricultural use, and lesser roads. These dams are:

- Goldin Dam (Linn County)—privately owned

- South Lake Dam (Linn County)—privately owned
- Oxford Mill Dam (Jones County)—Jones County Conservation Board

Figure 3.5. State Regulated Dam Locations with Potential to Impact Cedar County



Map Compiled: 04/2014
Intended for planning purposes only
Source: Cedar County GIS Department, Iowa DNR

Source: Iowa Department of Natural Resources

Federal Dams Upstream of Planning Area: There are two new NRCS dams upstream in Johnson County that were mentioned by West Branch City officials. Details of size and inundation path were not available.

Previous Occurrences

To determine previous occurrences of dam failure within Cedar County, the *2011Cedar County Multi-jurisdictional Hazard Mitigation Plan*, the *Iowa State Hazard Mitigation Plan*, and the Stanford University's National Performance of Dams Program (**https://npdp.stanford.edu/**) were reviewed for historical dam failures. No record of dam failure within Cedar County boundaries was found.

Probability of Future Occurrence

There is an overall low probability of dam failures impacting Cedar County.

Probability Score: 1—Unlikely

Vulnerability

Overview

Dam failure is typically an additional or secondary impact of another disaster such as flooding or earthquake. Based on the hazard class definitions, since the dams in Cedar County and those in close proximity upstream of the County are all low hazard dams, damages from a failure would be limited to loss of the dam, loss of livestock, damages to farm outbuildings, agricultural lands, and lesser used roads. Significant loss of property and loss of human life is considered unlikely.

Magnitude/Severity Score: 1—Negligible

Potential Losses to Existing Development

Potential losses to existing development would be limited to loss of the dam, loss of livestock, damages to farm outbuildings, agricultural lands, and lesser used roads.

Future Development

Future development located downstream from dams in floodplains or inundation zones would increase vulnerability to this hazard.

Dam Failure Hazard Summary by Jurisdiction

Based on the locations of the dams, the only jurisdictions that appear to be vulnerable to dam failure are: unincorporated County, City of Durant, and City of West Branch.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Cedar County	1	1	4	1	1.45	Low
City of Bennett	N/A	N/A	N/A	N/A	N/A	N/A
City of Clarence	N/A	N/A	N/A	N/A	N/A	N/A
City of Durant	1	1	4	1	1.45	Low
City of Lowden	N/A	N/A	N/A	N/A	N/A	N/A
City of Mechanicsville	N/A	N/A	N/A	N/A	N/A	N/A
City of Stanwood	N/A	N/A	N/A	N/A	N/A	N/A
City of Tipton	N/A	N/A	N/A	N/A	N/A	N/A
City of West Branch	1	1	4	1	1.45	Low
Bennett School District, #603	N/A	N/A	N/A	N/A	N/A	N/A
Durant School District, #1926	N/A	N/A	N/A	N/A	N/A	N/A
North Cedar School District, #3691	N/A	N/A	N/A	N/A	N/A	N/A
Tipton School District #6408	N/A	N/A	N/A	N/A	N/A	N/A
West Branch School District #6930	N/A	N/A	N/A	N/A	N/A	N/A

3.5.2 Drought

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
3	2	1	4	2.5	Moderate

Profile

Hazard Description

Drought is generally defined as a condition of moisture levels significantly below normal for an extended period of time over a large area that adversely affects plants, animal life, and humans. There are four types of drought conditions relevant to Iowa:

Meteorological drought is defined on the basis of the degree of dryness (in comparison to some "normal" or average amount) and the duration of the dry period. A meteorological drought must be considered as region-specific since the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region.

Hydrological drought is associated with the effects of periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply (e.g., streamflow, reservoir and lake levels, ground water). The frequency and severity of hydrological drought is often defined on a watershed or river basin scale. Although all droughts originate with a deficiency of precipitation, hydrologists are more concerned with how this deficiency plays out through the hydrologic system. Hydrological droughts are usually out of phase with or lag the occurrence of meteorological and agricultural droughts. It takes longer for precipitation deficiencies to show up in components of the hydrological system such as soil moisture, streamflow, and ground water and reservoir levels. As a result, these impacts are out of phase with impacts in other economic sectors.

Agricultural drought focus is on soil moisture deficiencies, differences between actual and potential evaporation, reduced ground water or reservoir levels, and so forth. Plant water demand depends on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth, and the physical and biological properties of the soil.

Socioeconomic drought refers to when physical water shortage begins to affect people.

The four different types of drought can all occur in Iowa. A meteorological drought is the easiest to determine based on rainfall data and is an easier drought to monitor from rain gauges and reports. A hydrological drought means that stream and river levels are low, which also has an impact for surface water and ground water irrigators. In addition, in-stream discharges that fall below a pre-required level also place the State in regulatory difficulty with U.S. Fish and Wildlife and with neighboring states over cross-border flowage rights. An agricultural drought represents difficulty for Iowa's agricultural-based economy and is also relatively easy to monitor based on crop viabilities for different regions.

The National Drought Mitigation Center (NDMC) located at the University of Nebraska in Lincoln provides a clearinghouse for information on the effects of drought, based on reports from media,

observers and other sources. NDMC's website is found at http://www.drought.unl.edu/. Specific drought impacts by county are recorded at http://droughtreporter.unl.edu/.

The NDMC categorizes impacts of drought as economic, environmental, or social. Many economic impacts occur in agriculture and related sectors, including forestry and fisheries, because of the reliance of these sectors on surface and subsurface water supplies. In addition to obvious losses in yields in both crop and livestock production, drought is associated with increases in insect infestations, plant disease and wind erosion. Droughts also bring increased problems with insects and disease to forests and reduce growth. The incidence of forest and range fires increases substantially during extended droughts, which in turn places both human and wildlife populations at higher levels of risk. Income loss is another indicator used in assessing the impacts of drought because so many sectors are affected.

Although drought is not predictable, long-range outlooks may indicate an increased chance of drought, which can serve as a warning. A drought period can last for months, years, or even decades. It is rarely a direct cause of death, though the associated heat, dust and stress can all contribute to increased mortality.

Warning Time Score: 1—24+ Hours

Duration Score: 4—more than 1 week

Geographic Location/Extent

The entire planning area in Cedar County is at risk to drought and 90 percent of the surface land in the county is for agriculture purposes.

According to the High Plains Regional Climate Center, the planning area received an average of 33.51 inches of rainfall per year from 1893 to 2010. In average years, this represents enough rainfall to prevent drought; however, it is the result of successive years of below-average rainfall that cause drought impacts in the planning area.

Previous Occurrences

Drought occurs periodically in Iowa with the most severe in historical times occurring in the 1930's. Other major droughts, usually characterized by deficient rainfall combined with unusually high summer temperatures, occurred in 1886, 1893-1894, 1901, 1954-1956, 1976–1977, 1988–1989, 1999, 2000, 2003, 2005, 2006, 2012-2013. Historically droughts cause more economic damage to the State than all other weather events combined.

According to the National Drought Mitigation Center's Drought Impact Reporter, during the 10-year period from March 2005 thru March 2014, Cedar County was included in 289 listed drought impacts. 160 of these impacts reported affect the entire State of Iowa. The following are the categories and reported number of impacts. Note: some impacts have been assigned to more than one category:

- Agriculture – 171
- Business & Industry – 33
- Energy – 5
- Fire – 19

- Plant & Wildlife – 38
- Relief, Response & Restrictions – 70
- Society & Public Health – 40
- Tourism & Recreation – 6
- Water Supply & Quality – 71

Impacts of recent drought periods in Iowa that affected Cedar County are provided below. Unless otherwise indicated, these impacts are from the Drought Impact Reporter.

- **October 15, 2013**—Bur oak blight and emerald ash borer have made considerable progress in damaging Iowa's ash and bur oak trees due to drought in 2012, which weakened trees and made them more susceptible to pests and disease. The emerald ash borer has been found in Des Moines, Cedar, Allamakee and Jefferson counties in 2013 and is expected to continue spreading throughout the State.
- **September 5, 2013**—Drought conditions are worsening across the State and spreading across the State. **Figure 3.6** is a photo of cornfields that are prematurely crisp because of expanding drought conditions.

Figure 3.6. Cornfields in Cedar County, Iowa

Source: Photo by Dean Borg

- **November 11, 2012**— Drought drove corn prices to record highs this year. As a result, Ethanol producers in the U.S. lost $0.36 per gallon produced compared to sales the year before.
- **October 12, 2012**—Iowa State University agriculture experts advised farmers to test forages for quality this fall because variable nutrient levels and high nitrate levels can occur in forages grown during drought.
- **September 25, 2012**—the U.S. Drought Monitor on this date shows the severity of the statewide drought conditions. Cedar County was in Severe Drought conditions.

- **July 26, 2012**—The Governor issued a disaster emergency proclamation that allowed for the suspension of state laws and regulations affecting the transportation of hay and straw. In the statement, it says, "the drought has destroyed or depleted sources of these products that are necessary for livestock production and feed."
- **July 1-30, 2012**—Very warm and dry weather that began in the spring continued into the summer. Rainfall was in short supply across the State. Much of the State recorded less than 50 percent of normal rainfall for July. Rapid deterioration of the corn and soybean crop took place with several periods of temperatures in excess of 100 degrees. By the end of July, officials estimated that 32 percent of the corn yield had been lost to the drought. At the current price, the loss total was in excess of $4.5 billion state-wide.
- **2012**—Governor Branstad created a website dedicated to the Iowa Drought 2012, https://governor.iowa.gov/drought/ as a resource for all Iowans. This year's drought damages surpassed that of 1988.
- **September 15, 2006 to October 20, 2006**—Agriculture Secretary Mike Johanns lengthened the time allowed for emergency livestock grazing on land in the Conservation Reserve Program (CRP) in 30 states including Iowa for farmers and livestock owners who were affected by drought.
- **July 31, 2006**—The statewide average precipitation for the May through July period was only 8.28 inches or 4.83 inches less than normal. This ranks 2006 as 8th driest among 134 years of record for this time period with only 1988 being drier in the most recent 70 years.
- **June-September 2005**—Severe to extreme drought continued across the eastern third of Iowa. By the end of August the governor of Iowa had requested areas south and east of a line from Dubuque, to Independence, to Ottumwa be declared an agricultural disaster area. Soybean crop losses generally were estimated at a 10-15 percent reduction in yield across eastern Iowa.
- **August 2003**—Dry conditions that began in September 2002 continued through 2003, manifesting into a moderate to severe drought at the start of August 2003 which is a crucial time for soybean development and corn in filling out the ears with large kernels. According to the Iowa State Climatologist, August 2003 was the driest on record with a statewide average of only 0.96 inches of rainfall which was 3.23 inches below the normal for August.
- **August & September 2000**—According to National Climatic Data Center (NCDC), crops were stressed with the warm temperatures and lack of rainfall. Livestock deaths occurred because of the daytime heat and warm overnight temperatures.

Table 3.19 provides the recorded low precipitation in Tipton, Iowa from 1893 to 2010 according to the NOAA Regional Climate Center, (http://www.hprcc.unl.edu).

Table 3.19. Lowest Precipitation and Year Occurred, 1893-2010 from Tipton, IA Station

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Low
Lowest Precip. (in.)	0.00	0.01	0.08	0.45	0.61	0.46	0.26	0.60	0.19	0.00	0.05	0.30	20.95
Year	1902	1995	1918	1942	1992	1910	1906	1941	1979	1952	1914	1976	2005

Source: http://www.hprcc.unl.edu/cgi-bin/cli_perl_lib/cliMAIN.pl?ia8266

Table 3.20 below provided by the U.S. Drought Monitor, summarizes the historical drought conditions for Iowa by intensity and percent area from 2004 through 2013. As you can see, a portion of the State was in exceptional drought intensity in 2012 and 2013 during this 10-year timeframe.

Table 3.20. Historic Drought Intensity (Percent Area) Iowa 2004-2014

Drought Intensity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2004-2013
None	62.16	76.29	22.94	69.51	81.32	24.41	100.00	71.05	25.97	27.55	56.12
D0 Abnormally Dry	17.03	18.74	20.81	24.61	15.01	16.77	0.00	14.58	12.51	18.97	15.90
D1 - Moderate	10.07	2.85	30.71	5.44	3.18	29.59	0.00	8.28	13.24	27.15	13.05
D2 - Severe	7.65	1.50	20.30	0.44	0.50	28.38	0.00	6.09	24.53	17.99	10.74
D3 - Extreme	3.09	0.62	5.24	0.00	0.00	0.86	0.00	0.00	23.11	8.11	4.10
D4 - Exceptional	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.64	0.24	0.09

Source: U.S. Drought Monitor, http://droughtmonitor.unl.edu/MapsAndData/DataTables.aspx

According to the USDA's Risk Management Agency, payments for insured crop losses in Cedar County as a result of drought conditions occurred in all ten years from 2004-2013 and totaled $30,231,703 (see **Table 3.21**). With the extensive drought conditions during the years of 2012 and 2013, 83 percent of the 10-year crop losses came from those two years alone.

Table 3.21. Crop Insurance Claims Paid From Drought, 2004-2013

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2005	Corn	Drought	$4,092,307
2005	Hybrid Corn Seed	Drought	$51,784
2005	Soybeans	Drought	$419,607
2006	Corn	Drought	$29,510
2006	Soybeans	Drought	$14,212
2007	Corn	Drought	$7,525
2008	Corn	Drought	$17,902
2008	Soybeans	Drought	$37,755
2011	Corn	Drought	$182,235
2011	Hybrid Corn Seed	Drought	$144,629
2011	Popcorn	Drought	$35
2011	Soybeans	Drought	$41,179
2012	Corn	Drought	$133,056
2012	Corn	Drought	$6,783
2012	Corn	Drought	$8,884,173
2012	Corn	Drought	$406,288
2012	Corn	Drought	$3,983
2012	Hybrid Corn Seed	Drought	$237,266
2012	Soybeans	Drought	$22,179
2012	Soybeans	Drought	$389,798
2012	Soybeans	Drought	$19,954
2012	Soybeans	Drought	$153
2013	Corn	Drought	$104,360
2013	Corn	Drought	$12,964,651
2013	Corn	Drought	$530,866
2013	Corn	Drought	$200,374

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2013	Hybrid Corn Seed	Drought	$12,853
2013	Soybeans	Drought	$33,483
2013	Soybeans	Drought	$1,241,475
2013	Soybeans	Drought	$1,328
Total			**$30,231,703**

Source: USDA Risk Management Agency Crop Insurance Payment FOIA Request; USDA Risk Management Agency Iowa Crop Insurance Profile, http://www.rma.usda.gov/pubs/2012/stateprofiles/iowa11.pdf

Probability of Future Occurrence

NOAA's National Climatic Data Center uses the U.S. Palmer Drought Indices and the Standardized Precipitation Index to monitor and predict drought conditions. Lack of precipitation for a given area is the primary contributor to drought conditions. Since precipitation levels cannot be predicted in the long term, the following indices can be used to determine the probability of future occurrences of drought.

The following are the indices:

- **Palmer Z Index** monitors short-term monthly moisture conditions when depart from normal,
- **Palmer Drought Severity Index** measures the duration and intensity of the long-term (meteorological) drought patterns,
- **Palmer Hydrological Drought Index** measures long-term (hydrological) drought and wet conditions reflecting groundwater and reservoir levels.
- **Standardized Precipitation Index** is a probability index that considers only precipitation. This is important to farmers to estimate soil moisture.

In the past 30 years, there have been nine years of recorded damages from drought conditions in Cedar County resulting in a probability rating of 30 percent. The Cedar County Hazard Mitigation Planning Team believes that the current trend of warmer climate conditions will continue and that the probability rating is "Likely"

Probability Score: 3—Likely

Vulnerability

Overview

Cedar County jurisdictions are impacted by drought because it is an expensive weather disaster; it reduces agricultural productivity and causes a strain on urban water supplies. In Cedar County, farmers bear the most direct stress from drought as wells may run dry; crops wilt and die, and forage for livestock becomes scarce and costly.

Cedar County has 955 farms in the County that cover 312,457 acres of land. This translates to 90 percent of the surface land in the County being used for agriculture. Therefore, the planning area has a high exposure to this hazard. Aside from agricultural impacts, other losses related to drought include increased costs of fire suppression and damage to roads and structural foundations due to the shrink dynamic of expansive soils during excessively dry conditions. Drought also presents hazards to public health in extreme cases, where drinking water production cannot keep up with demand. Water wells become less productive during drought

and a failure of remaining productive wells (due to power outage, etc.) can cause public drinking water supplies to become compromised.

According to the *2013 Iowa Hazard Mitigation Plan*, of the 8 hazards for which data was available to estimate annualized losses, drought ranked 2nd with $424 million in annualized losses based on data spanning an 18-year period. Although losses associated with this hazard can be very high, particularly associated with agriculture; crop insurance coverage mitigates the adverse economic impacts somewhat. Considering the planning area's capabilities to withstand a portion of the impacts associated with drought, the magnitude was determined to be "Limited".

Magnitude Score: 2—Limited

Potential Losses to Existing Development

Areas associated with agricultural use are vulnerable to drought conditions which could result in a decrease in crop production or a decrease in available grazing area for livestock. Drought has no real effect on houses and buildings. The impacts would be minimal in terms of landscaping. Rationing water supplies would most likely be the worst case scenario impact.

According to the ten year period from USDA's Risk Management Agency, the amount of claims paid for crop damage as a result of drought in Cedar County was $30,231,703. According to the 2013 Iowa Crop Insurance Profile from USDA's Risk Management Agency, 90.5 percent of the insurable crops in Iowa are insured with USDA Crop Insurance. To factor in estimated losses to insurable crops that are not insured, the 90.5 percent crop insurance coverage was factored in to provide an adjusted estimate of losses. According to this calculation, estimated annualized losses total $3,340,520 (see **Table 3.22**).

Considering the value of crops from the 2012 Census of Agriculture as baseline crop exposure, the estimated annual losses from drought was determined minimal compared to the value of the insurable crops.

Table 3.22. Estimated Insurable Annual Crops Lost Resulting From Drought

10-Year Drought Insurance Paid	Adjusted 10-Year Drought Losses (considering 90.5% insured)	Estimated Annualized Losses	2012 Value of Crops
$30,231,703	$33,405,197	$3,340,520	$219,282,000

Source: Crop value is from USDA 2012 Census of Agriculture; Crop Insurance Paid is from the USDA's Risk Management Agency for 2004-2013.; Crop Insurance Coverage is from USDAs 2013 State Crop Insurance Profile for Iowa
Note: This includes insurable crops that are insured

Future Development

Increases in acreage planted with crops would increase the exposure to drought-related agricultural losses. In addition, increases in population add additional strain on water supply systems to meet the growing demand for treated water.

Drought Hazard Summary by Jurisdiction

The magnitude determinations discussed in the vulnerability overview sections were factored into the following hazard summary table to show how this hazard varies by jurisdiction. As discussed in the drought previous occurrences and vulnerability sections, the majority of the

damages from drought are to crops and other agriculture-related activities. In the cities, the drought conditions would be the same, but the magnitude would be less with lawns and local gardens affected, and leading to expansive soil problems around foundations. The magnitude score is lower for the cities and school districts.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Cedar County	3	2	1	4	2.5	Moderate
City of Bennett	3	1	1	4	2.2	Moderate
City of Clarence	3	1	1	4	2.2	Moderate
City of Durant	3	1	1	4	2.2	Moderate
City of Lowden	3	1	1	4	2.2	Moderate
City of Mechanicsville	3	1	1	4	2.2	Moderate
City of Stanwood	3	1	1	4	2.2	Moderate
City of Tipton	3	1	1	4	2.2	Moderate
City of West Branch	3	1	1	4	2.2	Moderate
Bennett School District, #603	3	1	1	4	2.2	Moderate
Durant School District, #1926	3	1	1	4	2.2	Moderate
North Cedar School District, #3691	3	1	1	4	2.2	Moderate
Tipton School District #6408	3	1	1	4	2.2	Moderate
West Branch School District #6930	3	1	1	4	2.2	Moderate

3.5.3 Earthquakes

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
1	1	4	1	1.45	Low

Profile

Hazard Description

An earthquake is a sudden motion or trembling that is caused by a release of energy accumulated within or along the edge of Earth's tectonic plates. Earthquakes occur primarily along fault zones, tears in the Earth's crust, along which stresses build until one side of the fault slips, generating compressive and shear energy that produces the shaking and damage to the built environment. Heaviest damage generally occurs nearest the epicenter which is that point on the Earth's surface directly above the point of fault movement. The composition of geologic materials between these points is a major factor in transmitting the energy to buildings and other structures on the Earth's surface.

Warning Time Score: 4—less than 6 hours

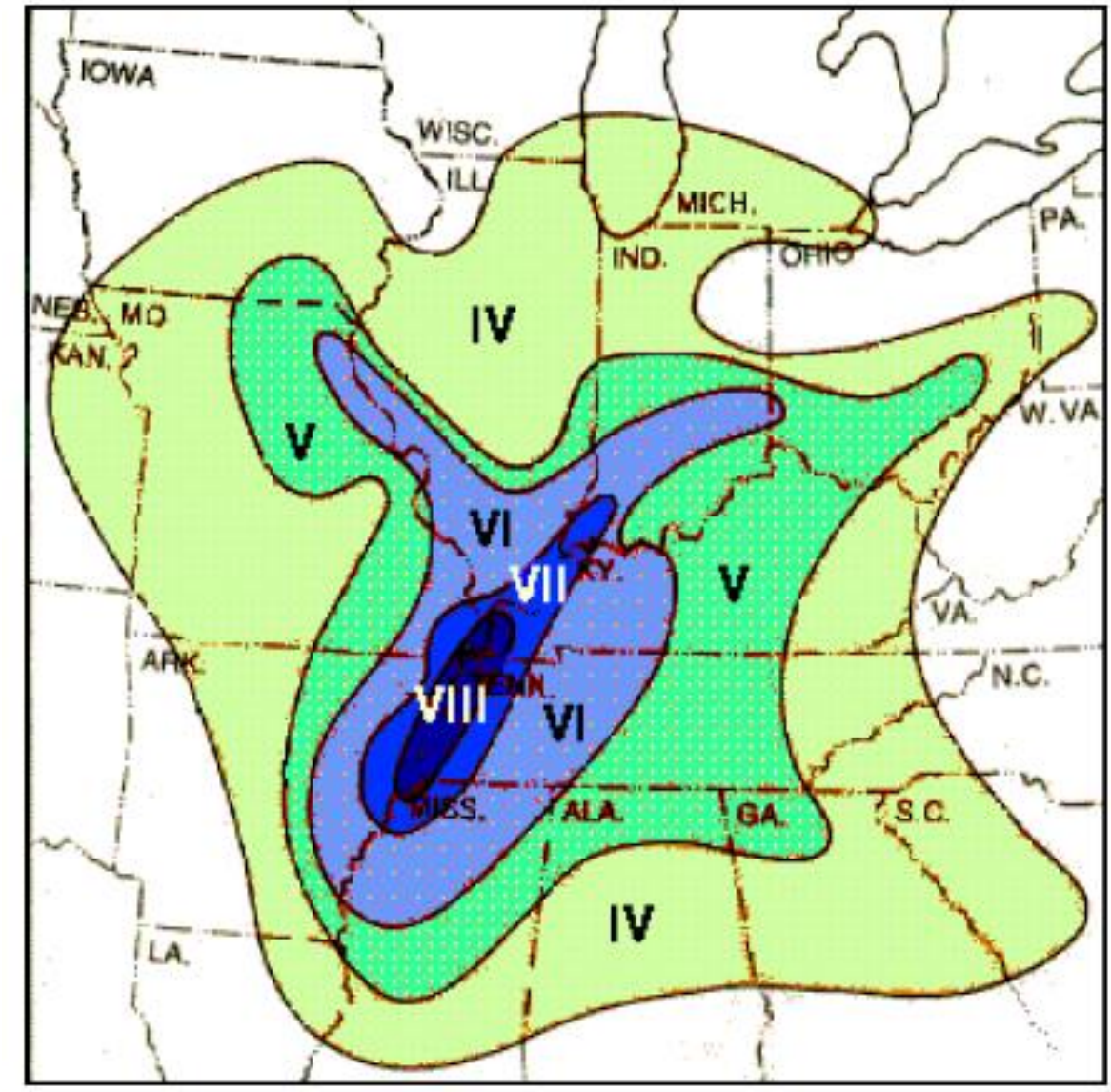
Duration Score: 1—less than 6 hours

Geographic Location/Extent

While geologists often refer to the Midwest as the "stable midcontinent," because of its lack of major crustal movements, there are two regions of active seismicity, the Nemaha Ridge and the New Madrid Fault Zone. The Nemaha Ridge in Kansas and Nebraska, associated with the Humboldt Fault, is characterized by numerous small earthquakes that release stresses before they build to dangerous levels. The fault is not considered a threat to Iowa. The New Madrid Fault Zone, on the other hand, has greater destructive potential. It is located along the valley of the Mississippi River, from its confluence with the Ohio River southward, and includes portions of Illinois, Kentucky, Tennessee, Missouri, Arkansas, and Mississippi. The Earth's crust in the midcontinent is older, and therefore thicker, cooler, and more brittle than that in California for example. Consequently, earthquake shock waves travel faster and farther in the Midwest, making quakes here potentially more damaging than similar sized events in other geologic settings.

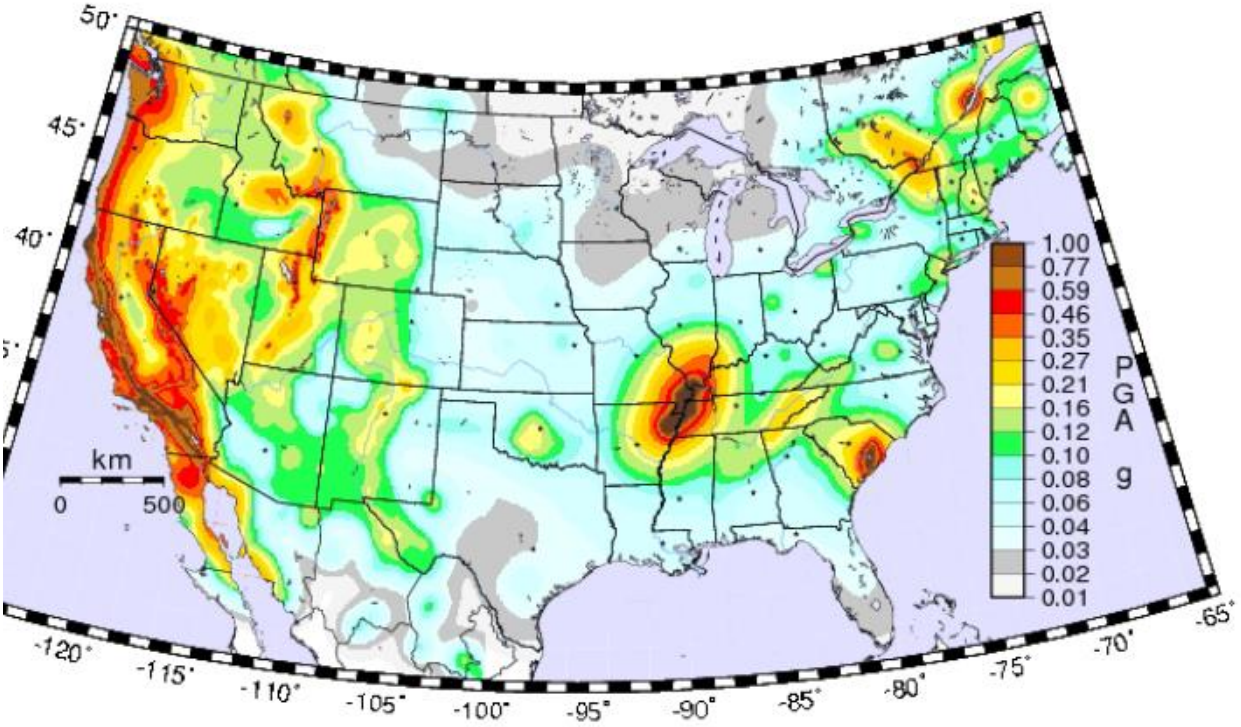
Iowa counties are located in low risk zones as a whole. The southeastern part of the State is more at risk to earthquake effects from the New Madrid Fault Zone. **Figure 3.7** shows the estimated effects of a 6.5 Richter magnitude earthquake scenario along the New Madrid Fault Zone. It suggests that Iowans in four southeast counties could experience trembling buildings, some broken dishes and cracked windows, movement and falling of small unstable objects, abrupt openings or closing doors, and liquids spilling from open containers. About 29 other counties, from Page to Cedar to Muscatine, could experience vibrations similar to the passing of a heavy truck, rattling of dishes and windows, creaking of walls, and swinging of suspended objects. These effects will vary considerably with differences in local geology and construction techniques. **Figure 3.8** shows the Seismic Hazard Map for the U.S. showing the peak ground acceleration of 10 percent in a 50 year timeframe.

Figure 3.7. 6.5 Richter Magnitude Earthquake Scenario, New Madrid Fault Zone



Source: http://www.igsb.uiowa.edu/Browse/quakes/quakes.htm

Figure 3.8. United States Seismic Hazard Map



Source: United States Geological Survey, http://earthquake.usgs.gov/hazards/products/conterminous/2008/maps/

The extent or severity of earthquakes is generally measured in two ways: 1) Magnitude Measurement utilizes the Richter Magnitude Scale and 2) Severity Measurement utilizes the Modified Mercalli Intensity Scale.

Richter Magnitude Scale

The Richter Magnitude Scale was developed in 1935 by Charles F. Richter of the California Institute of Technology as a mathematical device to compare the size of earthquakes. The magnitude of an earthquake is determined from the logarithm of the amplitude of waves recorded by seismographs. Adjustments are included for the variation in the distance between the various seismographs and the epicenter of the earthquakes. On the Richter Scale, magnitude is expressed in whole numbers and decimal fractions. For example, a magnitude 5.3 might be computed for a moderate earthquake, and a strong earthquake might be rated as magnitude 6.3. Because of the logarithmic basis of the scale, each whole number increase in magnitude represents a tenfold increase in measured amplitude; as an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Modified Mercalli Intensity Scale

The effect of an earthquake on the Earth's surface is called the intensity. The intensity scale consists of a series of certain key responses such as people awakening, movement of furniture,

damage to chimneys, and finally - total destruction. Although numerous *intensity scales* have been developed over the last several hundred years to evaluate the effects of earthquakes, the one currently used in the United States is the Modified Mercalli (MM) Intensity Scale. It was developed in 1931 by the American seismologists Harry Wood and Frank Neumann. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It does not have a mathematical basis; instead it is an arbitrary ranking based on observed effects.

The Modified Mercalli Intensity value assigned to a specific site after an earthquake has a more meaningful measure of severity to the nonscientist than the magnitude because intensity refers to the effects actually experienced.

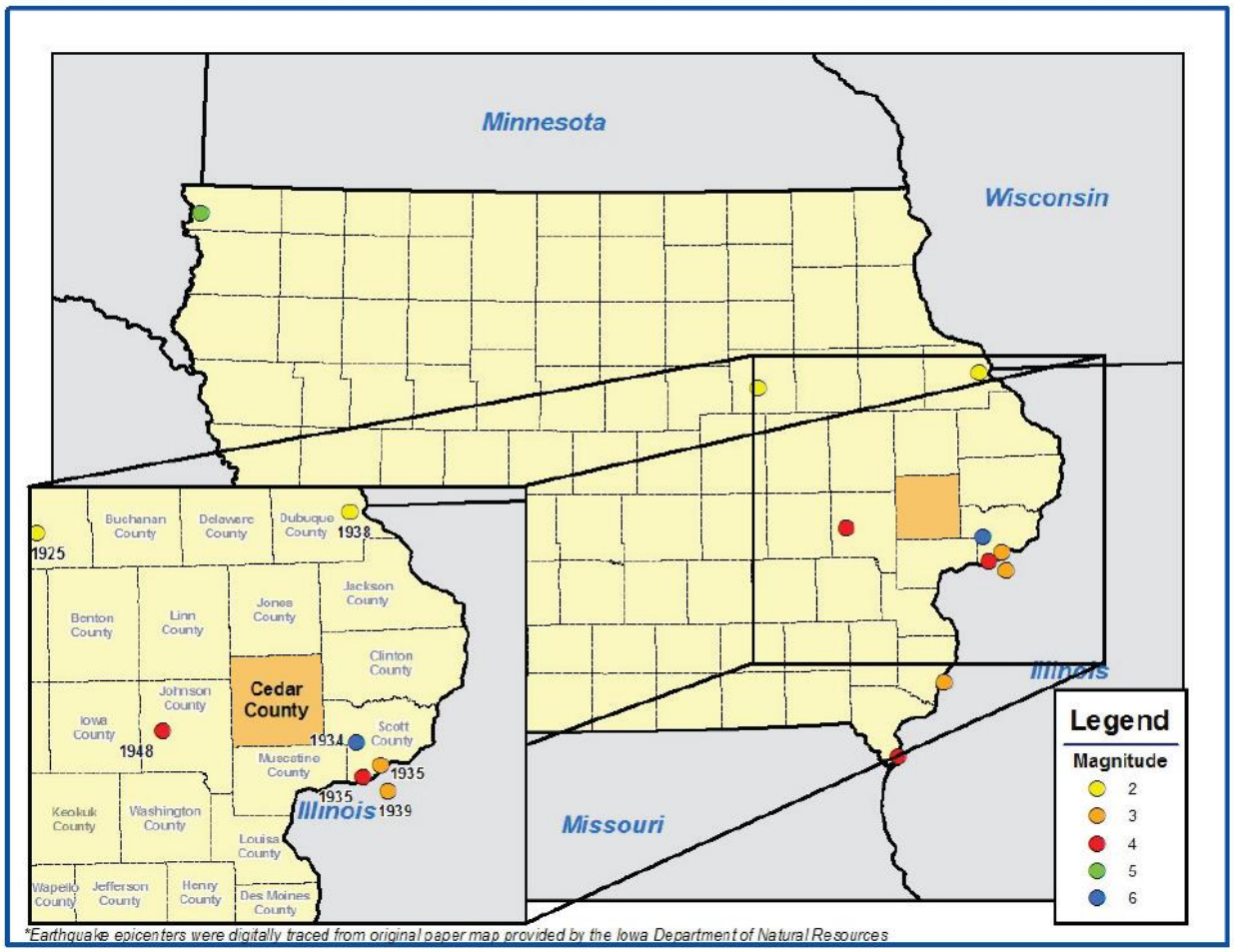
The **lower** numbers of the intensity scale generally deal with the manner in which the earthquake is felt by people. The **higher** numbers of the scale are based on observed structural damage. Structural engineers usually contribute information for assigning intensity values of VIII or above.

Previous Occurrences

Iowa has experienced little effects from only a few earthquakes in the past 175 years. The epicenters of 13 earthquakes have been located in the State with the majority along the Mississippi River. The strongest earthquake in Iowa occurred in Davenport in 1934 and resulted in only slight damage. (Source: *State of Iowa Hazard Mitigation Plan*, 2010).

There have been no recorded earthquakes in Cedar County. Neighboring Johnson (southwest) and Scott (southeast) Counties experienced earthquakes that registered on the Richter scale (2.0-4.0) from 1934 to 1948. **Figure 3.9** below displays historical occurrences of earthquakes around Cedar County and the State of Iowa. The information displayed was digitally traced from paper maps provided by the Iowa Department of Natural Resources.

Figure 3.9. Historical Earthquakes Near Cedar County Iowa

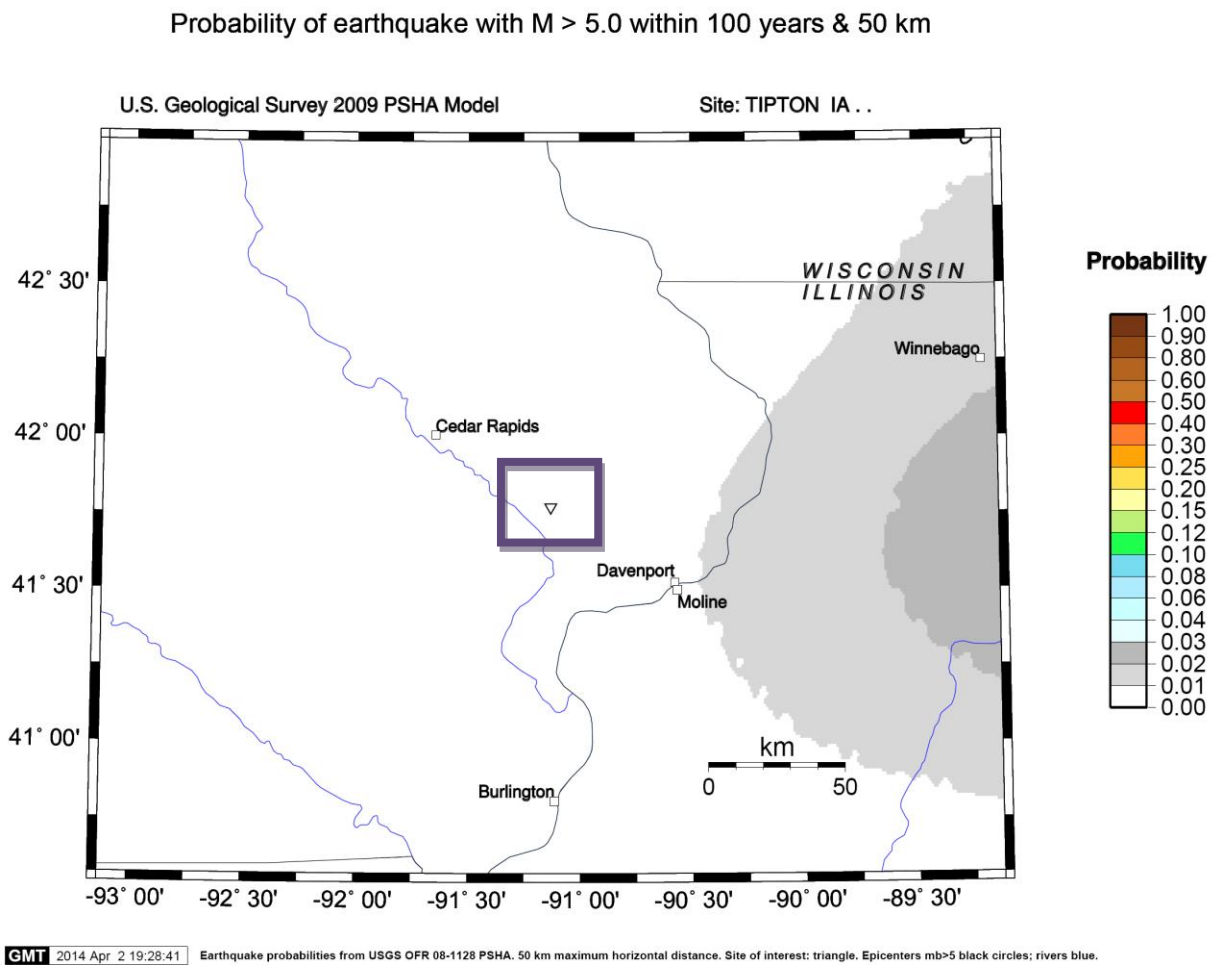


Source: *2011 Cedar County Multi-jurisdictional Hazard Mitigation Plan*

Probability of Future Occurrence

Figure 3.10 demonstrates the probability of an earthquake with a magnitude greater than 5.0 in the Cedar County in a 100 year time period. The purple square shows the approximate Cedar County boundary. As shown in this graphic, the probability of a 5.0 Magnitude or greater earthquake in the next 100 years is 0.00 percent. The probability converts to an estimated maximum recurrence interval of 5,000 years. The probability of a significant earthquake in any given year is unlikely.

Figure 3.10. Probability of Magnitude 5.0 or greater within 100 Years – Cedar County



Source: United States Geological Survey, http://geohazards.usgs.gov/eqprob/2009/ Note: Purple square is approximate location of Cedar County, IA

Probability Score: 1—Unlikely

Vulnerability

Overview

As discussed under the probability section, the probability of a 5.0 Magnitude or greater earthquake in the next 100 years is 0.00 percent. Although a damaging event is unlikely, the potential impacts could be costly in the more urban areas of the County. Most structures in Cedar County are not built to withstand earthquake shaking, but because of the relatively low magnitude of a possible quake, property damage would likely be very minor damage.

The main impacts to Cedar County from a New Madrid Earthquake would be related to incoming evacuees from areas more heavily damaged by the event. This could result in a shortage of short-term lodging, such as hotel rooms and extended stay establishments. Depending on the magnitude of the earthquake, shelters may be designated in Cedar County as

evacuee shelter locations. If this occurred, assistance would be coordinated through the Emergency Management Assistance Compact (EMAC) between the State of Iowa and State governments of impacted areas.

Magnitude Score: 1—Negligible

Potential Losses to Existing Development

FEMA's loss estimation software, HAZUS was utilized to analyze a worst-case, probabilistic, 2,500 year, 6.7 magnitude scenario event. The HAZUS Earthquake module reports earthquake damage by census tract. As a result, it is not possible to separate the resulting damage amounts by incorporated area, as the census tract boundaries are not the same as the incorporated area boundaries. **Table 3.23** below provides the results of the HAZUS analysis for Cedar County. This analysis estimates that the total direct structural damage would be just over $2.63 Million. The combined building, contents and related economic losses such as lost wages, rental, and relocation costs calculated to be nearly $12.61 Million.

Table 3.23. Cedar County, Iowa Estimated Economic Losses—2,500 Year 6.7 Magnitude Earthquake Event (In Millions of Dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.05	0.48	0.04	0.05	0.62
	Capital-Related	0.00	0.02	0.41	0.03	0.02	0.48
	Rental	0.19	0.12	0.30	0.02	0.02	0.66
	Relocation	0.71	0.13	0.44	0.08	0.25	1.60
	Subtotal	**0.90**	**0.31**	**1.64**	**0.16**	**0.34**	**3.36**
Capital Stock Losses							
	Structural	1.23	0.22	0.54	0.18	0.46	2.63
	Non_Structural	3.11	0.51	0.77	0.31	0.41	5.11
	Content	0.63	0.09	0.34	0.19	0.20	1.45
	Inventory	0.00	0.00	0.02	0.05	0.02	0.08
	Subtotal	**4.97**	**0.82**	**1.66**	**0.72**	**1.09**	**9.26**
	Total	**5.87**	**1.13**	**3.30**	**0.88**	**1.43**	**12.61**

Source: HAZUS-MH 2.1, April 2014

Table 3.24 provides the anticipated numbers of buildings by type and damage category that would result according to the HAZUS analysis. The estimated building types and counts are from the HAZUS damage outputs utilizing census block data.

Table 3.24. Expected Building Damage by Building Occupancy Type—2,500 Year 6.7 Magnitude Earthquake Event

Use Type	None	Slight	Moderate	Extensive	Complete
Agricultural	244	32	18	4	0
Commercial	427	55	27	5	0
Education	16	2	1	0	0
Government	17	2	1	0	0
Industrial	144	19	10	2	0
Other Residential	2,041	273	112	12	1
Religious	44	6	3	1	0
Single Family	5,180	530	133	14	1
Total	**8,113**	**919**	**305**	**38**	**2**

Source: HAZUS-MH 2.1, April 2014.

Based on an estimated 1,076 damaged single-family and other residential buildings and an average household size of 2.42 people, the impacted population is estimated to be 2,647 people. When considering just the residential structures estimated to have moderate or extensive damage (271), the impacted population would be 656 people.

Future Development

Overall the planning area has a low vulnerability to earthquake risk. Future development is not expected to increase the risk other than contributing to the overall exposure of what could become damaged as a result of an unlikely event.

Earthquake Hazard Summary by Jurisdiction

The following hazard summary table shows that this hazard does not significantly vary by jurisdiction. Although damage amounts would be higher in the more urban areas, damage ratios would be relatively the same.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Cedar County	1	1	4	1	1.45	Low
City of Bennett	1	1	4	1	1.45	Low
City of Clarence	1	1	4	1	1.45	Low
City of Durant	1	1	4	1	1.45	Low
City of Lowden	1	1	4	1	1.45	Low
City of Mechanicsville	1	1	4	1	1.45	Low
City of Stanwood	1	1	4	1	1.45	Low
City of Tipton	1	1	4	1	1.45	Low
City of West Branch	1	1	4	1	1.45	Low
Bennett School District, #603	1	1	4	1	1.45	Low
Durant School District, #1926	1	1	4	1	1.45	Low
North Cedar School District, #3691	1	1	4	1	1.45	Low
Tipton School District #6408	1	1	4	1	1.45	Low
West Branch School District #6930	1	1	4	1	1.45	Low

3.5.4 Expansive Soils

Hazard Score Calculation					
Probability	**Magnitude/Severity**	**Warning Time**	**Duration**	**Weighted Score**	**Level**
1	1	1	1	1.00	Low

Profile

Hazard Description

A relatively widespread geologic hazard for Iowa is the presence of soils that expand and shrink in relation to their water content. Expansive soils can cause physical damage to building foundations, roadways, and other components of the infrastructure when clay soils swell and shrink due to changes in moisture content. The effects of expansive soils are most prevalent in regions of moderate to high precipitation where prolonged periods of drought are followed by long periods of rainfall. These conditions exist in Cedar County from time to time.

Warning Time Score: 1—24 + hours

The warning time for expansive soils is consistent with other geologic hazards that occur slowly overtime.

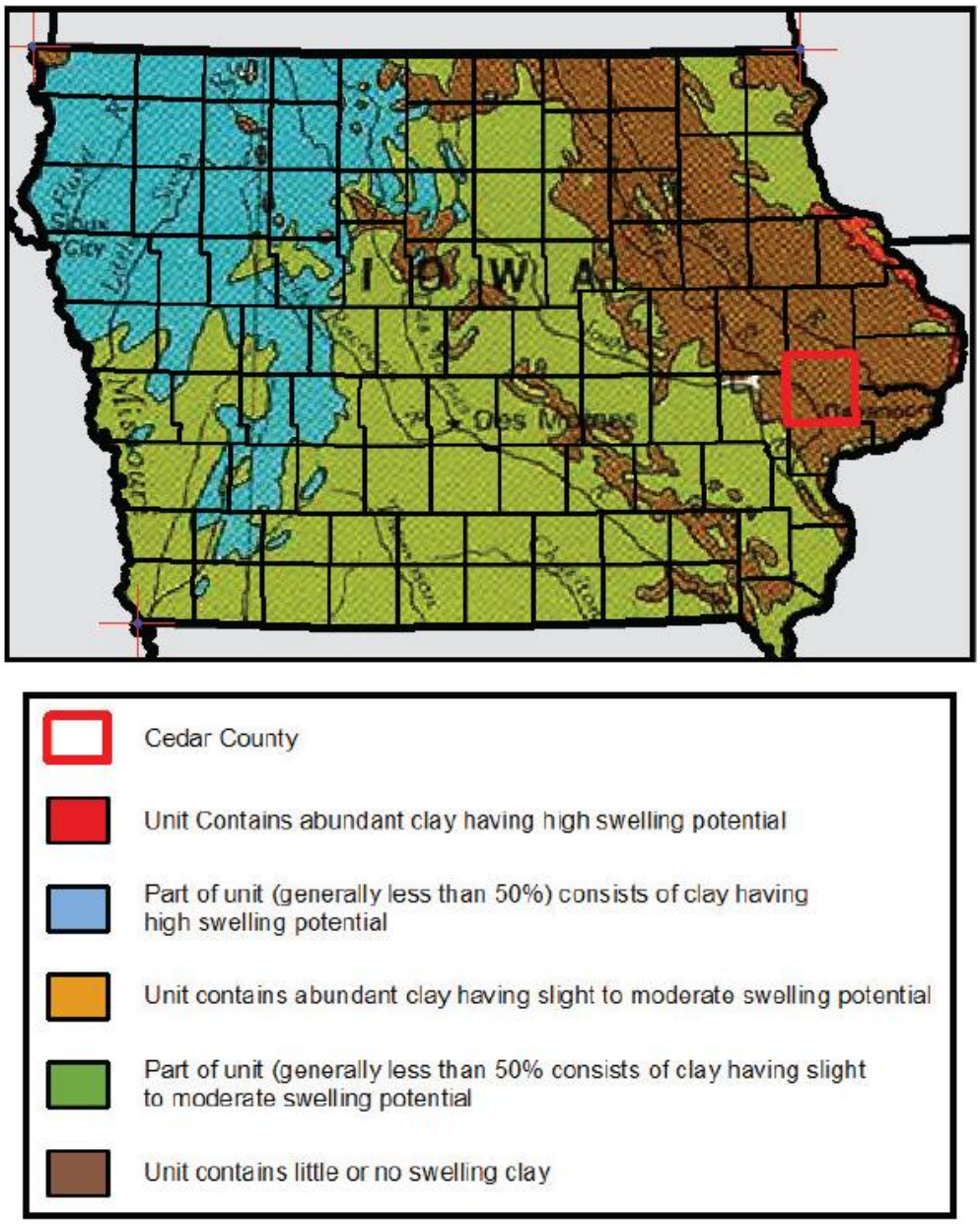
Duration Score: 1—Less than 6 hours

The duration of response to this hazard is limited in the State of Iowa. Although prolonged periods of drought are a primary indicator of risk followed by forecasted periods of precipitation, the response to expansive soils in Iowa is limited and is in large part coupled with response to flash flooding and river flooding.

Geographic Location/Extent

Figure 3.11 shows a map of the swelling potential of soils in Iowa. Cedar County is located in areas with little or no swelling clay (brown shading). This hazard affects all participating jurisdictions.

Figure 3.11. U.S. Geological Survey Swelling Clays Map of Iowa



Source: U.S. Geological Survey publication "Swelling Clays Map of the Conterminous United States" by W.W. Olive, A.F. Chleborad, C.W. Frahme, Julius Schlocker, R.R. Schneider, and R.L. Shuster, 1989

Previous Occurrences

Streets and parking lots throughout the County are damaged every year by the effects of expansive soils as well as underground water lines that are damaged as the soil expands and contracts at varying levels along a water line. The frequency of damage from expansive soils can be associated with the cycles of drought and heavy rainfall, which reflect changes in moisture content. Damages occur with isolated incidents and affected property owners, local governments, and businesses generally make any necessary repairs.

Probability of Future Occurrence
Although there will continue to be some damage to paved areas and foundations in Cedar County due to swelling soils, it is unlikely that these damages will become greater in the future unless new development occurs in areas where the hazard is more severe. Certain buildings and construction practices could be put in place to lessen these impacts. The HMPC determined that noticeable damage to assets in the planning area as a result of expansive soils has a 1 in 10 chance of occurring in any given year.

Probability Score: 1—Unlikely

Vulnerability

Overview
The HMPC has determined that while the entire planning area is vulnerable to some structural damage as a result of shrinking and expanding soils, there is no data available to determine damage estimates for this hazard and as a whole, the planning area does not have soils with high swelling potential. In most cases, individual property owners, local governments, and businesses pay for repairs to damages caused by this hazard. The HMPC felt that underground utility lines such as water and sewer pipes may be at risk to damages associated with expansive soils. However, there is no data to support damages and costs associated with this hazard at this time. The vulnerability of people to this hazard is negligible as this hazard does not impact human safety.

Magnitude Score: 1—Negligible

Potential Losses to Existing Development
Existing development will continue to be vulnerable to expansive soils.

Future Development
Additional future development in the planning area will also be vulnerable to this hazard.

Expansive Soils Hazard Summary by Jurisdiction
The following hazard summary table shows that this hazard does not vary by jurisdiction.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Cedar County	1	1	1	1	1.00	Low
City of Bennett	1	1	1	1	1.00	Low
City of Clarence	1	1	1	1	1.00	Low
City of Durant	1	1	1	1	1.00	Low
City of Lowden	1	1	1	1	1.00	Low
City of Mechanicsville	1	1	1	1	1.00	Low
City of Stanwood	1	1	1	1	1.00	Low
City of Tipton	1	1	1	1	1.00	Low
City of West Branch	1	1	1	1	1.00	Low
Bennett School District, #603	1	1	1	1	1.00	Low
Durant School District, #1926	1	1	1	1	1.00	Low
North Cedar School District, #3691	1	1	1	1	1.00	Low
Tipton School District #6408	1	1	1	1	1.00	Low
West Branch School District #6930	1	1	1	1	1.00	Low

3.5.5 Extreme Heat

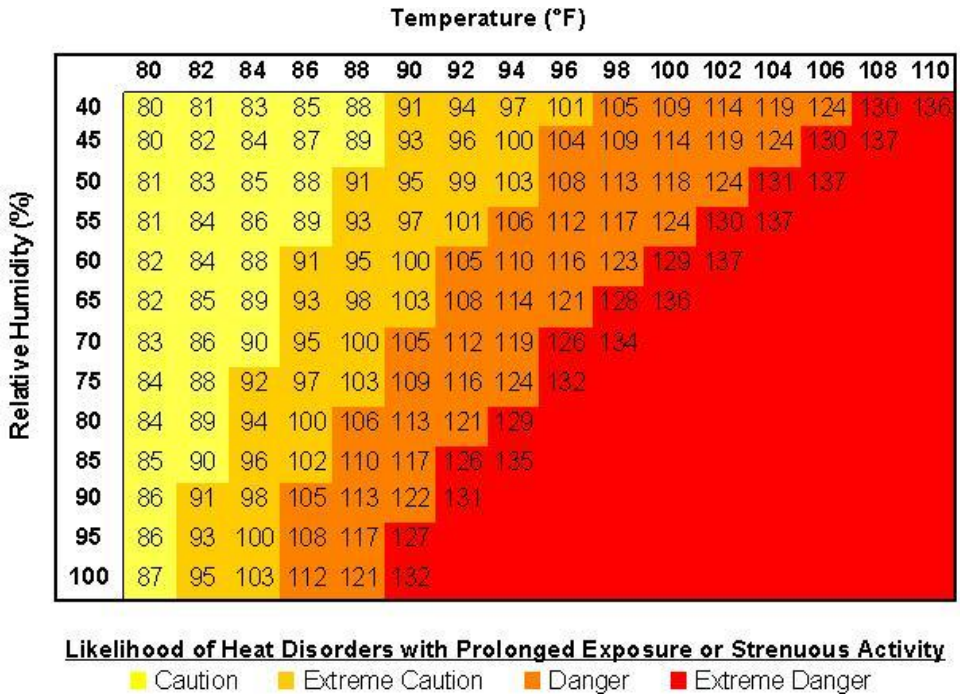
Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
2	2	1	3	1.95	Low

Profile

Hazard Description

According to information provided by FEMA, extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Ambient air temperature is one component of heat conditions, with relative humidity being the other. The relationship of these factors creates what is known as the apparent temperature. The Heat Index Chart in **Figure 3.12** uses both of these factors to produce a guide for the apparent temperature or relative intensity of heat conditions.

Figure 3.12. Heat Index (HI) Chart



Source: National Weather Service (NWS)

Note: Exposure to direct sun can increase Heat Index values by as much as 15°F. The shaded zone above 105°F corresponds to a HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

During these conditions, the human body has difficulties cooling through the normal method of the evaporation of perspiration. Health risks rise when a person is over exposed to heat.

According to the National Weather Service, in 2013, 92 people died as a result of extreme heat, down from 155 fatalities in 2012 in the U.S. In 2013, the most dangerous place to be was in a permanent home, likely with little or no air conditioning. Those at greatest risk for heat-related illness include people 65 years of age and older, people who are overweight, and people who

are ill or on certain medications. However, even young and healthy individuals are susceptible if they participate in strenuous physical activities during hot weather. In agricultural areas, the exposure of farm workers, as well as livestock, to extreme heat is a major concern.

Table 3.25 lists typical symptoms and health impacts of exposure to extreme heat.

Table 3.25. Typical Health Impacts of Extreme Heat

Heat Index (HI)	Disorder
80-90° F (HI)	Fatigue possible with prolonged exposure and/or physical activity
90-105° F (HI)	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and/or physical activity
105-130° F (HI)	Heatstroke/sunstroke highly likely with continued exposure

Source: National Weather Service Heat Index Program, www.weather.gov/os/heat/index.shtml

The National Weather Service has a system in place to initiate alert procedures (advisories or warnings) when the Heat Index is expected to have a significant impact on public safety. The expected severity of the heat determines whether advisories or warnings are issued. A common guideline for issuing excessive heat alerts is when the maximum daytime Heat Index is expected to equal or exceed 105 degrees Fahrenheit (°F) and the night time minimum Heat Index is 80°F or above for two or more consecutive days. A heat advisory is issued when temperatures reach 105 degrees and a warning is issued at 115 degrees.

Warning Time Score: 1—More than 24 hours warning time

Duration Score: 3—Less than one week

Geographic Location/Extent

The entire planning area is subject to extreme heat and all participating jurisdictions are affected.

Previous Occurrences

According to information obtained from the National Weather Service for Cedar County, Iowa on the Iowa Environmental Mesonet, Iowa State University Department of Agronomy website, (http://mesonet.agron.iastate.edu/vtec/search.php), there have been 3 heat-related watches, 5 heat-related warnings and 22 heat-related advisories between 2005 and April 2014.

Table 3.26. National Weather Service Issuances for Extreme Heat in Cedar County, IA

Phenomena	Significance	Number Issued between 2005 and April 2014
Heat	Watches	3
Heat	Warnings	5
Heat	Advisories	22
Total		**30**

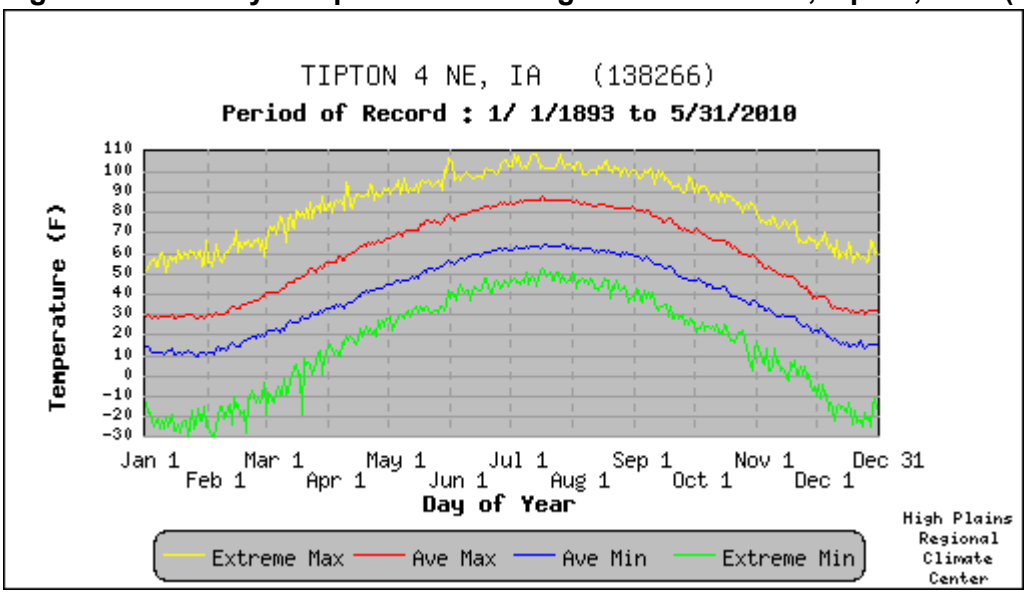
Source: Environmental Mesonet, Iowa State University Department of Agronomy website, http://mesonet.agron.iastate.edu/vtec/search.php

The planning committee identified 41 days that had temperatures above 100 °F between 1950 and 2013. Years when temperatures exceeded 100 during an event were 1953, 1955, 1956,

1974, 1983, 1987, 1988, and 2012. The highest recorded temperature in Tipton, Iowa during this time period was 103 °F which was reached in 1955, 1988, and 2012. The months of the year with the highest temperatures are generally July and August. The average temperature for July is 74.2 °F and August is 72.0 °F for the planning area.

Figure 3.13 provides the daily temperature averages and extremes for the Tipton, Iowa weather station for the period of record from 1893 to 2010 from the High Plains Regional Climate Center. This data shows that a temperature of 108 °F was reached in 1911 as the highest recorded temperature during the 118 year timeframe.

Figure 3.13. Daily Temperatures Averages and Extremes, Tipton, Iowa (1893 – 2010)



- Extreme Max. is the maximum of all daily maximum temperatures recorded for the day of the year.
- Ave. Max. is the average of all daily maximum temperatures recorded for the day of the year.
- Ave. Min. is the average of all daily minimum temperatures recorded for the day of the year.
- Extreme Min. is the minimum of all daily minimum temperatures recorded for the day of the year.

Source: High Plains Regional Climate Summary,
http://www.hprcc.unl.edu/data/historical/index.php?state=ia&action=select_state&submit=Select+State

The National Climatic Data Center reported four regional excessive heat events in and around Cedar County plan area from 1996 to March 2014. Those occurred in July 1997, July 1999, July 2012, and August 2013.

According to the USDA's Risk Management Agency, insured payments in Cedar County for damages to crops as a result of heat from 2004-2013 totaled $481,507. **Table 3.27** shows the insurable crop insurance claims paid in Cedar County as a result of heat.

Table 3.27. Claims Paid in Cedar County for Crop Loss as a Result of Heat (2004-2013)

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid ($)
2007	Soybeans	Heat	$310

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid ($)
2011	Corn	Heat	$4,638
2011	Hybrid Corn Seed	Heat	$163,408
2011	Soybeans	Heat	$17,405
2012	Corn	Heat	$279,467
2012	Hybrid Corn Seed	Heat	$4,098
2012	Soybeans	Heat	$10,994
2013	Soybeans	Heat	$1,187
Total			**$481,507**

Source: Crop Insurance Paid is from the USDA's Risk Management Agency for 2004-2013;
Note: This includes insurable crops that are insured

Probability of Future Occurrence

Based on historical data from the NWS station at Tipton, Iowa there were 30 heat-related watches, warnings and advisories issued during the 9.3 year period. This translates to a 31 percent chance probability of an extreme heat event occurring in the planning area in any given year. Most of these extreme heat events last for less than a week and then temperatures change and become milder. Although extreme heat events, by definition, occur almost every year for a short timeframe, the HMPC determined that damaging events occur less often and determined that the Probability Score for this hazard should be occasional, with a 10 to 20 percent likelihood of a damaging extreme heat event in any given year.

Probability Score: 2—Occasional

Vulnerability

Overview

Those at greatest risk for heat-related illness and deaths include people 65 years of age and older, people who are overweight, and people who are ill or on certain medications. To determine jurisdictions within the planning area with populations that may be more vulnerable to extreme heat, demographic data was obtained from the 2010 Census on numbers of people in each jurisdiction that are over the age of 65 are seen in **Table 3.28.** Data was not available for overweight individuals and those on certain medications.

Overall, Iowa is already older than the country as a whole. About 15 percent of its population is over 65, compared with 13 percent nationally. Cedar County, however, is slightly older than the U.S. as a whole, with 16.7 percent of the population over 65. The participating jurisdictions with the highest percent of adults 65 and over in descending order are: Clarence, Lowden, and Tipton

Table 3.28. Cedar County Population 65 years and Over, 2010 Census Data

Jurisdiction	Population 65 yrs and over	Percent 65 yrs and over
Cedar County	3,093	16.7%
City of Bennett	68	16.8%
City of Clarence	244	25.1%
City of Durant	312	17.0%
City of Lowden	186	23.6%
City of Mechanicsville	212	18.5%
City of Stanwood	110	16.1%

Jurisdiction	Population 65 yrs and over	Percent 65 yrs and over
City of Tipton	671	20.8%
City of West Branch	313	13.5%

Source: U.S. Census Bureau, 2010

Magnitude Score: 2—Limited

Estimated Losses to Existing Development

According to the ten year period from USDA's Risk Management Agency, the amount of claims paid for crop damages as a result of heat was $481,507. According to the 2013 Iowa Crop Insurance Profile Report issued by the USDA's Risk Management Agency, 90 percent of Iowa insurable crops were insured. To factor in estimated losses to insurable crops that are not insured, the 90 percent crop insurance coverage was factored in to provide an adjusted estimate of losses. According to this calculation, estimated annualized losses total $53,500 (see **Table 3.29**).

Considering the value of crops from the 2012 Census of Agriculture as baseline crop exposure, the estimated annual losses from heat was determined minimal compared to the value of the insurable crops.

Table 3.29. Estimated Insurable Annual Crops Lost Resulting From Heat

10-Year Drought Insurance Paid	Adjusted 10-Year Drought Losses (considering 90% insured)	Estimated Annualized Losses	2012 Value of Crops
$481,507	$535,007	$53,500	$219,282,000

Source: Crop value is from USDA 2012 Census of Agriculture; Crop Insurance Paid is from the USDA's Risk Management Agency for 2004-2013.; Crop Insurance Coverage is from USDAs 2013 State Crop Insurance Profile for Iowa
Note: This includes insurable crops that are not insured

Extreme heat can also cause a strain on electricity delivery infrastructure which can be overloaded during peak use of electricity to power air conditioning during extreme heat events. Another type of infrastructure damage that can occur as a result of extreme heat is road damage. When asphalt is exposed to prolonged extreme heat, it can cause buckling of asphalt-paved roads, driveways, and parking lots.

Future Development

Since Cedar County is not experiencing large population growth, the number of people vulnerable to extreme heat is not increasing.

Extreme Heat Hazard Summary by Jurisdiction

Extreme heat is a regional hazard and impacts all jurisdictions in the planning area.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Cedar County	2	2	1	3	1.95	Low
City of Bennett	2	2	1	3	1.95	Low
City of Clarence	2	2	1	3	1.95	Low
City of Durant	2	2	1	3	1.95	Low
City of Lowden	2	2	1	3	1.95	Low
City of Mechanicsville	2	2	1	3	1.95	Low
City of Stanwood	2	2	1	3	1.95	Low
City of Tipton	2	2	1	3	1.95	Low
City of West Branch	2	2	1	3	1.95	Low
Bennett School District, #603	2	2	1	3	1.95	Low
Durant School District, #1926	2	2	1	3	1.95	Low
North Cedar School District, #3691	2	2	1	3	1.95	Low
Tipton School District, #6408	2	2	1	3	1.95	Low
West Branch School District, #6930	2	2	1	3	1.95	Low

3.5.6 Flash Flooding

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
4	2	2	1	2.80	Moderate

Profile

Hazard Description

A flash flood is an event that occurs when water levels rise at an extremely fast rate as a result of intense rainfall over a brief period, sometimes combined with rapid snowmelt, ice jam release, frozen ground, saturated soil or impermeable surfaces.

Ice jam flooding is a form of flash flooding that occurs when ice breaks up in moving waterways, and then stacks on itself where channels narrow. This creates a natural dam, often causing flooding within minutes of the dam formation.

Riverine Flooding is discussed separately in **Section 3.5.10** and flooding caused by dam failure is discussed in **Section 3.5.7** respectively.

Most flash flooding is caused by slow-moving thunderstorms or thunderstorms repeatedly moving over the same area. Flash flooding is an extremely dangerous form of flooding which can reach full peak in only a few minutes and allows little or no time for protective measures to be taken by those in its path. Flash flood waters move at very fast speeds and can move boulders, tear out trees, scour channels, destroy buildings, and obliterate bridges. Flash flooding often results in higher loss of life, both human and animal, than slower developing river and stream flooding.

In some cases, flooding may not be directly attributable to a river, stream, or lake overflowing its banks. Rather, it may simply be the combination of excessive rainfall or snowmelt, saturated ground, and inadequate drainage. With no place to go, the water will find the lowest elevations–areas that are often not in a floodplain. This type of flooding, often referred to as sheet flooding, is becoming increasingly prevalent as development outstrips the ability of the drainage infrastructure to properly carry and disburse the water flow.

In certain areas, aging storm sewer systems are not designed to carry the capacity currently needed to handle the increased storm runoff. Typically, the result is water backing into basements, which damages mechanical systems and can create serious public health and safety concerns. This combined with rainfall trends and rainfall extremes all demonstrate the high probability, yet generally unpredictable nature of flash flooding in the planning area.

Although flash floods are somewhat unpredictable, there are factors that can point to the likelihood of flash floods occurring. Weather surveillance radar is being used to improve monitoring capabilities of intense rainfall. This, along with knowledge of the watershed characteristics, modeling techniques, monitoring, and advanced warning systems increases the warning time for flash floods.

Warning Time Score: 2—12-24 hours warning time. This refers to the period of time prior to the event with heightened awareness that a flash flood could occur, not the issuance of a "flash flood warning" by the National Weather Service.

Duration Score: 1—Less than 6 hours

Geographic Location/Extent

Cedar County has a gently rolling to steep upland terrain, deeply dissected in places by rivers and streams. The areas immediately north and south of the Cedar and Wapsipinicon Rivers are characterized by an intricate pattern of deep valleys and ravines that have steep slopes. Small streams extend into the uplands. The bottomlands along the Cedar and Wapsipinicon Rivers are nearly level. Stream terraces along the rivers are nearly level to undulating. Upland hills rise 100 to 200 feet from the level of the flood plains. The northern one fourth of Cedar County has a gently undulating topography that is called the Iowan Erosion Surface. A broad dissected plain that makes up the largest part of Cedar County separates the Cedar and Wapsipinicon Rivers. It is characterized by slopes of less than nine percent.

Flash flooding occurs in those locations of the planning area that are low-lying and/or do not have adequate drainage to carry away the amount of water that falls during intense rainfall events. According to NCDC, the following jurisdictions have a history of flash flooding events: unincorporated Cedar County, City of Stanwood, City of Tipton, City of Mechanicsville, and the City of Lowden.

Specific areas reported in NCDC flash flood narratives or provided by planning committee members are provided by jurisdiction below:

- Unincorporated Cedar County
  - King Avenue south of Stanwood,
  - Highway 38 south of Tipton,
  - Highway 30 between Mechanicsville and Stanwood.

- City of Mechanicsville
  - Intersection of E. Cedar Street and S. Cherry Street

- City of Lowden
  - Harding Avenue between Highway 30 and 5th Street
  - Intersection of Harding Avenue and Main Street
  - Intersection of Washington Avenue and 1st Street
  - City Public Works Building 618 Main Street

The National Weather Service has various flash flooding products that are issued to the public to provide information regarding upcoming and current flash flood threats (see **Table 3.30**).

Table 3.30. National Weather Service Flash Flooding Products

Product	What It Means	You Should...
Hazardous Weather Outlook	Will there be any threat of flash flooding in the next several days?	If there is a threat of flash flooding, check back later for updated forecasts and possible watches and warnings. Latest Hazardous Weather Outlook
Flash Flood Watch	There is a threat of flash flooding within the next 48 hours, either as a result of heavy rain, ice jams, or the threat of a dam break.	Monitor weather conditions closely, especially if you live in an area prone to flash flooding.
Flash Flood Warning	There is an immediate threat for flash flooding in the warned area, especially in low-lying and poor drainage areas. These warnings are updated frequently with Flash Flood Statements.	If you live in an area susceptible to flash flooding, be prepared to evacuate and head to higher ground. Be very cautious when driving in the warned area, especially at night or while it is still raining. You may not be able to see a flooded road until it is too late!
A *Flash Flood Emergency* may be declared when a severe threat to human life and catastrophic damage from a flash flood is imminent or ongoing. The declaration of a *Flash Flood Emergency* would typically be found in either a Flash Flood Warning or Flash Flood Statement. People are strongly encouraged to avoid the geographic area of concern in a *Flash Flood Emergency*. The *Flash Flood Emergency* wording is used very rarely and is reserved for exceptionally rare and hazardous events.		
Areal Flood Warning	The threat of flash flooding is over, but there is still significant standing water in the affected area.	Areal flood warnings will typically list locations and roads impacted by the flooding. Try to avoid these locations until the water has receded.

Source: National Weather Service, website accessed 8/26/2013 http://www.crh.noaa.gov/dmx/?n=prepare floodproducts

Previous Occurrences

Table 3.31 provides details regarding the flashflood and areal flood watches and warnings issued for Cedar County and the Cedar County forecast zone by the Quad Cities National Weather Service office. Areal flooding is a type of flash flooding that is generally over a large area usually due to the amount and duration of rainfall.

Table 3.31. Flash Flood-Related National Weather Service Watches and, Warnings Issued for Cedar County and, Cedar County, Iowa Forecast Zone (April 2005 – April 2014)

Year	NWS Product	# of Times Issued
2006	Areal Flood Watch	1
2007	Flash Flood Watch	7
2007	Areal Flood Watch	3
2008	Flash Flood Watch	15
2008	Flash Flood Warning	4
2008	Areal Flood Watch	4
2009	Flash Flood Watch	6
2009	Flash Flood Warning	6
2009	Areal Flood Watch	1
2009	Areal Flood Warning	3
2010	Flash Flood Watch	22

Year	NWS Product	# of Times Issued
2010	Flash Flood Warning	5
2011	Flash Flood Watch	2
2012	Flash Flood Watch	2
2012	Flash Flood Warning	1
2013	Flash Flood Watch	6
2013	Flash Flood Warning	7
2013	Areal Flood Warning	2
2014	Areal Flood Watch	1

Source: Iowa State University Department of Agronomy http://mesonet.agron.iastate.edu/vtec/search.php

As discussed in the Description Section, flash flooding can be caused by intense rainfall over a brief period. **Table 3.32** provides the top 30 rainfall events at the Tipton Weather Station from January 1, 1950 to December 31, 2013.

Table 3.32. Top 30 Rainfall Events, Tipton Weather Station, 1950 to 2013

Date	Precipitation (inches)
6/24/2013	6.8
4/17/2013	4.73
11/17/1952	4.58
6/16/1990	4.52
7/29/1970	4.5
9/17/1970	4.3
9/18/1977	4.3
7/19/2002	4.2
8/4/1965	4.1
6/22/2007	4.1
6/7/1967	3.98
8/16/1977	3.6
9/26/1981	3.56
7/14/1979	3.5
9/13/1961	3.48
6/15/1982	3.43
8/21/1987	3.41
8/17/1990	3.38
10/10/1954	3.35
9/12/1961	3.34
5/10/1996	3.25
10/13/1960	3.15
12/15/1971	3.15
4/29/1974	3.1
9/13/1955	3
10/31/1960	3
8/8/1967	3
7/18/1972	3
8/8/1977	3
7/25/1960	2.9

Source: Iowa State University Department of Agronomy http://mesonet.agron.iastate.edu/request/coop/fe.phtml

Information from the NCDC was obtained from 1996 to December 2013 to determine previous occurrences for flash flood in the planning area. During this time-frame, there were no injuries or deaths reported. Additionally, there were no damages reported to crops. **Table 3.33** provides a summary of the NCDC data.

Table 3.33. NCDC Cedar County, Iowa Flash Flood Events Summary, 1996 to December 2013

Location	Date	Time	Type	Property Damage
Countywide	2/20/1997	16:00	Flash Flood	$0
Countywide	6/13/2000	22:08	Flash Flood	$0
Stanwood	6/19/2009	16:30	Flash Flood	$100,000
Lime City	6/19/2009	17:10	Flash Flood	$50,000
Tipton	7/10/2009	11:13	Flash Flood	$0
Mechanicsville	6/15/2010	11:20	Flash Flood	$25,000
Lowden	8/23/2011	7:00	Flash Flood	$0
Mechanicsville	4/17/2013	10:30	Flash Flood	$250,000
Mechanicsville	6/24/2013	4:00	Flash Flood	$0
Totals:				**$425,000**

Source: NCDC, data accessed 3/24/2014

Descriptions of notable flash flood events are provided below in reverse chronological order:

- **June 24, 2013 (FEMA-4119-DR-IA**—Widespread heavy rain fell across Cedar County from the early morning hours into the mid morning. The cooperative observer in Lowden reported 6.25 inches, while broadcast media reported 6.75 inches of rain in Clarence. There was also a public report from 1 mile east of Lowden with 6.25 inches of rain. Other reports included: 2 feet of water flowing over the road near Mechanicsville; a road and bridge were washed out near Lowden; water was over Highway 30 between Mechanicsville and Stanwood; water was up to the first floor windows at several homes in Lowden—three homes were destroyed and many had water in the basements. The Lowden Wastewater Treatment Plant office flooded and the collection system was over capacity. The county road south of town was also closed for several months as the roadway washed out. Overall, the Cedar County Engineer reported 2 dozen roads closed across the County due to flash flooding. In The City of Bennett, basements flooded, pumps were damaged, and roads closed. Mechanicsville had to constantly monitor lift station pumps to prevent excess water from over-flowing and a storm drain washed out at E. First Street. Damages exceeded $2,000.

Figure 3.14. Flooding in Lowden, Iowa—June 24, 2013

Source: wate.com, accessed 7/10/2014, http://www.wate.com/category/266438/flash-flooding-in-lowden-ia-62413-slideshow

- **April 17, 2013 (FEMA-4135-DR-IA)**—Several rounds of heavy rains resulted in flash flooding across much of Cedar County from mid morning April 17 through the early morning

April 18**.** In Mechanicsville, the lift station flooded and caused back-up in basements. Damages exceeded $1,700

- **March 2012—**the City of Clarence reported a flash flood event.
- **August 23, 2011**—A thunderstorm moving through Cedar County produced heavy rain of between 3.5 to 4 inches in less than an hour causing severe flooding in Cedar County. Several streets were flooded with cars stalled. A number of residents reported flooding in their basements.
- **June 15, 2010**—Heavy rains resulted in flash flooding of parts of Mechanicsville and Lowden during the afternoon of June 15. Flood waters covered the intersection of E Cedar Street and S Cherry Street in Mechanicsville. A basement was flooded in Lowden. In addition, a gravel road was washed out about 2 miles east of Sutiff, IA.
- **July 10, 2009**—Heavy rains resulted in some flash flooding just south of Tipton, IA during the afternoon of July 10. Flood waters covered about half of Highway 38 just south of town.
- **June 19, 2009—**Heavy rains resulted in flash flooding of several streets in Durant and Stanwood. The flood waters were deep enough to stall cars in town in Durant and up to a foot deep in Stanwood. In addition, water was flowing over a road east of Highway 38.
- **June 13, 2000**—Creek flooding washed a bridge out 2 miles south of Sunbury in Cedar County. King Avenue south of Stanwood was closed due to high water, while street flooding was also observed in Tipton.
- **February 20, 1997—**Heavy rains fell over the area while soils were still partially frozen. One-to-three inch rains came as area rivers and streams were running high from snowmelt during the previous week. Numerous streams and rivers went out of their banks, leaving standing water for several days.

The US Army Corps of Engineers, Cold Regions Research and Engineering Laboratory (CRREL) maintains a database of historic ice jams. According to a query of that database from 1950 to the present, there were no recorded ice jams in Cedar County. Ice jams may have occurred in the planning area during this time, but were not observed or recorded in the ice jam database.

Probability of Future Occurrence

The frequency of past events is used to gauge the likelihood of future occurrences. The events from NCDC that occurred on the same day were combined to determine the total number of eight flash flooding events in the planning area over the 18-year period from 1996 to 2013. This translates to a 44 percent likelihood of flash flooding somewhere in the planning area in any given year.

Probability Score: 4—Highly Likely

Vulnerability

Vulnerability Overview

Water over low-lying roads and bridges are the most frequent types of impacts associated with flash flooding that has occurred in the planning area. This can cause wash out of bridge abutments and erosion/scour damage on roads. There is potential for loss of life if motorists drive into moving water. However, public education campaigns have helped to educate citizens

about not driving through moving water. Building damage is generally limited to water in basements where rain is too intense for drainage systems and natural drainage to carry water away from the structure. In addition, when combined storm/sanitary sewer systems are overloaded, this can result in sewer back-up. Generally, flash-flooding is short in duration and government services and business operations are not impacted.

Magnitude Score: 2—Limited. The magnitude was determined to be limited.

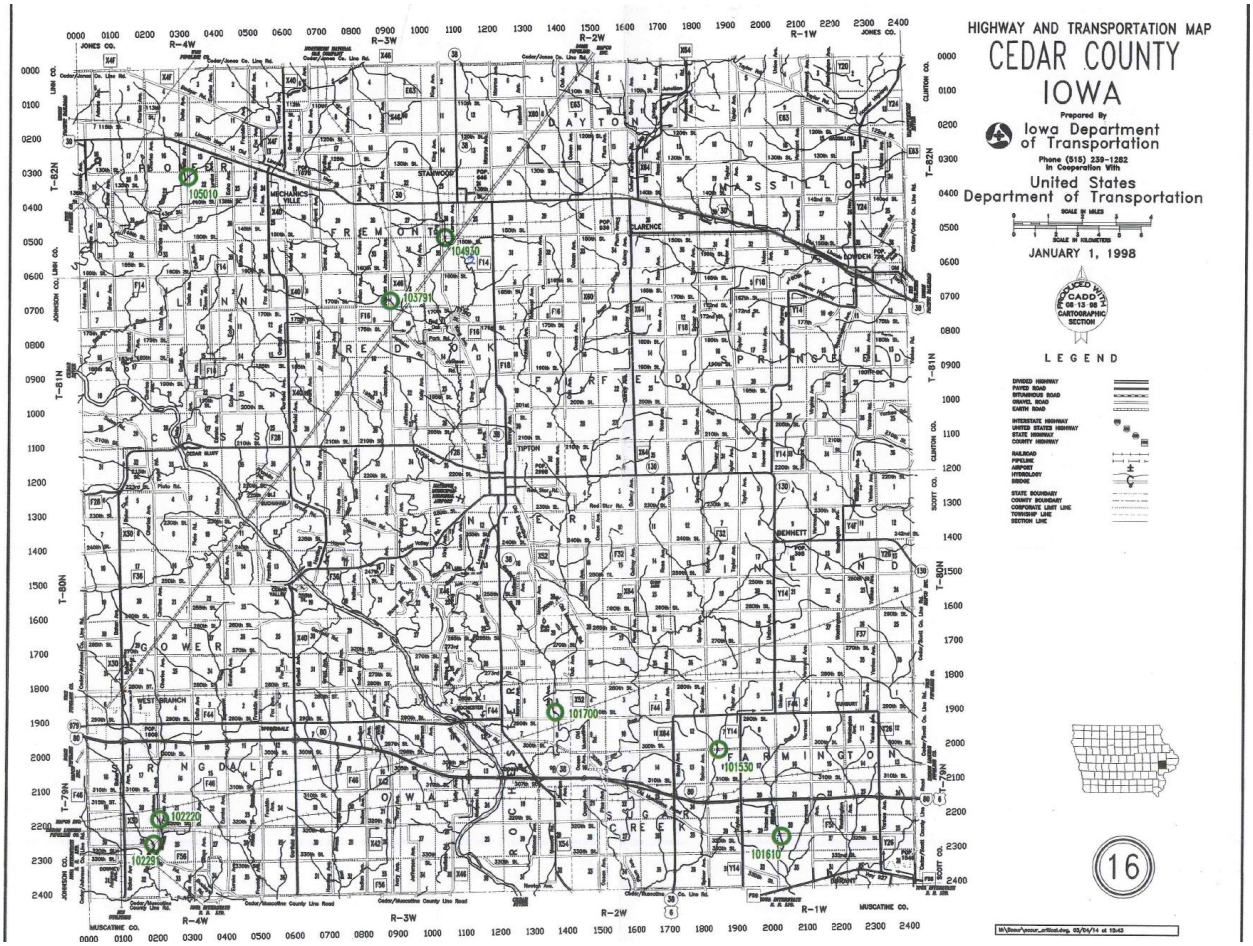
Potential Losses to Existing Development

When roads and bridges are inundated by water, damage often occurs as the water scours materials around bridge abutments and gravel roads. According to the Iowa Department of Transportation's 1998 survey, there were eight "scour critical" bridges as follows:

- Bridge 101530-scour critical
- Bridge 101610-moderate risk
- Bridge 101700-scour critical
- Bridge 102220-moderate risk
- Bridge 102291-scour critical
- Bridge 103791-high risk
- Bridge 104930-scour critical
- Bridge 105010-scour critical

Figure 3.15 provides the locations of the "scour critical" bridges.

Figure 3.15. Scour Critical Bridges in Cedar County



Source: Iowa Department of Transportation via the Cedar County Engineer; scour critical bridges are identified by green circle

The water can also cause erosion undermining road beds. In some instances, steep slopes that are saturated with water may cause mud or rock slides onto roadways. These damages can cause costly repairs for state, county, and city road/bridge maintenance departments. When sewer back-up occurs, this can result in costly clean-up for home and business owners as well as present a health hazard.

Based on loss estimates reported by NCDC, property losses averaged $23,611 per year over the 18-year period from 1996 to 2013.

Future Development

In planning future development, jurisdictions in the planning area should avoid development in low-lying areas near rivers and streams or where interior drainage systems are not adequate to provide drainage during heavy rainfall events. Future development should also take into consideration the impact of additional impervious surfaces to water run-off and drainage capabilities during heavy rainfall events.

Flash Flood Hazard Summary by Jurisdiction

For the jurisdictions indicated in previous flash flood events reported to NCDC, or mentioned in the episode narrative, the magnitude was determined to be "limited" (2) and the probability "highly likely" (4). For the remaining jurisdictions, the probability was determined to be "occasional" (2) and the magnitude was determined to be "negligible" (1) due to the small number of reported flash flooding events or no flash flooding events reported for these areas. For the school districts, the levels of the cities were applied.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Cedar County	4	2	2	1	2.8	Moderate
City of Bennett	2	1	2	1	1.6	Low
City of Clarence	2	1	2	1	1.6	Low
City of Durant	2	1	2	1	1.6	Low
City of Lowden	4	2	2	1	2.8	Moderate
City of Mechanicsville	4	2	2	1	2.8	Moderate
City of Stanwood	4	2	2	1	2.8	Moderate
City of Tipton	4	2	2	1	2.8	Moderate
City of West Branch	2	1	2	1	1.6	Low
Bennett School District, #603	2	1	2	1	1.6	Low
Durant School District, #1926	2	1	2	1	1.6	Low
North Cedar School District, #3691	4	2	2	1	2.8	Moderate
Tipton School District #6408	4	2	2	1	2.8	Moderate
West Branch School District #6930	2	1	2	1	1.6	Low

3.5.7 Grass or Wildland Fire

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
4	1	1	1	2.35	Moderate

Profile

Hazard Description

Iowa's urban/rural interface (areas where development occurs within or immediately adjacent to wildland, near fire-prone trees, brush, and/or other vegetation), is growing as metro areas expand into natural forest, prairies and agricultural areas that are in permanent vegetative cover through the Conservation Reserve Program (CRP). The State has the largest number of CRP contracts in the nation, totaling over 1.5 million acres. Most of this land is planted in cool and warm season grass plantings, tree plantings and riparian buffer strips. There is an additional 230,000 acres in federal ownership and conservation easements.

Wildfires are frequently associated with lightning and drought conditions, as dry conditions make vegetation more flammable. As new development encroaches into the wildland/urban interface more and more structures and people are at risk. On occasion, ranchers and farmers intentionally set fire to vegetation to restore soil nutrients or alter the existing vegetation growth. Also, individuals in rural areas frequently burn trash, leaves and other vegetation debris. These fires have the potential to get out of control and turn into wildfires.

The risk of wildfires is a real threat to landowners across the State. The National Weather Service monitors the conditions supportive of wildfires in the State on a daily basis so that wildfires can be predicted, if not prevented.

The risk factors considered are:

- High temperature
- High wind speed
- Fuel moisture (greenness of vegetation)
- Low humidity
- Little or no cloud cover

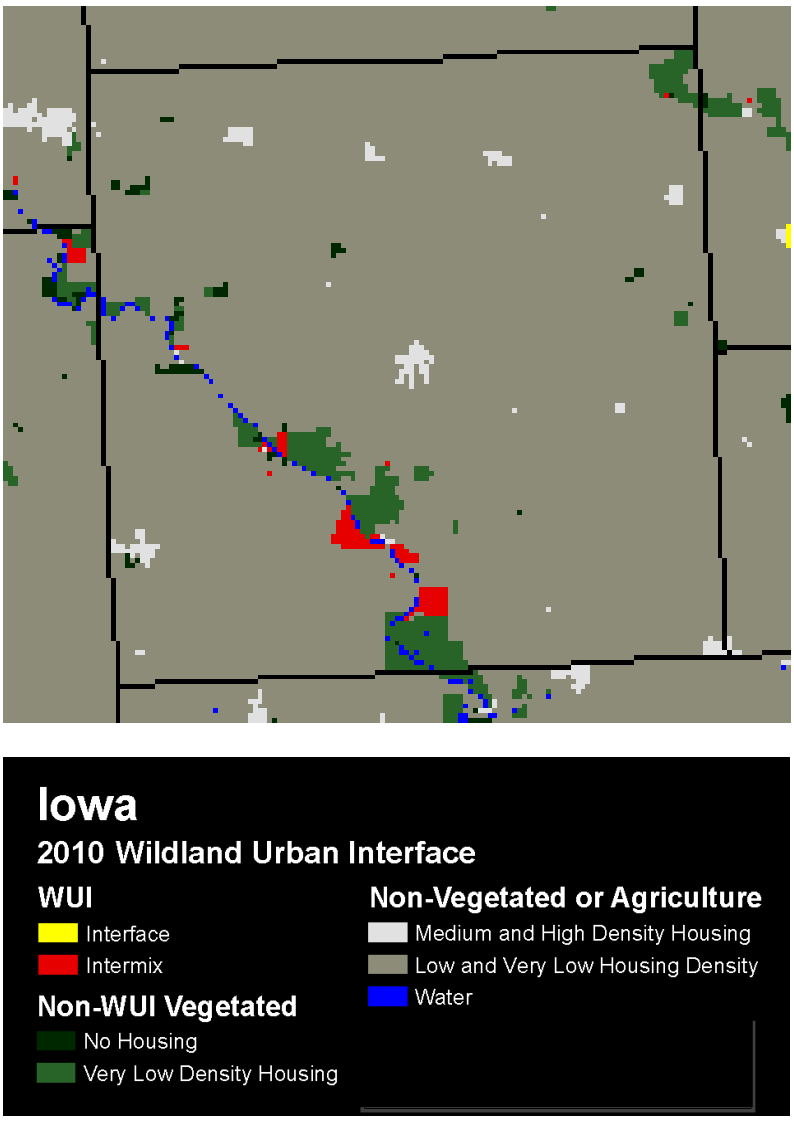
Warning Time Score: 1—More than 24 hours warning time. Although individual wildland/grass fires can ignite with very little warning, the warning time for the hazard condition is generally more than 24 hours.

Duration Score: 1—Less than 6 hours

Geographic Location/Extent

Wildland/Grass fires are most likely to occur in the Wildland Urban Interface (WUI). This is the area where houses meet or intermingle with undeveloped wildland vegetation. Within the WUI, there are two specific areas identified: 1) Interface and 2) Intermix. The interface areas are those areas that abut wildland vegetation and the Intermix areas are those areas that intermingle with wildland areas. As can be seen in **Figure 3.16**, Cedar County has very few areas of WUI Intermix and no WUI Interface areas. All of the Intermix areas are along the Cedar River.

Figure 3.16. Cedar County Wildland Urban Interface, 2010



Source: SILVIS Lab, Department of Forest Ecology and management, University of Wisconsin-Madison; WUI 2010, http://silvis.forest.wisc.edu/maps/wui/state10, accessed 4/2/2014

In addition, members of the planning committee discussed vulnerability of the Herbert Hoover Presidential Library and Museum in the City of West Branch due to new wildland areas adjacent to the facility.

Previous Occurrences

Data was obtained from the Iowa Department of Public Safety, State Fire Marshal Division to provide information on previous occurrences of grass/wildland fires in the planning area. Through the National Fire Incident Reporting System (NFIRS), the Iowa State Fire Marshal's Office collects and reports fire incidents throughout the State. NFIRS is a repository of statistical data reported by participating fire departments. Although this is the best available statistical data for grass and wildland fires, there are some data limitations.

- Not all fire departments report all fires to NFIRS;
- Fires outside Cedar County may be included in the data if a Cedar County-based Fire Department responded to the fire; and
- Fires inside Cedar County may not be included in the data if a Fire Department based outside Cedar County responded to the fire.

To report previous events of grass or wildland fires in the planning area, statistics were gathered from Fire Departments based in Cedar County for 2010-April 2014 for six categories: 1) Natural Vegetation Fires, 2) Forest, Woods or Wildland Fire, 3) Brush or Brush and Grass Mixture Fires, 4) Grass Fires, 5), cultivated grain or crop fire, and 6) cultivated vegetation, crop fire. **Table 3.34** provides the details of the number of fires in each of these categories by year and fire department. The first column provides the number of total reports received for each year. This column demonstrates that some fire departments do not report to the system. Therefore, there are likely additional fires that occur, but are not reported.

During this 4.25-year period, the total number of reported wildland/grass fires was 179 for an annual average of 42 fires. The data included associated property and contents losses, where available.

Table 3.34. Cedar County Grass and Wildland Fires Reported to the Iowa Fire Marshal Division Office 2010-2014

Fire Department	Total Fire Reports Received	Natural Vegetation Fire	Brush or Brush-and-Grass Mixture Fires	Forest, Woods, or Wildland Fire	Grass Fires	cultivated grain or crop fire	cultivated vegetation, crop fire	Total All Categories of Wildland/Grass Fires
2014—as of 4/22/2014								
Bennett Fire Department	0	0	0	0	0	0	0	0
Clarence Fire Department	0	0	0	0	0	0	0	0
Durant Fire Department	0	0	0	0	0	0	0	0
Lowden Fire Department	0	0	0	0	0	0	0	0
Mechanicsville Fire Department	26	0	3	0	4	1	0	8
Stanwood Fire Department	0	0	0	0	0	0	0	0
Tipton Fire Department	27	0	0	0	9	0	0	9
West Branch Fire Department	30	1	0	0	11	0	0	12
Total-2014 as of 4/22	**83**	**1**	**3**	**0**	**24**	**1**	**0**	**29**
2013								
Bennett Fire Department	31	0	0	0	4	0	1	5
Clarence Fire Department	23	0	0	0	0	0	0	0
Durant Fire Department	0	0	0	0	0	0	0	0
Lowden Fire Department	24	0	0	0	0	0	0	0
Mechanicsville Fire Department	48	1	1	0	2	3	1	8
Stanwood Fire Department	0	0	0	0	0	0	0	0
Tipton Fire Department	88	0	1	0	4	0	1	6
West Branch Fire Department	86	1	0	1	15	0	1	18
Total-2013	**300**	**2**	**2**	**1**	**25**	**3**	**4**	**37**
2012								
Bennett Fire Department	21	0	0	0	2	0	1	3
Clarence Fire Department	18	0	0	0	1	0	2	3
Durant Fire Department	0	0	0	0	0	0	0	0
Lowden Fire Department	3	0	0	0	0	0	0	0
Mechanicsville Fire Department	91	5	8	0	6	2	1	27
Stanwood Fire Department	9	0	0	0	0	0	0	0
Tipton Fire Department	74	0	0	0	6	1	1	8
West Branch Fire Department	114	1	1	0	28	0	0	30
Total-2012	**330**	**6**	**9**	**0**	**43**	**3**	**5**	**66**
2011								
Bennett Fire Department	0	0	0	0	0	0	0	0
Clarence Fire Department	26	0	0	0	2	0	0	2
Durant Fire Department	0	0	0	0	0	0	0	0
Lowden Fire Department	26	0	1	0	0	0	0	1

Fire Department	Total Fire Reports Received	Natural Vegetation Fire	Brush or Brush-and-Grass Mixture Fires	Forest, Woods, or Wildland Fire	Grass Fires	cultivated grain or crop fire	cultivated vegetation, crop fire	Total All Categories of Wildland/Grass Fires
Mechanicsville Fire Department	0	0	0	0	0	0	0	0
Stanwood Fire Department	4	0	0	0	0	0	0	0
Tipton Fire Department	77	1	2	3	6	1	0	13
West Branch Fire Department	94	0	1	0	9	0	1	11
Total-2011	**227**	**1**	**4**	**3**	**17**	**1**	**1**	**27**
2010								
Bennett Fire Department	0	0	0	0	0	0	0	0
Clarence Fire Department	0	0	0	0	0	0	0	0
Durant Fire Department	0	0	0	0	0	0	0	0
Lowden Fire Department	28	0	0	0	1	1	0	2
Mechanicsville Fire Department	0	0	0	0	0	0	0	0
Stanwood Fire Department	2	0	0	0	0	0	0	0
Tipton Fire Department	52	3	0	0	2	0	1	6
West Branch Fire Department	96	0	2	1	6	2	1	12
Total-2010	**178**	**3**	**2**	**1**	**9**	**3**	**2**	**20**
Total 2010-4/22/2014	**1,118**	**13**	**20**	**5**	**118**	**11**	**12**	**179**

Source: Iowa Department of Public Safety, State Fire Marshal Division, April 2014

Probability of Future Occurrence

Available data documents at least 42 wildland/grass fires per year in the planning area. It is anticipated that similar occurrences will continue in the future.

Probability Score: 4—Highly Likely

Vulnerability

Overview

Most wildland-type fires that have occurred in the planning area are smaller scale grass/brush fires. The fire departments in the County are equipped to handle this type of smaller-scale wildland fire. As such, these smaller-scale brush/grass fires are well within the existing firefighting capabilities and are generally extinguished before much damage occurs. Areas that are most vulnerable to wildfire are agricultural areas where land is burned, rural areas where trash and debris are burned, and the wildland-urban interface areas.

To demonstrate how vulnerability to this hazard varies by jurisdiction, the 2010 spatial data indicating acreage of Wildland Urban Interface/Intermix areas from the SILVIS Lab, Department of Forest Ecology and Management, University of Wisconsin-Madison was compared against the corporate boundary layer for the planning area. **Table 3.35** provides the results of this analysis.

Table 3.35. Wildland Urban Intermix/Interface Acreage by Jurisdiction

Jurisdiction	Intermix (Acreage)	Interface (Acreage)
Unincorporated Cedar County	2,679	0
City of Bennett	0	0
City of Clarence	0	0
City of Durant	0	0
City of Lowden	0	0
City of Mechanicsville	3	0
City of Stanwood	0	0
City of Tipton	0	0
City of West Branch	0	0
City of Wilton	0	0
Total	**2,682**	**0**

Source: SILVIS Lab, Department of Forest Ecology and management, University of Wisconsin-Madison; Corporate Boundary layer from the Cedar County GIS Department.

As shown in the table above, nearly all of the Wildland Urban Intermix areas are in the unincorporated portions of Cedar County. These areas are comprised of the tree line and brushy areas that border the Cedar River. There is also a small 3-acre are of WUI intermix in the City of Mechanicsville. There are no WUI interface areas in the planning area.

These WUI intermix areas are the primary locations where larger wildfires might occur. As evidenced by previous wildland-type fires in the planning area, they have historically been the smaller brush/grass fires that can occur anywhere that has open grassy areas. As the previous

events show, the number of wildland-type fires increases during periods of severe drought. 2012 was one of the worst years of drought in recent history in the planning area.

Potential Losses to Existing Development

Wildfires can be responsible for extensive damage to crops, the environment and occasionally residential or business facilities. Homes built in rural areas are more vulnerable since they are in closer proximity to land that is burned and homeowners are more likely to burn trash and debris in rural locations. The vulnerability of structures in rural areas is exacerbated due to the lack of hydrants in these areas for firefighting and the distance required for firefighting vehicles and personnel to travel to respond. Potential losses to crops and rangeland are additional concerns.

Utilizing the data available from the Fire Marshal Division as summarized in **Table 3.34**, there was an annual average of 42 grass and wildland fires, causing an annual average of $71,329 in property damages during the 4.25-year period. Note: only reporting fire departments are listed.

Table 3.36. Summary of Grass and Wildland Fire Property and Contents Losses (2010-4/22/2014)

Responding Fire Department	# of Incidents	Property Loss	Content Loss	Total Losses
2014 Grass and Wildland Fires Reported				
Mechanicsville Fire Department	8	$0	$0	$0
Tipton Fire Department	9	$0	$0	$0
West Branch Fire Department	12	$0	$3,500	$3,500
Total-2014 as of 4/22	**29**	$0	**$3,500**	**$3,500**
2013 Grass and Wildland Fires Reported				
Bennett Fire Department	5	$5,000	$0	$5,000
Mechanicsville Fire Department	8	$0	$0	$0
Tipton Fire Department	6	$50	$11,000	$11,050
West Branch Fire Department	18	$0	$0	$0
Total-2013	**37**	**$5,050**	**$11,000**	**$16,050**
2012 Grass and Wildland Fires Reported				
Bennett Fire Department	3	$0	$0	$0
Clarence Fire Department	3	$0	$1,400	$1,400
Mechanicsville Fire Department	27	$0	$0	$0
Tipton Fire Department	8	$0	$0	$0
West Branch Fire Department	30	$276,000	$5,000	$281,000
Total-2012	**66**	**$276,000**	**$6,400**	**$282,400**
2011 Grass and Wildland Fires Reported				
Clarence Fire Department	2	$0	$0	$0
Lowden Fire Department	1	$0	$0	$0
Tipton Fire Department	13	$1,200	$0	$1,200
West Branch Fire Department	11	$0	$0	$0
Total-2011	**27**	**$1,200**	**$0**	**$1,200**
2010 Grass and Wildland Fires Reported				
Lowden Fire Department	2	$0	$0	$0
Tipton Fire Department	6	$0	$0	$0
West Branch Fire Department	12	$0	$0	$0
Total-2011	**20**	**$0**	**$0**	**$0**
Total-2010 to 4/22/2014	**179**	**$0**	**$0**	**$303,150**

Magnitude Score: 1—Negligible

Future Development

Future development in the wildland-urban interface/intermix areas would increase vulnerability to this hazard.

Grass or Wildland Fires Hazard Summary by Jurisdiction

The unincorporated portions of Cedar County are more vulnerable to the larger wildland/grass fires as a result of the WUI intermix areas along the Cedar River. Therefore the magnitude for the unincorporated portions of the County was determined to be a 2. Additionally due to the new wildland areas adjacent to the Herbert Hoover Presidential Library and Museum, the magnitude for the City of West Branch was also determined to be a 2. Although the magnitude would not be as great, numerous small-scale grass/brush fires have occurred in the other incorporated areas as well. There is less potential for wildland/grass fires to impacting schools due to general locations away from Wildland Urban Interface/Intermix Areas. If a wildland/grass fire were to occur near school buildings, the magnitude would be lower due to close proximity to firefighting services.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Cedar County	4	2	1	1	2.65	Moderate
City of Bennett	4	1	1	1	2.35	Moderate
City of Clarence	4	1	1	1	2.35	Moderate
City of Durant	4	1	1	1	2.35	Moderate
City of Lowden	4	1	1	1	2.35	Moderate
City of Mechanicsville	4	1	1	1	2.35	Moderate
City of Stanwood	4	1	1	1	2.35	Moderate
City of Tipton	4	1	1	1	2.35	Moderate
City of West Branch	4	2	1	1	2.65	Moderate
Bennett School District, #603	1	1	1	1	1.00	Low
Durant School District, #1926	1	1	1	1	1.00	Low
North Cedar School District, #3691	1	1	1	1	1.00	Low
Tipton School District #6408	1	1	1	1	1.00	Low
West Branch School District #6930	1	1	1	1	1.00	Low

3.5.8 Hazardous Materials Incident

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
4	2	4	1	3.10	High

Profile

Hazard Description

A hazardous substance is one that may cause damage to persons, property, or the environment when released to soil, water, or air. Chemicals are manufactured and used in increasing types and quantities. Each year over 1,000 new synthetic chemicals are introduced and as many as 500,000 products pose physical or health hazards and can be defined as "hazardous chemicals". Hazardous substances are categorized as toxic, corrosive, flammable, irritant, or explosive. Hazardous material incidents generally affect a localized area.

Fixed Hazardous Materials Incident

A fixed hazardous materials incident is the accidental release of chemical substances or mixtures during production or handling at a fixed facility.

Transportation Hazardous Materials Incident

A transportation hazardous materials incident is the accidental release of chemical substances or mixtures during transport. Transportation Hazardous Materials Incidents in Cedar County can occur during rail transport or highway transport. Accidents involving rail shipments of hazardous materials typically fall into four general categories: track deterioration, equipment failures, human error, and other causes. Highway accidents involving hazardous materials pose a great potential for public exposures. Both nearby populations and motorists can be impacted and become exposed by accidents and releases. Generally speaking, the volume of hazardous materials transported is greater in rail transport than highway transport due to the higher capacity in rail cars.

Pipeline Incident

A pipeline transportation incident occurs when a break in a pipeline creates the potential for an explosion or leak of a dangerous substance (oil, gas, etc.) possibly requiring evacuation. An underground pipeline incident can be caused by environmental disruption, accidental damage, or sabotage. Incidents can range from a small, slow leak to a large rupture where an explosion is possible. Inspection and maintenance of the pipeline system along with marked gas line locations and an early warning and response procedure can lessen the risk to those near the pipelines.

Warning Time Score: 4—Less than six hours warning time

Duration Score: 1—Less than 6 hours

Geographic Location/Extent

This section provides geographic locations within Cedar County impacted by each type of potential hazardous materials incident.

Fixed Hazardous Materials Incident

According to the Iowa Department of Natural Resources, as of 2014, there were 29 sites in Cedar County that because of the volume or toxicity of the materials on site were designated as Tier II Facilities under the Superfund Amendments and Reauthorization Act. Of these 29 facilities, 14 reported materials on site that are considered to be "Extremely Hazardous Substances" (EHS).

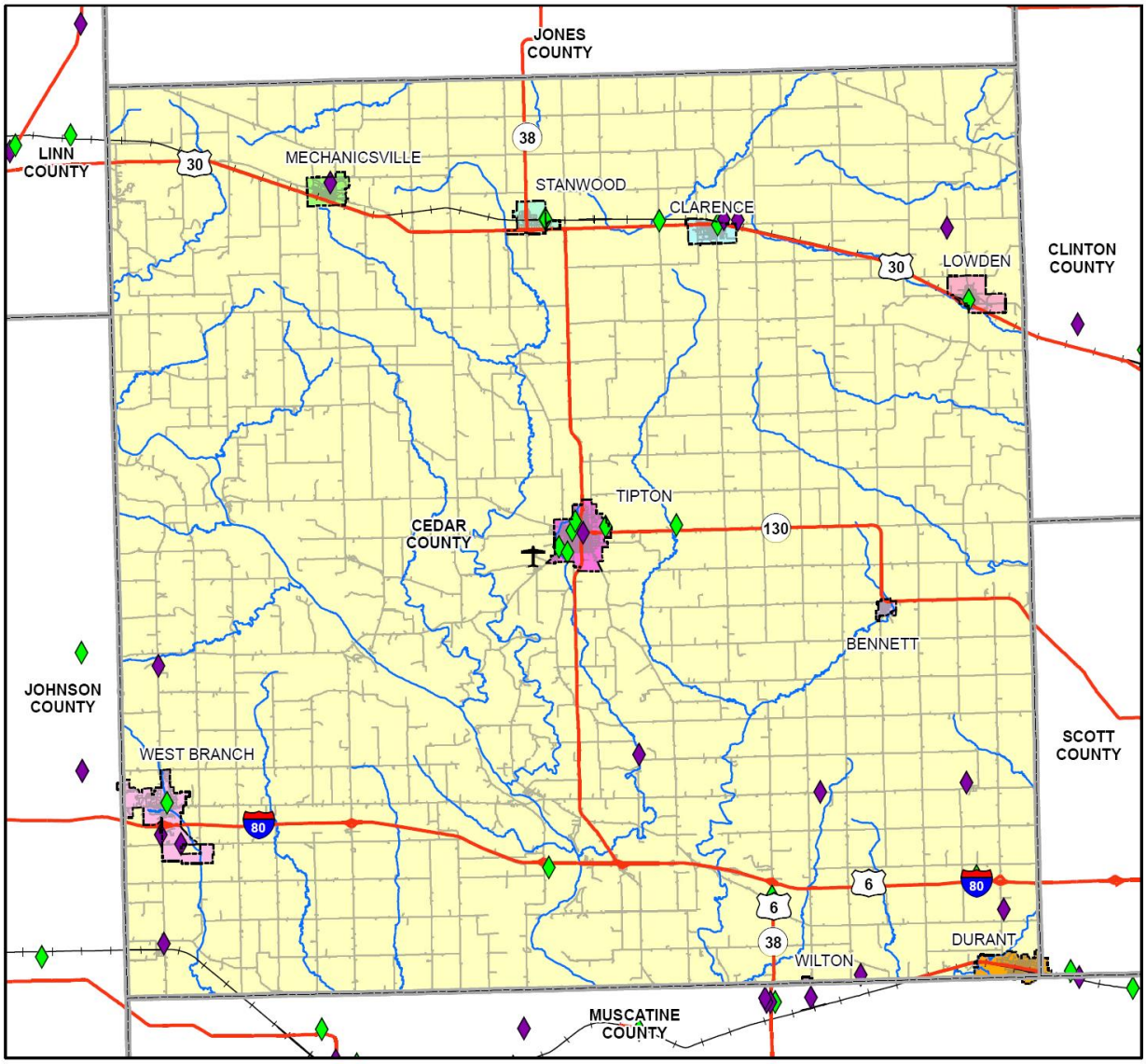
Table 3.37 provides the number of Tier II Facilities, as well as the number with EHS for each jurisdiction in the planning area. The locations of the facilities were overlaid with the corporate boundaries provided by the Cedar County GIS Department to determine the number of facilities in each jurisdiction. **Figure 3.17** that follows is a map showing the locations of Tier II Facilities, including those with EHS.

Table 3.37. Number of Tier II Facilities and EHS Facilities by Jurisdiction

Jurisdiction	Tier II Facilities	EHS Facilities
Unincorporated Cedar County	17	11
City of Bennett	0	0
City of Clarence	1	0
City of Durant	0	0
City of Lowden	1	0
City of Mechanicsville	1	1
City of Stanwood	1	0
City of Tipton	6	1
City of West Branch	2	1
City of Wilton	0	0
Total	29	14

Source: Iowa Department of Natural Resources; Cedar County GIS Department

Figure 3.17. Tier II Facilities in Cedar County



Transportation Hazardous Materials Incident

The transport of hazardous materials in Cedar County occurs via trucks on the highways/roads, trains on the railroads in the county, as well as via airplanes. A Commodity Flow Study, including Cedar County in the study area was under development at the time of this plan update. This study is targeted for completion by December 2015. After completion of the study, a gap analysis will be completed indentifying shortfalls in resources in identified high vulnerability areas. The county has a goal to obtain identified resources by December 2018. Information regarding identified vulnerable areas for transportation hazardous materials incidents identified in the Commodity Flow Study will be added to the next hazard mitigation plan update.

Truck Transport

Hazardous materials can be transported on any of the roads in Cedar County. I-80, a federal interstate crosses east/west over the southern portion of the County and is the main conduit for hazardous materials that are transported through the County. U.S. Highway 30 crosses east/west over the northern portion of the County and Iowa State Highway 38 bisects the County from north to south. These highways are also main arteries for transport of materials through the County. Iowa Highway 130 runs east/west from Tipton into Scott County, making it a route for materials originating or terminating in Tipton.

Agriculture is important to the economy of Cedar County and 90 percent of the land in the County is designated as agricultural use. As a result, chemicals utilized in agriculture are frequently transported along county and local roadways.

Rail Transport

Railroads pass through the following jurisdictions in the planning area:

- Unincorporated Cedar County
- City of Clarence
- City of Durant
- City of Lowden
- City of Mechanicsville
- City of Stanwood

Since rail cars generally have larger capacity to transport goods, a rail car hazardous materials incident can be much more devastating.

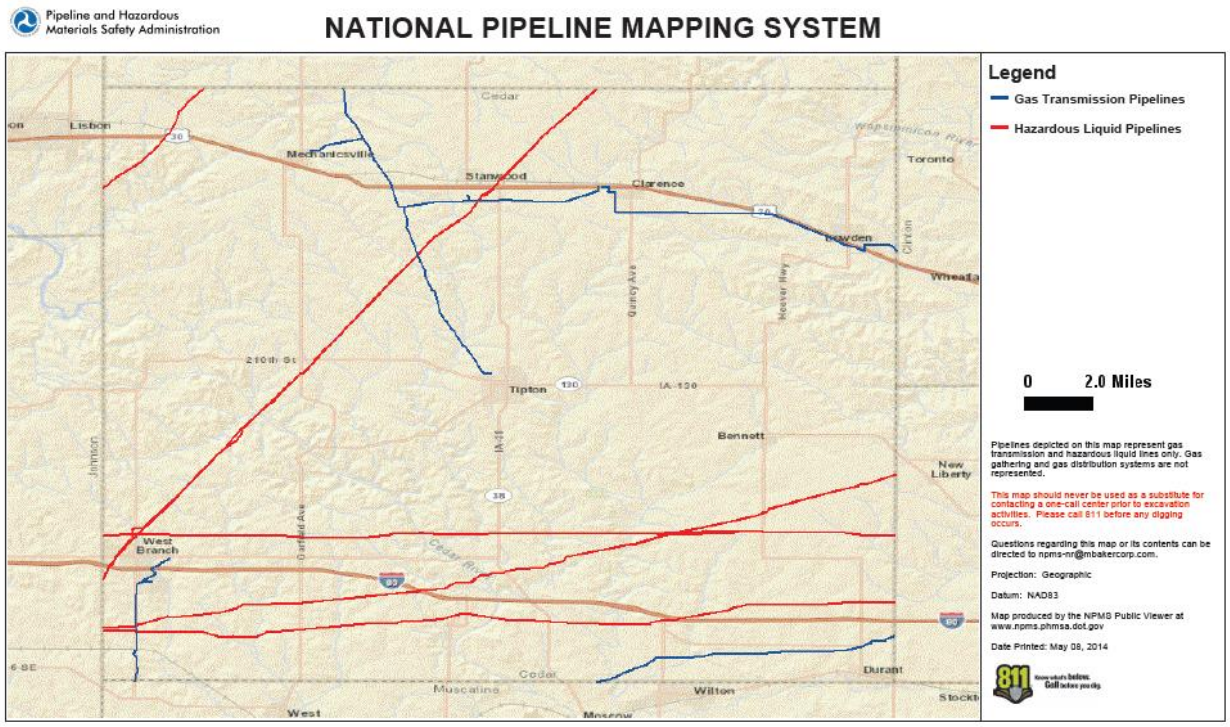
Air Freight

There is one public airport in Cedar County just west of the city of Tipton, the Mathews Memorial Airport. The primary risk of air-related hazardous materials incidents is related to crop-dusting. Crop dusters carry insecticides, fertilizer, fungicides and herbicides to spray on crops. A crash or other incident involving one of these plans could also be hazardous.

Pipeline Incident

Figure 3.18 provides the locations of pipelines in Cedar County. The data for this map consists of gas transmission pipelines and hazardous liquid trunklines. It does not contain gathering or distribution pipelines, such as lines which deliver gas to a customer's home. Therefore, not all pipelines in the County will be visible.

Figure 3.18. Pipelines in Cedar County



Source: Pipeline and Hazardous Materials Safety Administration, National Pipeline Mapping System, https://www.npms.phmsa.dot.gov/PublicViewer/ retrieved on 5/8/2014

Previous Occurrences

In Iowa, hazardous materials spills are reported to the Department of Natural Resources. According to Iowa Administrative Code Chapter 131, *Notification of Hazardous Conditions*, any person manufacturing, storing, handling, transporting, or disposing of a hazardous substance must notify the Department of Natural Resources and the local police department or the office of the sheriff of the affected county of the occurrence of a hazardous condition as soon as possible but not later than six hours after the onset of the hazardous condition or the discovery of the hazardous condition. The Department of Natural Resources maintains a database of reported spills.

According to the DNR database, from May 2005 to May 2014 (10 years), there have been 75 hazardous materials spills reported in Cedar County. Of the 75 spills, 21 were air releases, 3 affected ground water, 51 were on land, and 4 affected surface water. Please note: some spills had multiple mediums of release. **Table 3.38** provides a summary of the reported spills during this time period for each jurisdiction indicated in the database.

Table 3.38. Cedar County Hazardous Materials Spills Reported to Iowa DNR, May 2005-May 2014

Location	Reported Spills
Unincorporated County	2
Bennett	9
Clarence	2
Durant	6
Lowden	3
Mechanicsville	3
Stanwood	6
Tipton	16
West Branch	20
Wilton	8
Total	**75**

Source: Iowa Department of Natural Resources, http://www.iowadnr.gov/InsideDNR/RegulatoryLand/EmergencyPlanningEPCRA/SpillReporting.aspx, retrieved 4/22/2014

Another source consulted to report previous Hazardous Materials Incidents is the Environmental Protection Agency's Toxics Release Inventory (TRI). This inventory tracks the management of over 650 toxic chemicals that pose a threat to human health and the environment. U.S. facilities in certain industry sectors that manufacture, process, or otherwise use these chemicals in amounts above established levels must report how each chemical is managed through recycling, energy recovery, treatment, and releases to the environment. A "release" of a chemical means that it is emitted to the air or water, or placed in some type of land disposal. The information submitted by facilities to the EPA and states is compiled annually as the Toxics Release Inventory or TRI, and is stored in a publicly accessible database in Envirofacts.

TRI data are available for all facilities that have submitted a Form R or Form A to EPA since the program began in 1987. TRI facilities are legally required to report to EPA by July 1st of each year**. Table 3.39** provides the TRI on-site and off-site reported disposed of or otherwise released report for industries in Cedar County that have TRI reporting requirements for 2008-2012.

Table 3.39. TRI On-site and Off-site Reported Disposed of or Otherwise Released (in pounds), for All Industries, for All Chemicals, Cedar County, Iowa, 2008-2012

Chemical	Total On-site Disposal or Other Releases	Total Off-site Disposal or Other Releases	Total On- and Off-site Disposal or Other Releases
2012			
Ammonia	18,900	.	18,900
Copper Compounds	.	.	.
Dimethyl Phthalate	.	.	.
Manganese Compounds	.	.	.
Styrene	137,360	.	137,360
Zinc Compounds	18	.	18
2011			
Ammonia	20,175	.	20,175
Copper Compounds	.	.	.
Manganese Compounds	.	.	.
Styrene	119,160	.	119,160
Zinc Compounds	0	.	0
2010			
Ammonia	17,100	.	17,100
Copper Compounds	.	.	.
Manganese Compounds	.	.	.
Styrene	95,080	.	95,080
Zinc Compounds	0	.	0
2009			
Ammonia	16,255	.	16,255
Copper Compounds	.	.	.
Manganese Compounds	.	.	.
Styrene	93,936	.	93,936
Zinc Compounds	0	.	
2008			
Ammonia	11,805	.	11,805
Copper Compounds	.	.	.
Manganese Compounds	.	.	.
Styrene	147,780	.	147,780
Zinc Compounds	0	.	0

Source: Environmental Protection Agency Toxics Release Inventory (TRI), http://iaspub.epa.gov/triexplorer/tri_release.chemical, retrieved 5/8/2014

TRI data reflect releases and other waste management activities of chemicals, not whether (or to what degree) the public has been exposed to those chemicals. Release estimates alone are not sufficient to determine exposure or to calculate potential adverse effects on human health and the environment. TRI data, in conjunction with other information, can be used as a starting point in evaluating exposures that may result from releases and other waste management activities which involve toxic chemicals. The determination of potential risk depends upon many factors, including the toxicity of the chemical, the fate of the chemical, and the amount and duration of human or other exposure to the chemical after it is released.

Pipelines

The U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration maintains a database of pipeline incidents and mileage reports. According to the "Significant Incidents Listing", there have been no significant pipeline incidents in Cedar County from 2003-May 2014.

Probability of Future Occurrence

Based on the annual average of 7.5 spills per year reported to Iowa DNR since May 2005 (75 reported from May 2005 to May 2014-10 years), the probability of future occurrence of hazardous materials incidents is determined to be "Highly Likely".

Probability Score: 4—Highly Likely

Vulnerability

Vulnerability Overview

A hazardous materials incident can occur almost anywhere. So, all jurisdictions are considered to have at least some vulnerability to this hazard. People, pets, livestock, and vegetation in close proximity to facilities producing, storing, or transporting hazardous substances are at higher risk. Populations downstream, downwind, and downhill of a released substance are particularly vulnerable. Depending on the characteristics of the substance released, more people, in a larger area may be in danger from explosion, absorption, injection, ingestion, or inhalation.

Most of the hazardous materials incidents are localized and are quickly contained or stabilized. Depending on the characteristic of the hazardous material or the volume of product involved, the affected area can be as small as a room in a building or as large as 5 square miles or more. Many times, additional regions outside the immediately affected area are evacuated for precautionary reasons. More widespread effects occur when the product contaminates the municipal water supply or water system such as river, lake, or aquifer. The previous hazardous materials incidents in the planning area have been generally localized and quickly contained or stabilized. However, spills are costly to clean up due to the specialized equipment and training, and disposal sites that are necessary. With these factors in mind, magnitude was determined to be "limited". It is noted that it is possible for a larger scale event to occur in the planning area, especially due to the major highways that traverse the County.

Magnitude Score: 2—Limited

Potential Losses to Existing Development

The impact of this type of disaster will likely be localized to the immediate area surrounding the incident. The initial concern will be for people, then the environment. If contamination occurs, the spiller is responsible for the cleanup actions and will work closely with responders in the local jurisdiction, the Iowa Department of Natural Resources, and the Environmental Protection Agency to ensure that cleanup is done safely and in accordance with federal and state laws.

As mentioned, it is difficult to determine the potential losses to existing development because of the variable nature of a hazardous materials spill. For example, a spill of a toxic airborne

chemical in a populated area could have greater potential for loss of life. By contrast a spill of a very small amount of a chemical in a remote rural area would be much less costly and possibly limited to remediation of soil.

According to the Pipelines and Hazardous Materials Safety Administration in the Department of Transportation, the overall average per-gallon response cost for crude oil, gasoline, and other fuels is $1,270 per gallon. To determine the potential cost for future hazardous materials spills in Cedar County, the average number of gallons spilled in incidents with a material type indicated as "petroleum" was calculated. From May 2005 to May 2014, there were 32 incidents that involved "petroleum" material with a total 947 spilled for an average of 29.6 gallons per spill. At $1,270 per gallon, this translates to a cleanup cost of $37,592 per spill. During the 10 year reporting period, there was a total of 947 gallons of petroleum type hazardous materials spilled for a total estimated cleanup cost of $1,202,690 for the entire 10-year period and an average annual cost of $120,269.

To analyze critical facilities at risk in the planning area, the planning committee compiled an inventory of 184 critical and essential facilities and infrastructure in the planning area. A comparison was made with the locations of Tier II Facilities to determine those critical/essential facilities that are within ½ mile of Tier II fixed chemical facilities. This analysis revealed 80 critical or essential facilities within ½ mile of fixed chemical facilities with the Tier II reporting requirement. Appendix E contains the results of analysis. This Appendix is "For Official Use Only". To obtain access for official use, contact the Cedar County Emergency Manager.

Future Development

Interstate 80 is one of the United States' most important freight corridors for east/west movements. This Interstate is projected to experience substantial growth in freight traffic over the coming years. Interstate 80 is perhaps one of the most significant roadways in the United States connecting many major cities including New York, Cleveland, Chicago, Salt Lake City and San Francisco.

The number and types of hazardous chemicals stored and transported through Cedar County will likely continue to increase. As populations grow, this also increases the number of people vulnerable to the impacts of hazardous materials spills. Population and business growth along major transportation corridors increases the vulnerability to transportation hazardous materials spills.

Hazardous Materials Hazard Summary by Jurisdiction

Transportation Hazardous Materials Incidents can, and have, occurred in all cities and the unincorporated county. Therefore all are considered to have some probability for transportation hazardous materials incidents. All cities with the exception of Bennett have pipelines near them. Fixed facility incidents at Tier II facilities are limited to those jurisdictions that have these facilities. Of the cities in the planning area, Bennett, Durant, and Wilton (Cedar County portion) do not have any Tier II Facilities. Since all jurisdictions have exposure through at least one source for potential hazardous materials incidents and since records indicate spills have occurred in all cities and the unincorporated county, the probability for all was determined to be 4, Highly Likely. For the schools, the probability was determined to be 1. The magnitude was determined to be slightly variable based on the presence of major highways, railroads, fixed facilities, and pipelines. If 3 or more are present, the magnitude was determined to be 2-limited, if 2 or fewer were present, the magnitude was determined to be 1-negligible. The magnitude for the School Districts was determined to be 1 for those with no buildings in the ½ mile buffer zone of Tier II Facilities. If a building is in the ½ mile buffer zone, the magnitude was determined to be a 2.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Cedar County	4	2	4	1	3.10	High
City of Bennett	4	1	4	1	2.80	Moderate
City of Clarence	4	2	4	1	3.10	High
City of Durant	4	2	4	1	3.10	High
City of Lowden	4	2	4	1	3.10	High
City of Mechanicsville	4	2	4	1	3.10	High
City of Stanwood	4	2	4	1	3.10	High
City of Tipton	4	2	4	1	3.10	High
City of West Branch	4	2	4	1	3.10	High
Bennett School District, #603	1	1	4	1	1.45	Low
Durant School District, #1926	1	1	4	1	1.45	Low
North Cedar School District, #3691	1	1	4	1	1.45	Low
Tipton School District #6408	1	1	4	1	1.45	Low
West Branch School District #6930	1	1	4	1	1.45	Low

3.5.9 Radiological Incident

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
1	3	4	4	2.35	Moderate

Profile

Hazard Description

A radiological incident is an occurrence resulting in the release of radiological material at a fixed facility (such as power plants, hospitals, laboratories, etc) or in transit.

Radiological incidents related to transportation are described as an incident resulting in a release of radioactive material during transportation. Transportation of radioactive materials through Iowa over the interstate highway system is considered a radiological hazard. The transportation of radioactive material by any means of transport is licensed and regulated by the federal government. As a rule, there are two categories of radioactive materials that are shipped over the interstate highways:

1. Low level waste consists of 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 a wide array of other hazardous materials.
2. High level waste, usually in the form of spent fuel from nuclear power plants, is transported in specially constructed casks that are built to withstand a direct hit from a locomotive.

Warning Time Score: 4—less than six hours warning time

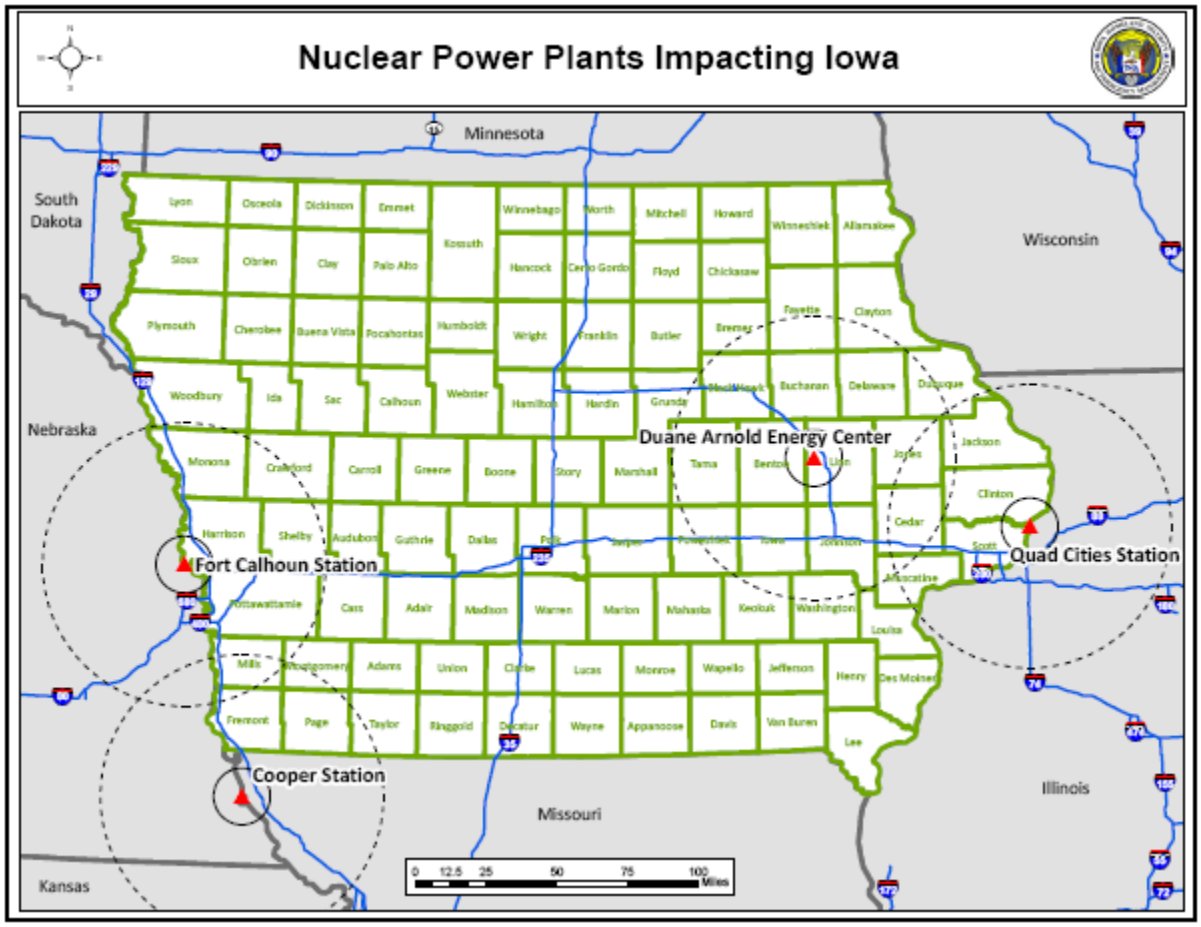
Duration Score: 4—More than 1 week

Geographic Location/Extent

Fixed Facilities

An incident resulting in a release of radiological material at a fixed facility is a fixed radiological incident. There is one nuclear power plant located within Iowa: the Duane Arnold Energy Center near Palo in Linn County. There are three additional nuclear facilities in adjacent states with planning buffer zones that cross into Iowa. Cedar County is in the 50-mile planning buffers of Duane Arnold Energy Center and Quad Cities Station in Illinois (see **Figure 3.19**).

Figure 3.19. Map of Nuclear Power Plants Impacting Iowa



Source: Iowa Homeland Security and Emergency Management

According to the Iowa Department of Public Health, there are no licensed radioactive material facilities in Cedar County. The Cedar County Health Department does not maintain any special radiological plans outside this plan and the County Emergency Operations Plan.

Transportation Radiological Incidents

There is potential for the transport of low-level radioactive waste in all jurisdictions within Cedar County. For high-level waste, Interstate 80 has been identified as a potential transportation route for nuclear waste material. In Cedar County, I-80 traverses the jurisdictions of: unincorporated Cedar County and West Branch.

Previous Occurrences

The U.S. Regulatory Commission has emergency classifications divided into four categories. Each level has a certain response requirement from the plant and government. The following are the emergency classifications from least to most severe:

- Unusual Event

- Alert
- Site Area Emergency
- General Emergency

Since 1990, the following emergency classifications have occurred for the two nuclear plants that Cedar County is in the 50-mile planning buffer.

- Duane Arnold Energy Center has had seven Unusual Events, one Alert, and no Site Area Emergencies or General Emergencies.
- Quad Cities Nuclear Power Plan has had 18 Unusual Events, seven Alerts, and no Site Area Emergencies or General Emergencies.

According to the Iowa State Hazard Mitigation Plan, 2013, there have been no occurrences of a radiological transportation incident in Iowa since 1990.

Probability of Future Occurrence
Based on the minor number of previous occurrences for this hazard and the relatively few locations within the county that house radioactive material, the probability of future occurrences of radiological incidents is “Unlikely”.

Probability Score: 1—Unlikely

Vulnerability

Vulnerability Overview
In general, danger to the public in the planning area is less than a wide array of other hazardous materials. Those working with or near sources of radiation are at a greater risk than the general citizens in the planning area. Those responding to a radiological incident should be trained in recognizing a radiological incident and minimize exposure to radioactive materials.

Other than a transportation incident involving large amounts of high-level radioactive materials, radiation exposure would be limited to localized areas.

Magnitude Score: 3—Critical

Potential Losses to Existing Development
Responding to the effects of a radiological incident in the planning area would be extensive and would require resources and assistance from several state and federal agencies to determine and evaluate the threat to life and the environment. Due to the variable nature of this hazard, it is not possible to quantify potential losses.

Future Development
Increased development near fixed facilities that house radioactive materials and along transportation corridors would increase the number of people vulnerable to this hazard in the planning area.

Radiological Incident Hazard Summary by Jurisdiction

The whole planning area is considered moderate risk for a radioactive incident since the whole county is within the 50-mile planning buffers of either the Duane Arnold Energy Center or Quad Cities Station.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Cedar County	1	3	4	4	2.35	Moderate
City of Bennett	1	3	4	4	2.35	Moderate
City of Clarence	1	3	4	4	2.35	Moderate
City of Durant	1	3	4	4	2.35	Moderate
City of Lowden	1	3	4	4	2.35	Moderate
City of Mechanicsville	1	3	4	4	2.35	Moderate
City of Stanwood	1	3	4	4	2.35	Moderate
City of Tipton	1	3	4	4	2.35	Moderate
City of West Branch	1	3	4	4	2.35	Moderate
Bennett School District, #603	1	3	4	4	2.35	Moderate
Durant School District, #1926	1	3	4	4	2.35	Moderate
North Cedar School District, #3691	1	3	4	4	2.35	Moderate
Tipton School District #6408	1	3	4	4	2.35	Moderate
West Branch School District #6930	1	3	4	4	2.35	Moderate

3.5.10 River Flooding

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
4	3	1	4	3.25	High

Profile

Hazard Description

Flooding has been a major problem for many of the communities in Cedar County. Many of the communities were settled and developed largely because of their proximity to water resources. A flood is partial or complete inundation of normally dry land areas. Heavy precipitation can cause flooding either in the region of precipitation or in areas downstream. Heavy accumulations of ice or snow can also cause flooding during the melting stage. These events are complicated by the freeze/thaw cycles characterized by moisture thawing during the day and freezing at night. There are two main types of flooding in the planning area: riverine flooding and flash flooding which includes ice jam flooding. Flash flooding is discussed separately in **Section 3.5.6.**

Riverine flooding is defined as the overflow of rivers, streams, drains, and lakes due to excessive rainfall, rapid snowmelt or ice melt. The areas adjacent to rivers and stream banks that carry excess floodwater during rapid runoff are called floodplains. A floodplain is defined as the lowland and relatively flat area adjoining a river or stream. The terms “base flood” and “100-year flood” refer to the area in the floodplain that is subject to a one percent or greater chance of flooding in any given year. Floodplains are part of a larger entity called a basin, which is defined as all the land drained by a river and its branches.

Flooding caused by dam failure is discussed in **Section 3.5.1**

Warning Time Score: 1—More than 24 hours warning time

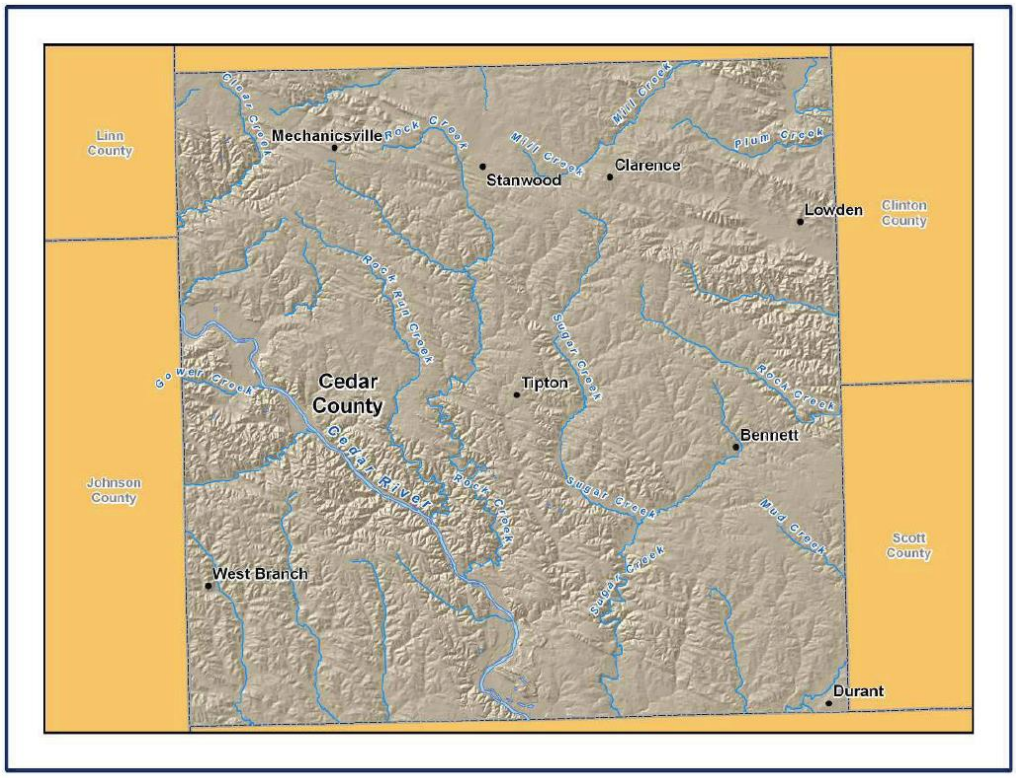
Duration Score: 4—More than 1 week

Geographic Location/Extent

Cedar County has two major rivers within its borders. The Cedar River enters along the west border with Johnson County. The river then flows in a southeast direction and exits on the southern border just north of the town of Moscow. The Cedar River makes an interesting 90 degree turn to the southwest after leaving Cedar County due to a particularly hard outcropping of limestone along the border with Muscatine County. The Wapsipinicon River enters Cedar County in the extreme northeast part of the county from Jones County. It flows through Cedar County for only a few miles before it enters Clinton County.

Cedar County has a gently rolling to steep upland terrain, deeply dissected in places by rivers and streams. The areas immediately north and south of the Cedar and Wapsipinicon Rivers are characterized by an intricate pattern of deep valleys and ravines that have steep slopes. Small streams extend into the uplands. The bottom lands along the Cedar and Wapsipinicon rivers are nearly level. Stream terraces along the rivers are nearly level to undulating. Upland hills rise 100 to 200 feet from the level of the floodplains. The northern one-fourth of Cedar County has a gently undulating topography that is called the Iowan Erosion Surface. A broad dissected plain that makes up the largest part of Cedar County separates the Cedar and Wapsipinicon Rivers. **Figure 3.20** below displays the river system and shaded topographic relief of Cedar County.

Figure 3.20. Cedar County Shaded Relief Map



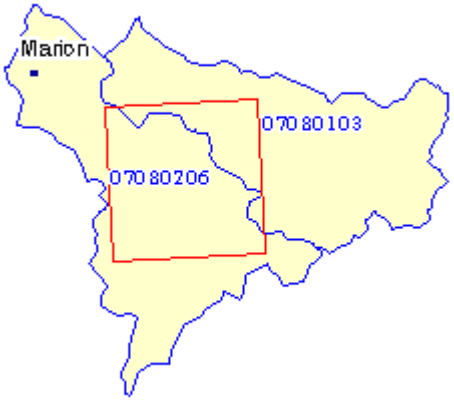
Source: 2011 *Cedar County Multi-jurisdictional Hazard Mitigation Plan*

Cedar County crosses two watersheds. A list of these watersheds with the cities contained within each is provided below:

- 07080103 Lower Wapsipinicon—Clarence, Lowden, Mechanicsville, Unincorporated County
- 07080206 Lower Cedar—Bennett, Durant, Mechanicsville, Stanwood, Tipton, West Branch, Wilton, and Unincorporated County

Figure 3.21 shows the two watersheds in Cedar County.

Figure 3.21. Cedar County, Iowa Watersheds (Cedar County is red square)



Source: Environmental Protection Agency, http://cfpub.epa.gov/surf/county.cfm?fips_code=19031

For purposes of this hazard profile and vulnerability analysis, the geographic location/extent for river flooding will be considered as those areas at risk to the 100-year flood (also known as the 1-percent annual chance flood). The 1-percent annual chance flood has been adopted by FEMA as the base flood for floodplain management purposes.

Determining "Best Available Data" To Depict the 1-Percent Annual Chance Flood

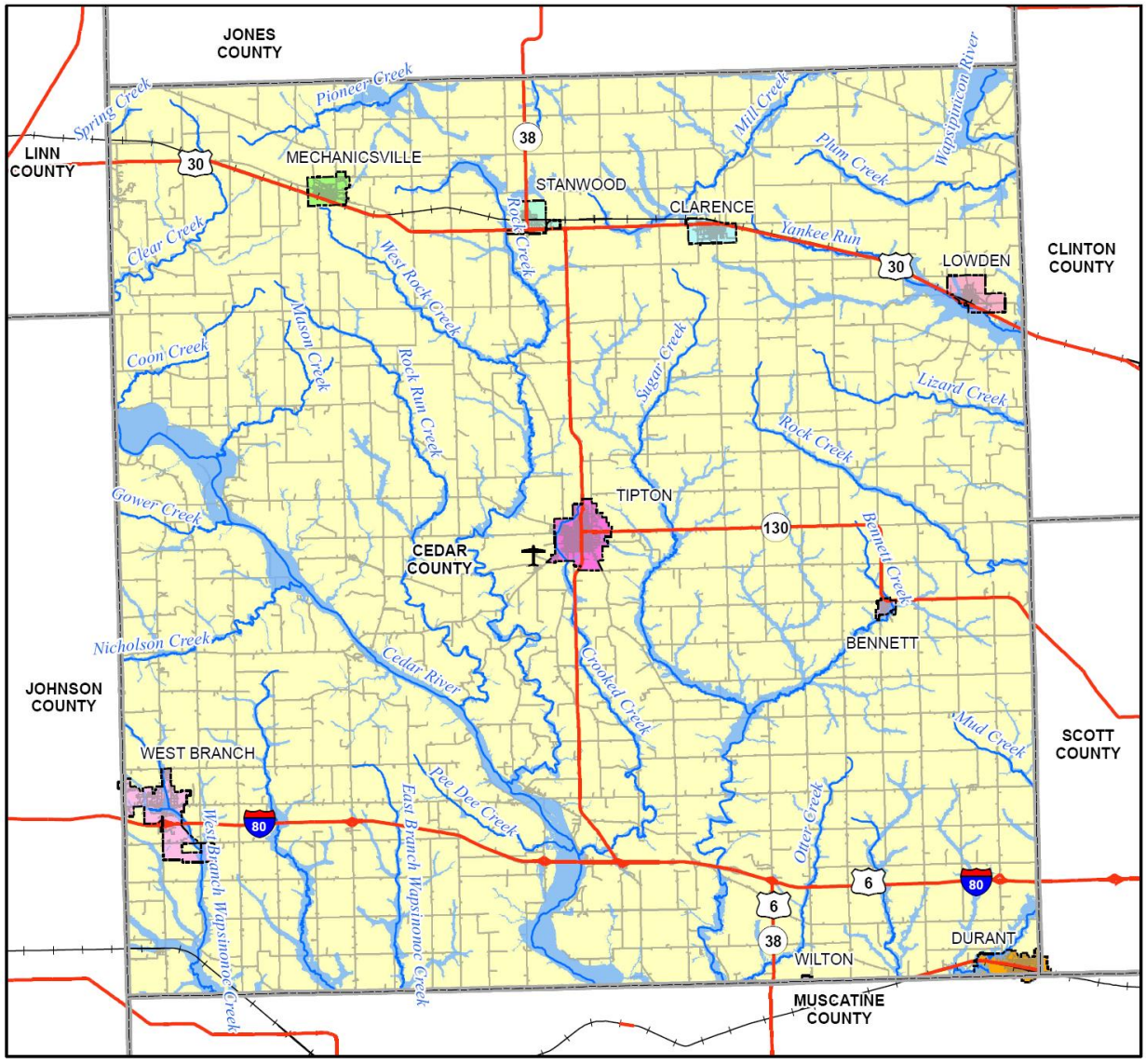
With the availability of a Digital Flood Insurance Rate Map (DFIRM) as well as detailed parcel data with assessed values, analysis of these two layers was determined to be the preferred approach for the Flood Risk Assessment. This will allow for analysis of actual structures and values by type that fall within the boundaries of the regulatory floodplain. A Level I HAZUS analysis, which can provide loss estimates according to the depth-damage function is considered to be less accurate since census block data is used and aggregated and the HAZUS approximated floodplain considers only those streams that drain 10 square miles or more.

Jurisdictional Flood Hazard Maps

Figure 3.22 to **Figure 3.30** provide the DFIRM 1-percent annual chance floodplain for all jurisdictions in the planning area. The county-level map is provided first and the remaining maps are provided in alphabetical order by city. Appendix E provides locations of available

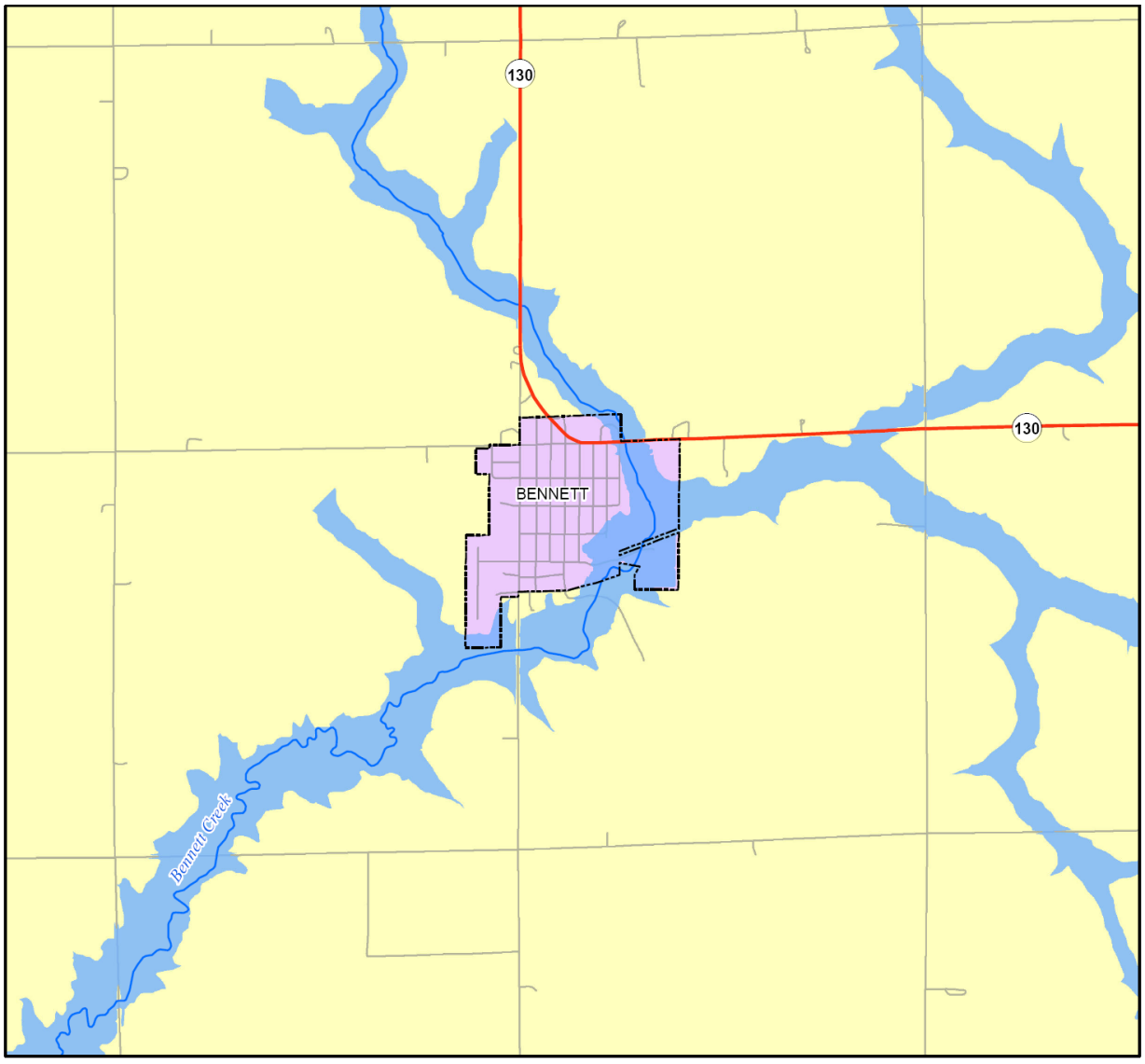
critical facilities in relation to the 1-percent annual chance floodplain. This will be discussed in greater detail in the vulnerability section. Please Note: The City of Clarence has “no special flood hazard areas identified”. Additionally, there is no Flood Map for the small portion of the City of Wilton that is in Cedar County as the City of Wilton was not included in the DFIRM for Cedar County. See the separately published Muscatine County Flood Insurance Report and Flood Insurance Rate Map as well as the Muscatine County Multi-jurisdictional Hazard Mitigation Plan for additional flood risk details for the City of Wilton.

Figure 3.22. Cedar County DFIRM 1-Percent Annual Chance Floodplain (100-Year Floodplain



Map Compiled: 04/2014
Intended for planning purposes only
Source: Cedar County GIS Department, Iowa DNR, FEMA

Figure 3.23. City of Bennett DFIRM 1-Percent Annual Chance Floodplain (100-Year Floodplain



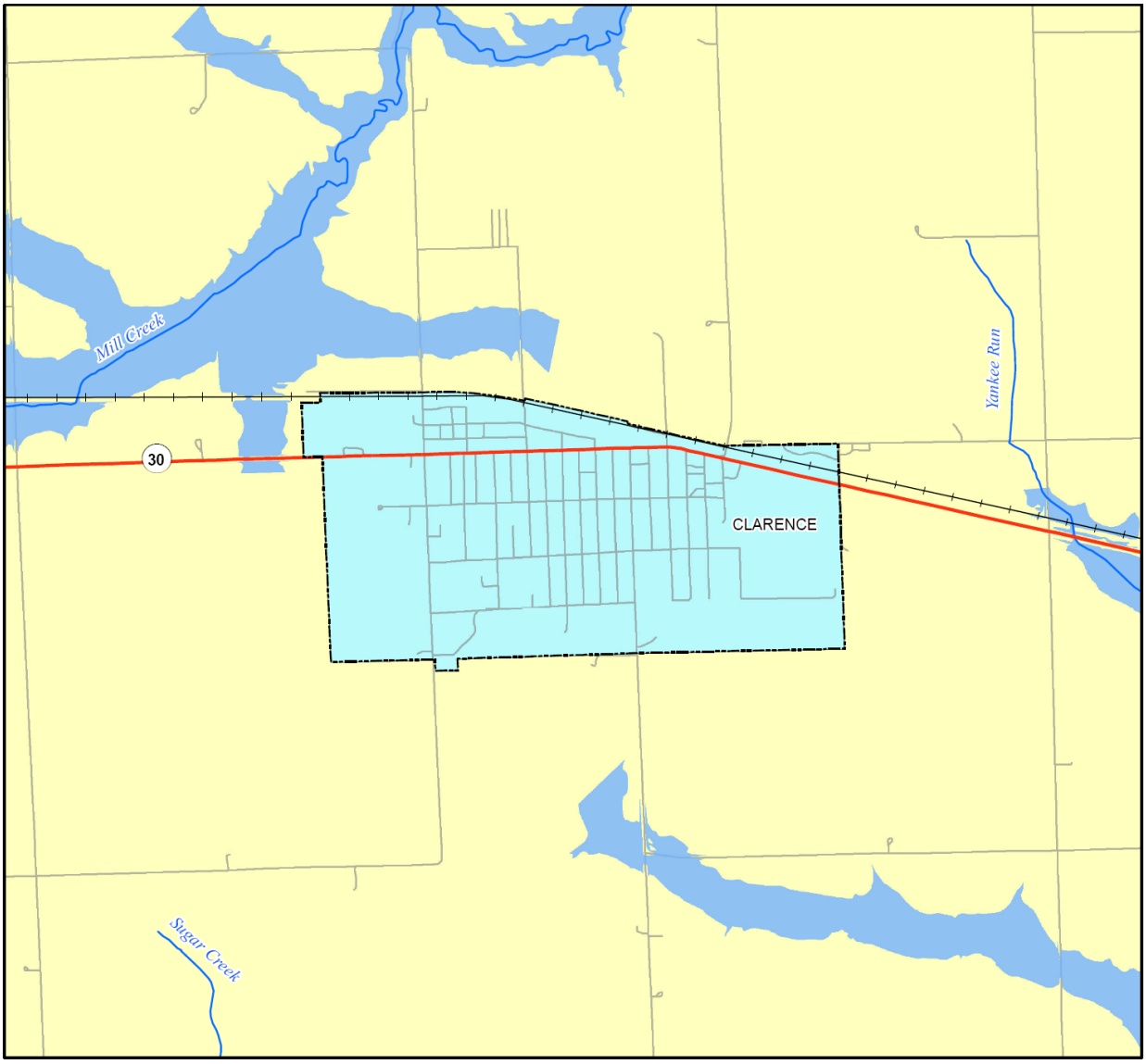
0 0.25 0.5 1 Miles

N

Map Compiled: 04/2014
Intended for planning purposes only
Source: Cedar County GIS Department, Iowa DNR, FEMA

Counties
Cities
Airports
100 Year Floodplain
Highways
Railroads
Streams
Local Roads

Figure 3.24. City of Clarence DFIRM 1-Percent Annual Chance Floodplain (100-Year Floodplain



Map Compiled: 04/2014
Intended for planning purposes only
Source: Cedar County GIS Department, Iowa DNR, FEMA

Figure 3.25. City of Durant DFIRM 1-Percent Annual Chance Floodplain (100-Year Floodplain

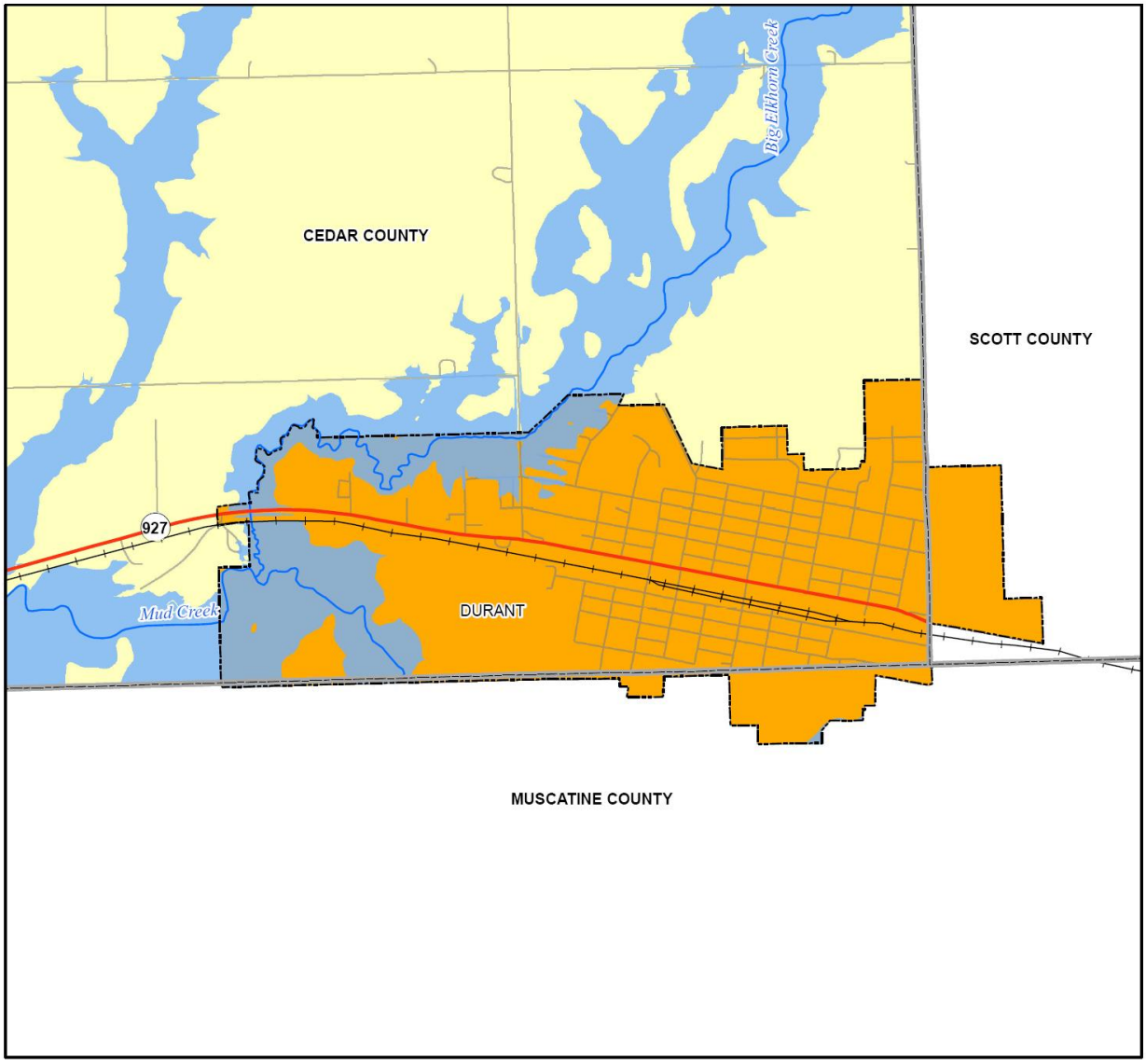


Figure 3.26. City of Lowden DFIRM 1-Percent Annual Chance Floodplain (100-Year Floodplain

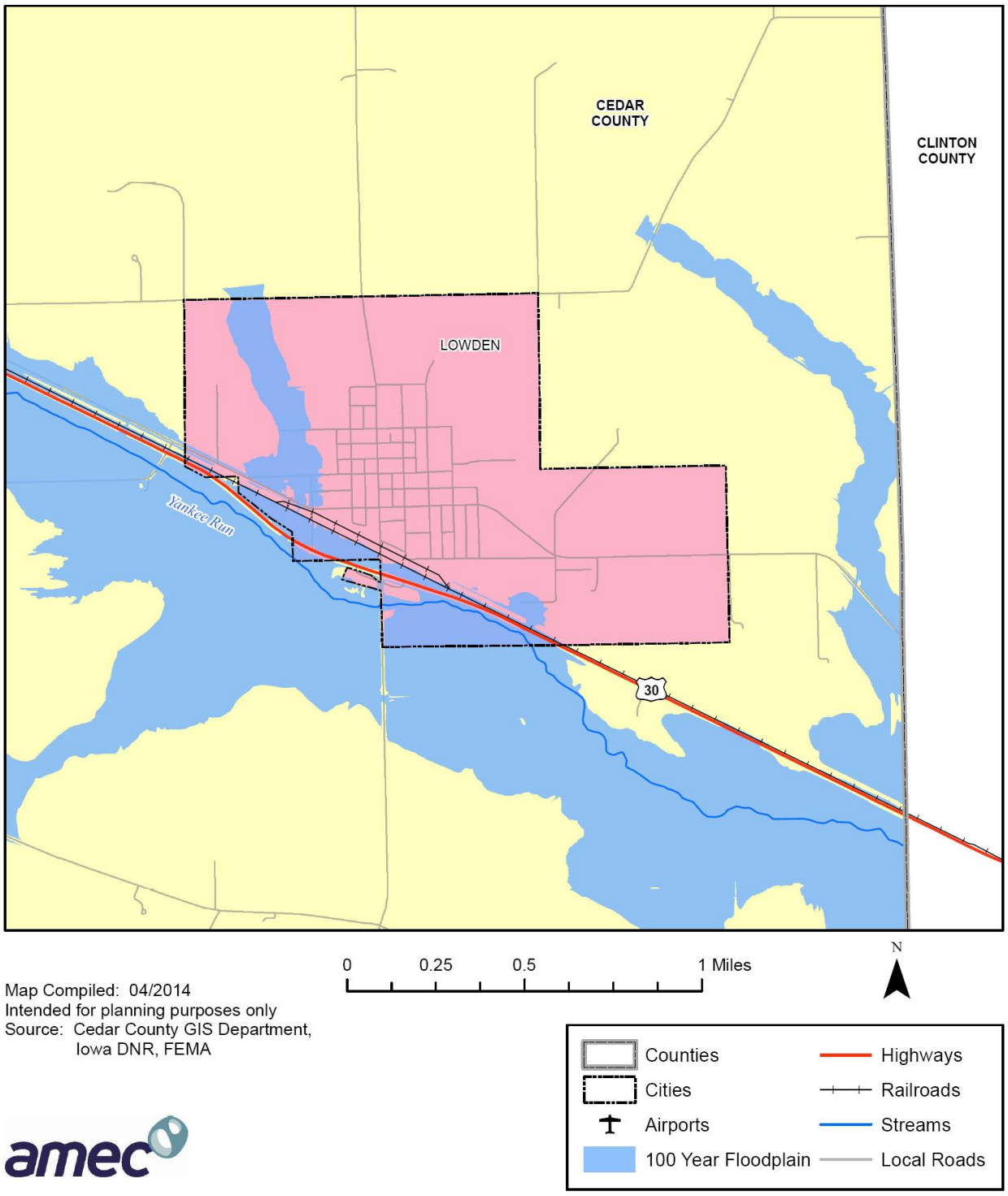


Figure 3.27. City of Mechanicsville DFIRM 1-Percent Annual Chance Floodplain (100-Year Floodplain

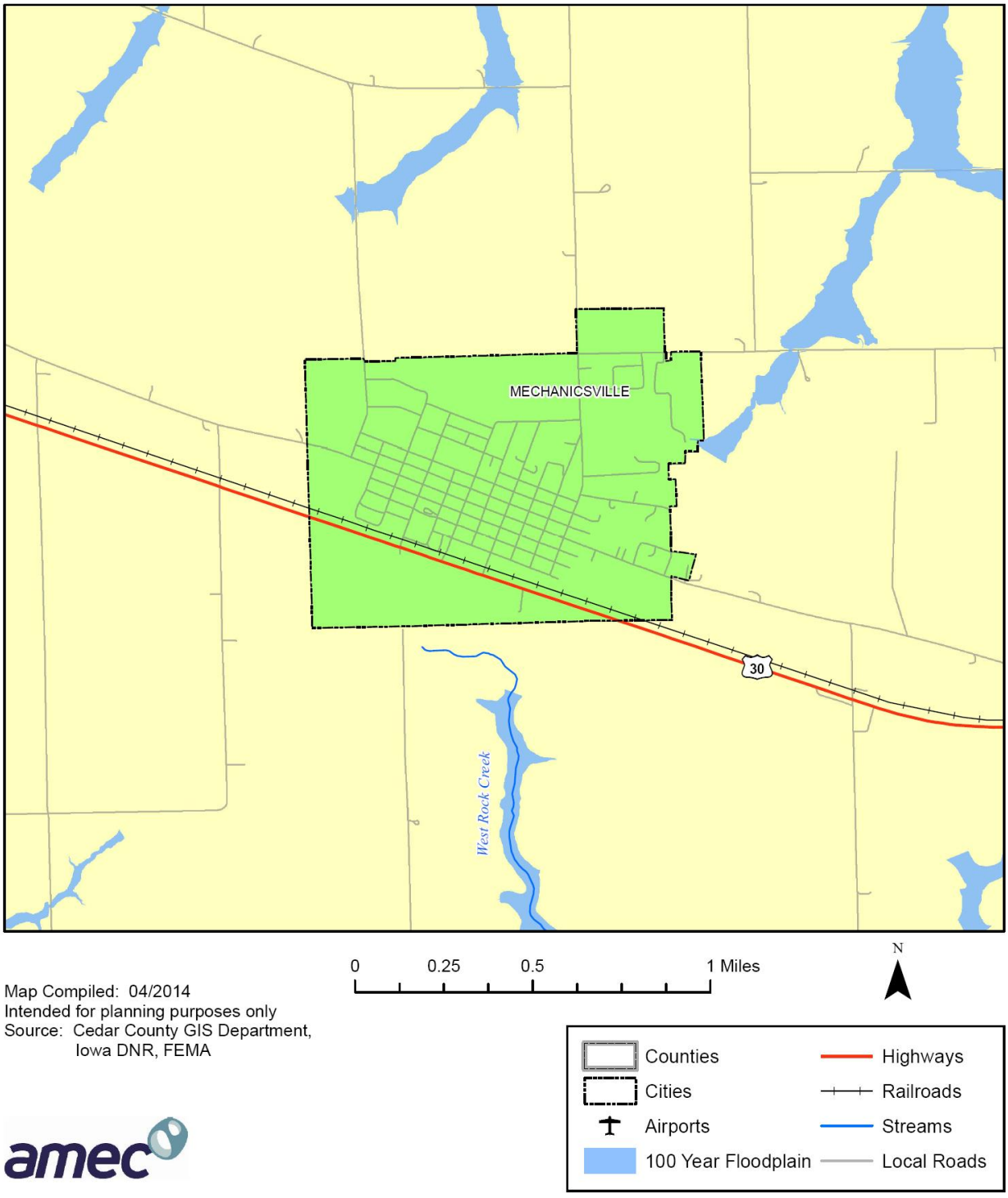


Figure 3.28. City of Stanwood DFIRM 1-Percent Annual Chance Floodplain (100-Year Floodplain

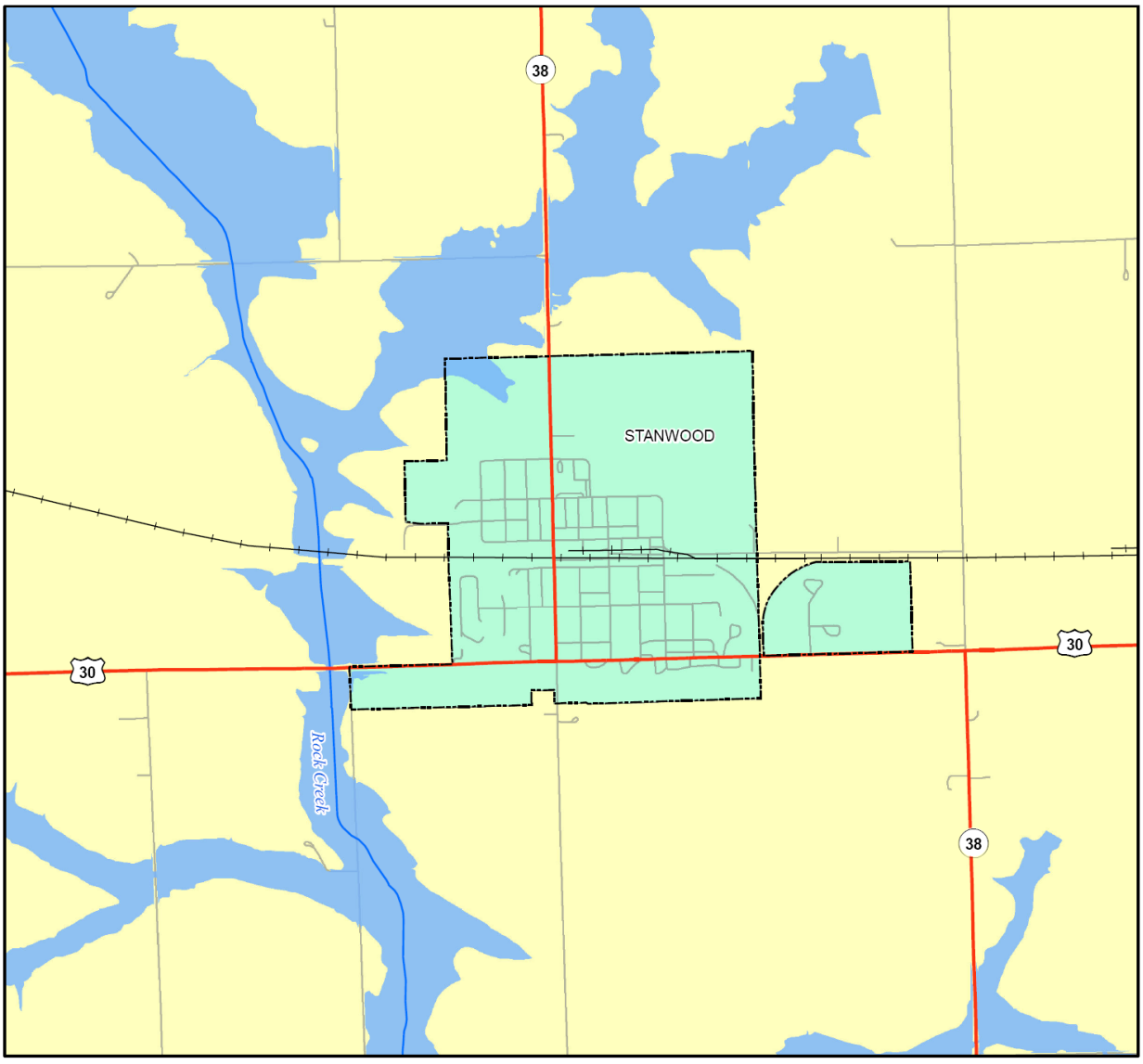
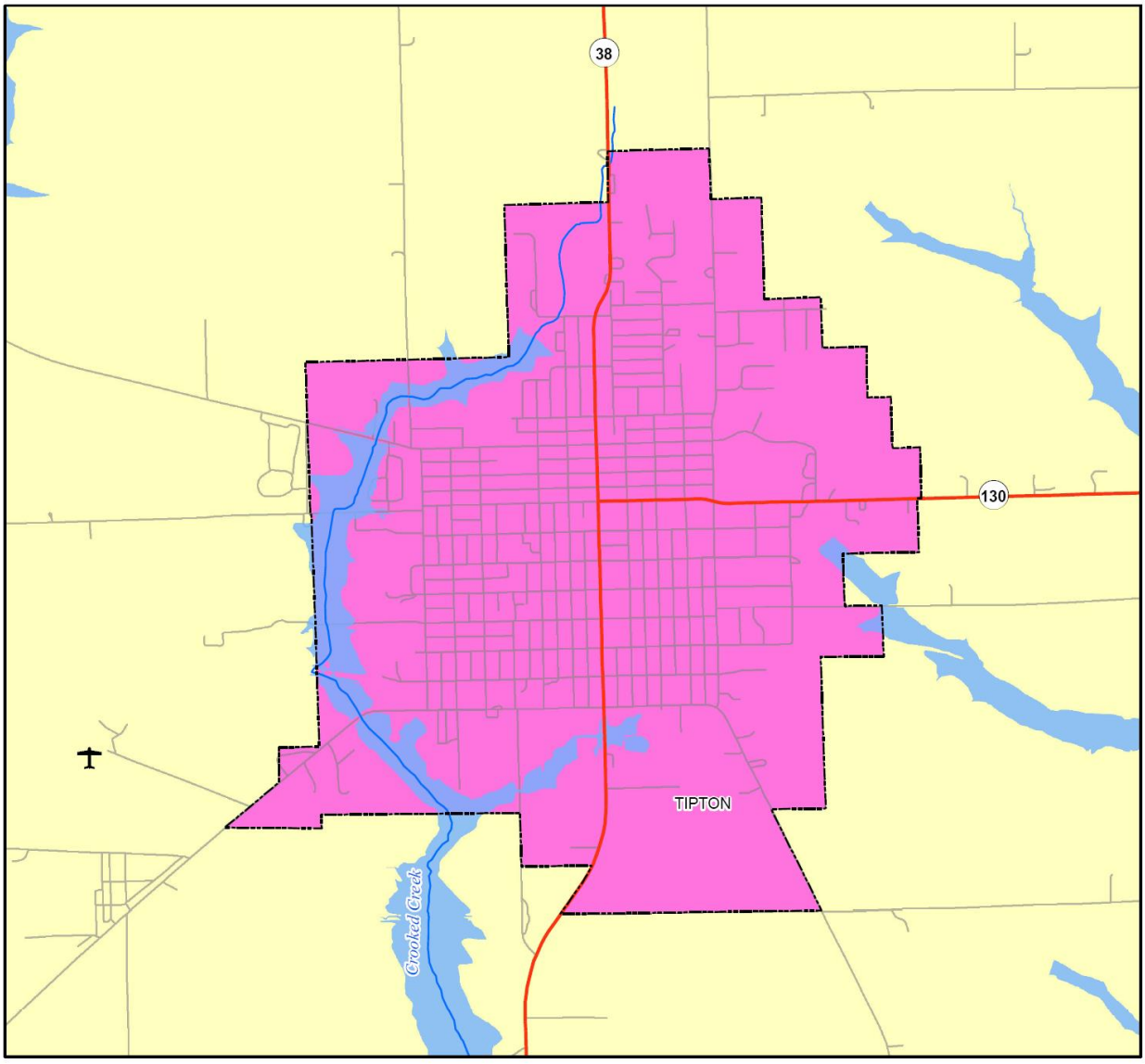
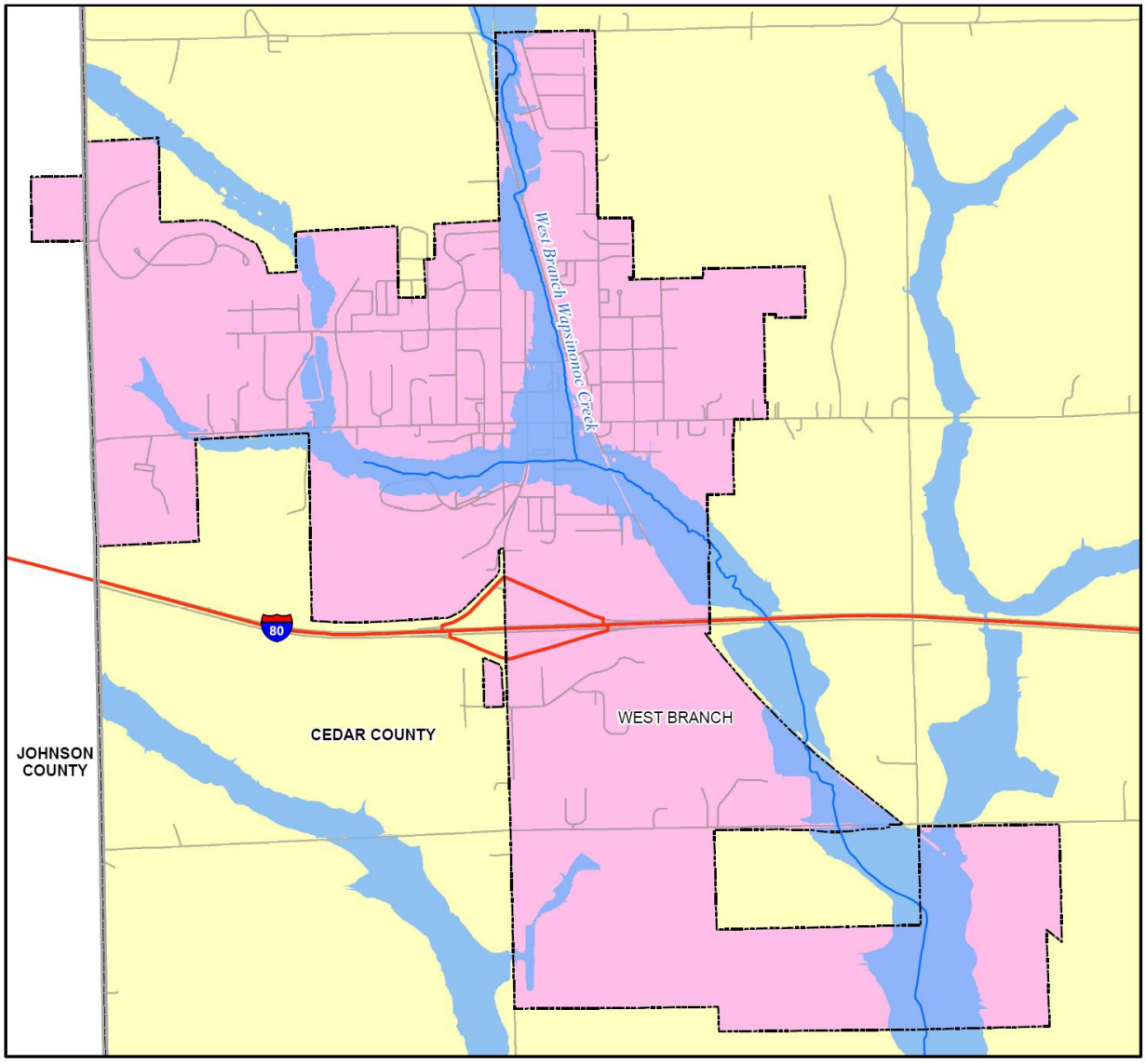


Figure 3.29. City of Tipton DFIRM 1-Percent Annual Chance Floodplain (100-Year Floodplain



Map Compiled: 04/2014
Intended for planning purposes only
Source: Cedar County GIS Department, Iowa DNR, FEMA

Figure 3.30. City of West Branch DFIRM 1-Percent Annual Chance Floodplain (100-Year Floodplain



Previous Occurrences

This section provides information on previous occurrences of riverine flooding in the planning area.

Presidential Declarations for Flooding in Planning Area

Since 2004 there have been five Presidential Disaster Declarations that included flooding in the planning area. Only two declarations during this time period did not include flooding and those were for Winter/Snow Storm. Additional details of the flood-related disaster declarations are provided in **Table 3.40**

Table 3.40. FEMA Flood Disaster Declarations that included Cedar County, Iowa, 2004-2013

Number	Declared	Incident Period	Description
4187	8/5/2014	6/26 to 7/7/2014	Severe Storms, Tornadoes, Straight-line Winds, and Flooding
4135	07/31/2013	06/21 to 06/28/2013	Severe Storms, Tornadoes, and Flooding
4119	05/31/2013	04/17 to 04/30/2013	Severe Storms, Straight-line Winds, and Flooding
1763	5/27/2008	5/25 to 8/13/2008	Severe Storms, Tornadoes and Flooding
1518	05/25/2004	5/19 to 6/24/2004	Severe Storms, Tornadoes, and Flooding

Source: Federal Emergency Management Agency, www.fema.gov/

The following section provides additional detail regarding principle flooding issues and previous flooding events in the planning area.

Unincorporated Cedar County

The Cedar and Wapsipinicon Rivers are the major river systems in the county. The floodplains of these main-stem rivers and their tributaries criss-cross the county. The main flood season in Cedar County is in spring and early summer. Most of the larger floods have resulted from heavy general rains during this season. Presence of railroad and interstate highway embankments, restrictive bridges, and buildings in the floodplain has added further complications to the flooding. The greatest known flood flow on record occurred in 1967.

City of Bennett

The Bennett Creek floodplain traverses north-south along the eastern side of city limits as well and wraps east-west across the southern boundary.

City of Clarence

There are No Special Flood Hazard Areas within the corporate limits of the City of Clarence. However, the Mill Creek floodplain is in the unincorporated county area just to the northwest of corporate limits.

City of Durant

The Big Elkhorn Creek floodplain extends east-west over the western half of the northern corporate boundary and the floodplain combined with the Mud Creek floodplain covers the western boundary of the city as well.

City of Lowden

The broad floodplain of the Yankee Run River extends over the southwest boundary of city limits.

City of Mechanicsville

The floodplain of a small tributary of Pioneer Creek touches a very small section of the western corporate boundary.

City of Stanwood

Rock Creek flows through the unincorporated county to the west of the City of Stanwood. Small portions of the floodplain extend into corporate limits on the southwest and northwest corners of city limits.

City of Tipton

Crooked Creek and its narrow floodplain flow along the western boundary of the city and a small portion of the floodplain a tributary of Sugar Creek extends into the city at the middle of the eastern city boundary.

City of West Branch

The West Branch Wapsinonoc Creek bisects the city north to south, including some developed areas of the city center. An offshoot tributary of the creek extends into the western city limits as well.

Previous Agricultural Impacts

Flooding and excess moisture take a toll on crop production in the planning area. According to the USDA's Risk Management Agency, payments for insured crop losses in the planning area as a result of excess moisture and flood conditions from 2004-2013 totaled $8,423,922. This translates to an annual average of $842,392. According to USDA Risk Management Agency's 2012 Iowa Crop Insurance Profile, 90.5 percent of insurable crops in Iowa were insured. **Table 3.41** summarizes the claims paid by year.

Table 3.41. Crop Insurance Claims Paid in Cedar County for Crop Loss as a result of Excess Moisture/Precipitation/Rain and Flood (2004-2013)

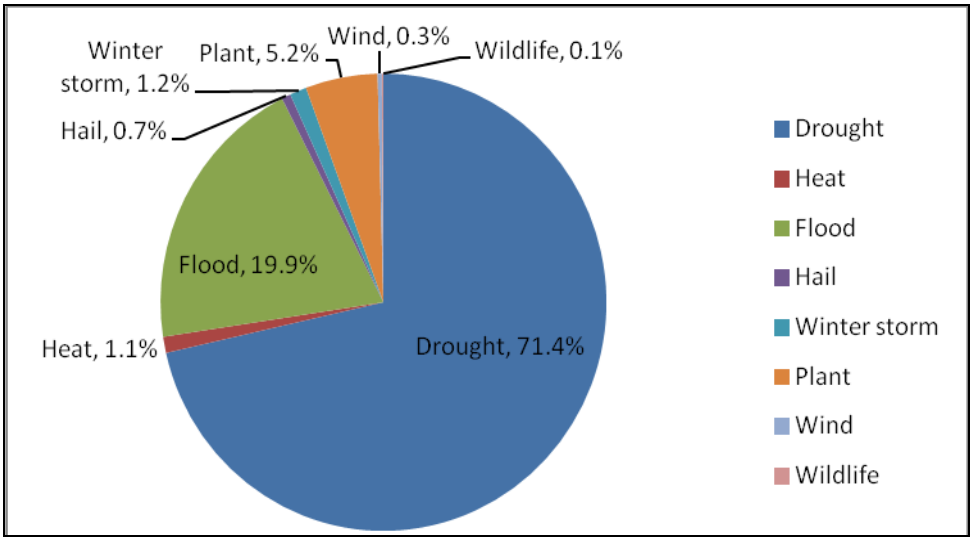
Crop Year	Crop Insurance Paid
2004	$455,633
2005	$40,429
2006	$32,930
2007	$832,588
2008	$4,427,371

Crop Year	Crop Insurance Paid
2009	$309,569
2010	$1,516,084
2011	$17,268
2012	$36,446
2013	$755,604
Total	**$8,423,922**

Source: USDA Risk Management Agency

An analysis of crop insurance paid as a result of all hazards reveals that19.9 percent of the crop insurance payments during this 10-year period from 2004-2013 were attributed to excess moisture/precipitation/rain and flood (see **Figure 3.31**).

Figure 3.31. Percent of Crop Insurance Payments in Cedar County by Hazard (2004-2013)



Source: Statistics from USDA Risk Management Agency, Analysis by AMEC

National Flood Insurance Program (NFIP) Participation

Table 3.42 provides details on NFIP participation for the communities in the planning area as well as the number of policies in force, amount of insurance in force, number of closed losses, and total payments for each jurisdiction, where applicable. The claims information is for the period from January 1, 1978 to December 31, 2013.

Table 3.42. NFIP Participation, Policy, and Claim Statistics (as of 12/31/2013)

Community Name	NFIP Participant (Yes/No)	Participant in CRS (Yes/No)	Community ID #	Current Effective Map Date	Regular-Emergency Program Entry Date	Policies in Force	Insurance in Force	Closed Losses	Total Payments
Cedar County	Yes	No	190050	8/19/2013	8/5/1985	29	$6,459,100	4	$495,604
Bennett	Yes	No	190051	08/19/2013(M)	9/4/1985	0	$0	0	0
Clarence	Yes	No	190045	NSFHA	8/19/2013	0	$0	0	0
Durant	Yes	No	190922	08/19/2013(M)	6/11/1976	2	$455,000	0	0
Lowden	Yes	No	190054	08/19/2013(M)	8/19/1985	3	$346,600	0	0
Mechanicsville	Yes	No	190970	08/19/2013(M)	8/16/2013	0	$0	0	0
Stanwood	Yes	No	190056	08/19/2013(M)	11/1/1979	0	$0	0	0
Tipton	Yes	No	190057	08/19/2013(M)	9/4/1985	3	$700,000	0	0
West Branch	Yes	No	190058	8/19/2013	3/16/1983	33	$4,187,700	6	$21,587

Source: Participation details from NFIP Community Status Book, 12/31/2013; BureauNet, http://www.fema.gov/national-flood-insurance-program/national-flood-insurance-program-community-status-book; M= No elevation determined – all Zone A, C, and X: NSFHA = No Special Flood Hazard Area; E=Emergency Program: Policy and Loss Statistics from BureauNet, http://bsa.nfipstat.fema.gov/reports/reports.html; *Closed Losses are those flood insurance claims that resulted in payment. Loss statistics are for the period from January 1, 1978 to December 31, 2013.

According to the policy and loss statistics, policy holders in the unincorporated portion of Cedar County have received the most in insurance payments by far with over $495,604 in payments. The City of West Branch is the only other community with closed losses. West Branch losses total $21,587.

Repetitive Loss/Severe Repetitive Loss Properties

Repetitive Loss: Repetitive Loss Properties are those properties with at least two flood insurance payments of $5,000 or more in a 10-year period. According to the Flood Insurance Administration, there are no repetitive loss properties in the planning area.

Severe Repetitive Loss (SRL): SRL properties are defined it as "a single family property" (consisting of one-to-four residences) that is covered under flood insurance by the NFIP and has incurred flood-related damage for which four or more separate claims payments have been paid under flood insurance coverage with the amount of each claim payment exceeding $5,000 and with cumulative amounts of such claims payments exceeding $20,000; or for which at least two separate claims payments have been made with the cumulative amount of such claims exceeding the reported value of the property.

According to the Flood Insurance Administration, there are not severe repetitive loss properties in the planning area.

Probability of Future Occurrence

With the history of flooding in the planning area, it is likely that flooding of various levels will continue to occur. In 10 years time, Cedar County was declared for events involving flooding four times. This translates to a 40 percent annual probability

Probability Score: 4—Highly Likely

Vulnerability

Overview

The flood vulnerability and loss estimates for the unincorporated county and the incorporated cities were generated using the 8/19/2013 Effective DFIRM layer and the Cedar County parcel and building data layer provided by the Cedar County GIS Department. GIS analysis was conducted to determine the number and values of buildings at risk to the 1-percent annual chance flood. For purposes of this analysis, if any portion of a parcel was within the 1-percent annual chance floodplain, then all buildings and the total value of improvements associated with the parcel were considered at risk to the 1-percent annual chance flood (Note: land values were excluded). Additionally, to determine the population at risk, the number of residential properties at risk was multiplied by the average household size.

Table 3.43 provides the numbers of buildings per jurisdiction by type that are in the 1-percent annual chance floodplain for the unincorporated county and cities according to the analysis methodology described above. **Table 3.44** that follows provides the building exposure values in the floodplain for the unincorporated county and the incorporated cities in the planning area.

According to this analysis, unincorporated Cedar County has the greatest number of buildings in the floodplain with a total of 209. Of those, 76 are residential. The next highest number of buildings in the floodplain is in the City of West Branch, followed by the City of Lowden. The greatest exposure of building value in the 1-percent annual chance floodplain is in the unincorporated portion of Cedar County with a total of $14,565,900 in improvements present in the 1-percent annual chance floodplain.

Table 3.43. Cedar County, Iowa Building Counts In The 1-Percent Annual Chance Floodplain

Jurisdiction	Agricultural	Commercial	Industrial	Residential	Total
Unincorporated Cedar County	122	11	0	76	209
Bennett	0	2	0	3	5
Clarence	0	0	0	0	0
Durant*	0	1	1	6	8
Lowden	2	5	0	15	22
Mechanicsville	0	0	0	0	0
Stanwood	0	0	0	0	0
Tipton	0	3	0	3	6
West Branch*	0	30	2	23	55
Wilton**	0	0	0	0	0
Total	**124**	**52**	**3**	**126**	**305**

Source: 8/19/2013 Effective DFIRM; Cedar County GIS Department.
*Data includes all incorporated area, including portion(s) in adjacent counties.
** Data is for the portion in Cedar County only.

Table 3.44. Cedar County Building Values In The 1-Percent Annual Chance Floodplain

Jurisdiction	Agricultural	Commercial	Industrial	Residential	Total
Unincorporated Cedar County	$8,438,450	$439,380	$0	$5,688,070	$14,565,900
Bennett	$0	$16,080	$0	$288,360	$304,440
Clarence	$0	$0	$0	$0	$0
Durant*	$0	$102,640	$87,870	$619,600	$810,110
Lowden	$21,510	$371,950	$0	$746,630	$1,140,090
Mechanicsville	$0	$0	$0	$0	$0
Stanwood	$0	$0	$0	$0	$0
Tipton	$0	$426,000	$0	$237,460	$663,460
West Branch*	$0	$1,303,070	$105,020	$2,227,820	$3,635,910
Wilton**	$0	$0	$0	$0	$0
Total	**$8,459,960**	**$2,659,120**	**$192,890**	**$9,807,940**	**$21,119,910**

Source: 8/19/2013 Effective DFIRM; Cedar County GIS Department.
*Data includes all incorporated area, including portion(s) in adjacent counties.
** Data is for the portion in Cedar County only.

For the planning area ranking, the HMPC determined the magnitude of river flooding to be critical. Individual jurisdictional ratings are provided at the end of this hazard section.

Magnitude Score: 3—Critical

Potential Losses to Existing Development
The potential losses to existing development will be provided for the following categories of losses:

- Building Losses—this will include counts and values for buildings exposed to potential damage from the 1-percent annual chance flood for each jurisdictions in the planning area;
- Estimated Population Displaced;
- Agricultural Impacts; and
- Critical Facilities and Infrastructure at Risk.

Building Losses and Impacted Population

The result of the exposure analysis summarizes the values at risk in the floodplain. When a flood occurs, seldom does the event cause total destruction of an area. Potential losses from flooding are related to a variety of factors including flood depth, flood velocity, building type and construction. Based on FEMA Flood Insurance Administration (FIA) flood depth-damage curves, the percent of damage is directly related to the flood depth. FEMA's HAZUS flood loss estimation tool and the flood benefit/cost module both use this simplified approach to model flood damage based on building type and flood depth. A damage estimation of 20 percent of the total value was used based on FIA depth-damage curves for a one-story structure with no basement flooded to two feet. While there are several limitations to this model, it does present a methodology to estimate potential damages. This model may include structures within the 1-percent annual chance floodplain that may be elevated above the level of the base flood elevation, according to local floodplain development requirements, and thus mitigate the risk.

Additionally, structures with finished basements and commercial properties would likely sustain a higher percentage of damage.

To determine the population that would be impacted and potentially displaced by a 1-percent annual chance flood event, the average household size, as determined by the 2010 census, was multiplied by the number of residential structures in the 1-percent annual chance floodplain for each jurisdiction. The population impacted is somewhat underestimated since some of the residential structures are multi-family structures. However, data was not available to determine the number of households in each multi-family structure.

Table 3.45 provides the summary of potential flood loss estimates and impacted population for the 1-percent annual chance flood by jurisdiction.

Table 3.45. Flood Loss Estimates For 1-Percent Annual Chance Flood

	Total Building/ Improvement Value	Total Building/ Improvement Value in Floodplain	Estimated Building/ Improvement Losses	Loss Ratio (%)	Total Residential Buildings in Floodplain	Average Household Size	Estimated Impacted Population	2012 Population Estimate Total	Estimated Impacted Population (%)
Unincorporated County	$422,049,350	$14,565,900	$2,913,180.0	0.69%	76	2.42	184	7,107	2.59%
City of Bennett	$10,455,940	$304,440	$60,888.0	0.58%	3	2.53	8	398	1.91%
City of Clarence	$35,047,570	$0	$0.0	0.00%	0	2.22	0	966	0.00%
City of Durant*	$94,971,006	$810,110	$162,022.0	0.17%	6	2.45	15	1,829	0.80%
City of Lowden	$27,227,056	$1,140,090	$228,018.0	0.84%	15	2.28	34	780	4.38%
City of Mechanicsville	$39,365,410	$0	$0.0	0.00%	0	2.34	0	1,129	0.00%
City of Stanwood	$23,475,106	$0	$0.0	0.00%	0	2.49	0	675	0.00%
City of Tipton	$133,371,010	$663,460	$132,692.0	0.10%	3	2.25	7	3,201	0.21%
City of West Branch*	$141,927,556	$3,635,910	$727,182.0	0.51%	23	2.39	55	2,331	2.36%
City of Wilton**	$124,240	$0	$0.0	0.00%	0	2.43	0	N/A	0.00%
Total	**$928,014,244**	**$21,119,910**	**$4,223,982.0**	**0.46%**	**126**	**N/A**	**302**	**18,416**	**1.64%**

Source: 8/19/2013 Effective DFIRM; Cedar County GIS Department; Average Household Size from U.S. Bureau, 2010 Census; U.S. Census Bureau 2012 Populations Estimates.
*Data includes all incorporated area, including portion(s) in adjacent counties.
** Data is for the portion in Cedar County only.

Agricultural Impacts

Additionally, USDA crop insurance claims for excess moisture/precipitation/rain and flood conditions for the ten-year period from 2004-2013 totaled $8,423,922. Considering that 90.5 percent of insurable crops are insured in Iowa (2013 Iowa Crop Insurance Profile, USDA, RMA), the adjusted losses calculate to $9,359,913 for all insurable crops for the period. This results in an average annual loss of $935,991 to insurable crops as a result of excess moisture/precipitation/rain and flood conditions affecting agriculture.

Critical Facilities and Infrastructure at Risk

To analyze critical facilities at risk in the planning area, the planning committee reviewed and updated the inventory of critical and essential facilities and infrastructure in the planning area that was compiled in 2011 as part of the development of the 2011 *Cedar County Multi-jurisdictional Hazard Mitigation Plan*. After the critical facilities were validated and revised as part of this plan update effort, a comparison was made with the Effective DFIRM layer to determine those facilities that would be damaged in a 1-percent annual chance flood event. This analysis revealed 12 critical or essential facilities that are in the 1-percent annual chance floodplain and one critical facility in the 0.2-percent annual chance floodplain.

Appendix E provides the list of critical facilities in the 1-percent annual chance floodplain that could be damaged in the event of a 1-percent annual chance flood. This Appendix is "For Official Use Only". To obtain access for official use, contact the Cedar County Emergency Management Coordinator.

Future Development

Any future development in floodplains would increase risk in those areas. For those communities that participate in the National Flood Insurance Program, enforcement of the floodplain management regulations will ensure mitigation of future construction in those areas. However, even if structures are mitigated, evacuation may still be necessary due to rising waters. In addition, floods that exceed mitigated levels may still cause damages.

The City of West Branch 2013 Comprehensive Plan specifically addresses future development in terms of the flood hazards in the community. **Figure 3.4** provides a comparison of future development with the flood risk based on the 2011 FEMA Flood map.

River Flooding Hazard Summary by Jurisdiction

Since the City of Clarence does not have any 1-percent annual chance floodplain in the Effective DFIRM (No Special Flood Hazard Area), it was determined that the River Flood hazard does not apply. Additionally, the analysis revealed there are no improvements in the floodplain in Mechanicsville or Stanwood. Therefore, it was determined that the River Flood hazard does not apply to these jurisdictions as well.

To demonstrate how river flooding varies additionally by jurisdiction, all jurisdictions that had any improvements in the 1-percent annual chance floodplain (including school districts) received a rating of 4 for probability. To determine the magnitude rating, those jurisdictions with critical facilities in the 1-percent annual chance floodplain and/or a loss ratio higher than .5 percent were assigned a magnitude of 3. Those jurisdictions with no critical facilities in the floodplain

and loss ratio less than .5 percent were assigned a magnitude of 1. The warning time and duration were considered to be 1 and 4 for all jurisdictions that have any properties in the floodplain.

For those jurisdictions that do not have improvement exposures in the floodplain, all elements indicate Not Applicable (N/A). To determine the rankings for the school districts, the critical facility layer of school buildings was compared against the revised preliminary DFIRM. This analysis revealed no school buildings in the 100-year floodplain.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Cedar County	4	3	1	4	3.25	High
City of Bennett	4	3	1	4	3.25	High
City of Clarence	N/A	N/A	N/A	N/A	N/A	N/A
City of Durant	4	1	1	4	2.65	Moderate
City of Lowden	4	3	1	4	3.25	Moderate
City of Mechanicsville	N/A	N/A	N/A	N/A	N/A	N/A
City of Stanwood	N/A	N/A	N/A	N/A	N/A	N/A
City of Tipton	4	1	1	4	2.65	Moderate
City of West Branch	4	3	1	4	3.25	High
Bennett School District, #603	N/A	N/A	N/A	N/A	N/A	N/A
Durant School District, #1926	N/A	N/A	N/A	N/A	N/A	N/A
North Cedar School District, #3691	N/A	N/A	N/A	N/A	N/A	N/A
Tipton School District #6408	N/A	N/A	N/A	N/A	N/A	N/A
West Branch School District #6930	N/A	N/A	N/A	N/A	N/A	N/A

3.5.11 Severe Winter Storm

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
4	2	3	3	3.15	High

Profile

Hazard Description

Severe winter storms are an annual occurrence in Iowa. A major winter storm can last for several days and be accompanied by high winds, freezing rain or sleet, heavy snowfall, cold temperatures and drifting snow creating blizzards. The National Weather Service describes different types of winter storm events as follows:

- **Blizzard**—Winds of 35 mph or more with snow and blowing snow reducing visibility to less than ¼ mile for at least three hours.
- **Blowing Snow**—Wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground picked up by the wind.
- **Snow Squalls**—Brief, intense snow showers accompanied by strong, gusty winds. Accumulation may be significant.
- **Snow Showers**—Snow falling at varying intensities for brief periods of time. Some accumulation is possible.
- **Freezing Rain**—Measurable rain that falls onto a surface with a temperature below freezing. This causes it to freeze to surfaces, such as trees, cars, and roads, forming a coating or glaze of ice. Most freezing-rain events are short lived and occur near sunrise between the months of December and March.
- **Sleet**—Rain drops that freeze into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects.

Heavy accumulations of ice, often the result of freezing rain, can bring down trees, utility poles, and communications towers and disrupt communications and power for days. Even small accumulations of ice can be extremely dangerous to motorists and pedestrians.

Severe winter storms include extreme cold, heavy snowfall, ice, and strong winds which can push the wind chill well below zero degrees in the planning area. Heavy snow can bring a community to a standstill by inhibiting transportation (in whiteout conditions), weighing down utility lines, and by causing structural collapse in buildings not designed to withstand the weight of the snow. Repair and snow removal costs can be significant. Ice buildup can collapse utility lines and communication towers, as well as make transportation difficult and hazardous. Ice can also become a problem on roadways if the air temperature is high enough so that precipitation falls as freezing rain rather than snow.

Extreme cold often accompanies severe winter storms and can lead to hypothermia and frostbite in people who are exposed to the weather without adequate clothing protection. Cold can cause fuel to congeal in storage tanks and supply lines, stopping electric generators. Cold temperatures can also overpower a building's heating system and cause water and sewer pipes

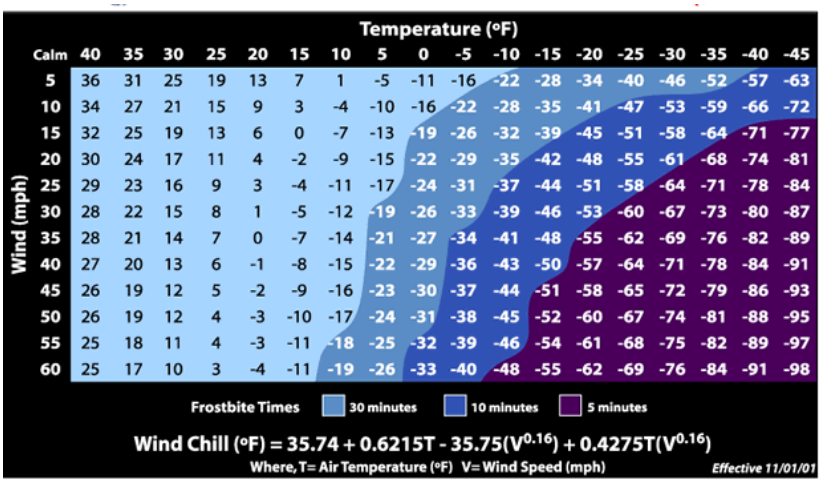
to freeze and rupture. When combined with high winds from winter storms, extreme cold becomes extreme wind chill, which is extremely hazardous to health and safety.

The National Institute on Aging estimates that more than 2.5 million Americans are especially vulnerable to hypothermia, with the isolated elderly being most at risk. About 10 percent of people over the age of 65 have some kind of temperature-regulating defect, and 3-4 percent of all hospital patients over 65 are hypothermic.

Also at risk are those without shelter or who are stranded, or who live in a home that is poorly insulated or without heat. Other impacts of extreme cold include asphyxiation (unconsciousness or death from a lack of oxygen) from toxic fumes from emergency heaters; household fires, which can be caused by fireplaces and emergency heaters; and frozen/burst pipes.

Wind can greatly amplify the impact of cold ambient air temperatures. Provided by the National Weather Service**, Figure 3.32** below shows the relationship of wind speed to apparent temperature and typical time periods for the onset of frostbite.

Figure 3.32. Wind Chill Chart



Source: National Weather Service

Warning Time Score: 3—6-12 hours

Duration Score: 3—less than 1 week

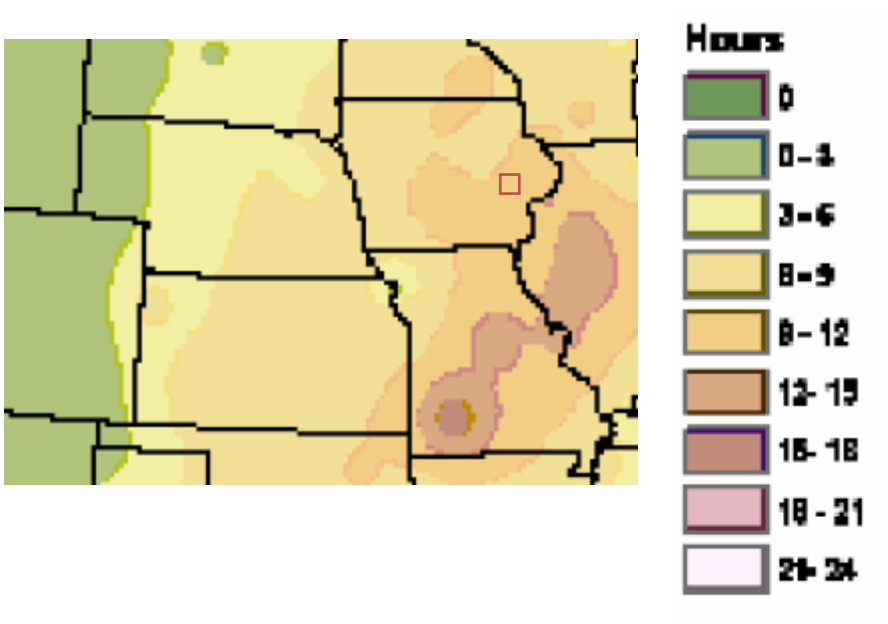
Geographic Location/Extent

According to the High Plains Regional Climate Center, the planning area had a winter high temperature normal of 31.9 degrees (F), the winter low temperature normal of 14.2 degrees (F) and the annual average snowfall of 30.7 inches from 1893 to 2010.

The entire state of Iowa is vulnerable to heavy snow, extreme cold temperatures and freezing rain. Generally, winter storms occur between the months of November and March, but can occur as early as October and as late as April.

Figure 3.33 shows that the entire planning area (approximated within the red square) is in the orange-shaded area that receives 9-12 hours of freezing rain per year.

Figure 3.33. Average Number of Hours per Year with Freezing Rain



Source: American Meteorological Society. "Freezing Rain Events in the United States." http://ams.confex.com/ams/pdfpapers/71872.pdf.; Note: Red square provides approximate location of planning area.

Previous Occurrences

Historically, there have been two Presidential Disaster Declarations for Severe Winter Storm that included Cedar County (**Table 3.46)**.

Table 3.46. Winter Storm Presidential Disaster Declarations (1965-April 2014)

Disaster Number	Description	Declaration Date (Incident Period)
DR-1737	Severe Winter Storms	01/04/2008 (12/10 to 12/11/2007)
DR-1688	Severe Winter Storms	03/14/2007 (2/23 to 3/2/2007)

Source: Federal Emergency Management Agency, www.fema.gov/; Note: Incident dates are in parentheses

From 1996 thru 2013, the National Climatic Data Center reports five blizzard events, 15 heavy snow events, 48 winter storm events, six ice storm events, and seven wind chill events for a total of 81 winter events that impacted the planning area during this 18 year time-period. This translates to an average of five winter storm events each year. The total property damage for these 81 events was a conservative $1,205,000.

NOAA's National Weather Service has issued 296 Advisory, Watch, and/or Warnings concerning winter weather phenomena between 2005 and April 2014 (see **Table 3.47**). The data is kept with Iowa Environmental Mesonet, Iowa State University Department of Agronomy website, (http://mesonet.agron.iastate.edu/vtec/search.php).

Table 3.47. National Weather Service Issuances for Winter Weather in Cedar County, IA

Phenomena	Significance	Number Issued between 2005 and April 2014
Blizzard	Watch	3
Blizzard	Warning	8
Blowing Snow	Advisory	7
Freeze	Watch	3
Freeze	Warning	17
Freezing Rain	Advisory	7
Frost	Advisory	21
Ice Storm	Warning	4
Snow	Advisory	15
Snow and Blowing Snow	Advisory	4
Wind Chill	Advisory	52
Wind Chill	Watch	1
Wind Chill	Warning	8
Winter Storm	Watch	39
Winter Storm	Warning	29
Winter Weather	Advisory	78
Total		**296**

Source: Environmental Mesonet, Iowa State University Department of Agronomy website, http://mesonet.agron.iastate.edu/vtec/search.php

The following section provides additional information for some of the winter storm and ice storm events that have impacted Cedar County:

- **February 21-22, 2013**—This system spread a swath of moderate to briefly heavy snow and strong winds over much of the area. Snowfall amounts of 3 to 6 inches were common, and 4.5 inches of snow was reported at Lowden. Wind gusts in the 30 to 35 mph range created considerable blowing and drifting as temperatures were in the 20s.
- **December 12, 2012**—A powerful storm system moved from the Southern Plains on Wednesday morning into Michigan by early Friday morning. This brought a potent winter storm to eastern Iowa through the period. Precipitation began as rain on Wednesday evening and quickly changed over to snow. A powerful cold front swept through eastern Iowa on Thursday morning changing the precipitation over to all snow from west to east by noon. In addition, winds switched to the northwest and increased rapidly to 25 to 35 mph with gusts as high as 60 mph. This created blizzard conditions across all of eastern Iowa reducing visibility to a half mile or less for several hours. The COOP observer in Lowden measured 8.0 inches of snow.
- **March 2, 2012**—Rain quickly changed over to snow during the afternoon of March 2, as a strong low pressure system pushed across the region. Snow ended by 7pm with snow accumulations ranging from 1 to 3 inches in most locations and 3.5 inches of snow was measured in Lowden.

  February 1-2, 2011—A tremendous blizzard, one of the worst in memory, impacted much of the region, as deep low pressure tracked from Texas to southern Indiana. Snowfall total reported at the Lowden COOP was 17.5 inches and wind gusts were 52 mph. Blizzard conditions were widespread with visibilities near zero in heavy snow and winds gusting to

over 50 to 60 mph. Temperatures were in the teens which added to the misery and the fluffy snow was easily blown around. Most roads, including interstates, were closed with numerous vehicles stuck in drifts or sliding into ditches, but no major accidents were reported. Many people became stranded but were eventually rescued. Many schools and events were cancelled or closed for a couple of days, as it took crews a while to open up rural roads and even side streets. At the height of the blizzard during the late afternoon and evening hours on February 1, snowfall rates were as high as 1 to 3 inches per hour. These rates were enhanced by thunder-snows that developed in the evening across eastern Iowa and northwest Illinois.

- **January 25-26, 2010**—Snowfall was only in the 1 to 3 inch range in eastern Iowa, but northwest winds gusting to 45 to 50 mph caused brief near-blizzard conditions with local whiteouts in rural and open areas. Trained spotters reported visibilities less than 1/4 mile to near zero at times. The worst conditions occurred during the afternoon and evening of January 25, but significant blowing and drifting was still being reported in some areas during the early morning hours of January 26.
- **December 25-27, 2009**—Over this three day period widespread snow accumulations of three to eight inches were noted. At Lowden, 6.2 inches of snow was reported.
- **January 13, 2009**—A COOP observer measured 7.2 inches of snow at Lowden.
- **November 29, 2008**—This was the first snowfall of the winter season and produced widespread accumulations of two to four inches.
- **FEMA-1688-DR-IA, February 2007**—A widespread and crippling ice/snow storm affected eastern Iowa, northwest and western Illinois, and extreme northeast Missouri on February 24, 2007. This massive ice storm was the worst to affect the region since January 22-23, 1965. Ice accumulations of around one inch were common, with some reports to near two inches. To make matters worse, east winds gusting over 50 mph, combined with the heavy ice accumulation, brought down numerous tree branches and power lines, along with several thousand power poles. There were even whole trees crashing down from the weight of the ice. Widespread power outages occurred, affecting over 180,000 people, which lasted more than a week in some of the rural areas. The city of Lowden reported losing electricity for approximately 12 hours. Many shelters were opened to accommodate those without power. The Governor of Iowa declared much of the state a disaster area, and requested President Bush to declare much of eastern Iowa a federal disaster area. Considering the magnitude of the storm, remarkably no direct deaths were reported.

  Mechanicsville reported power outages for three days with water plant, sewer lift station, and city office off line. The storm also caused damage to trees and vegetation.

  Tipton reported power outages, broken power poles at West 4th, bad road conditions, and downed trees.
- **FEMA-1737-DR-IA, December 2007**—A large area of freezing rain developed by the late evening hours over Iowa. Ice accumulations were in the ¼ to 1 inch range, with snow and sleet mixed with the freezing rain in some areas. The ice knocked down some trees and branches, with scattered power outages reported.

  Mechanicsville reported power outage for about six hours.

Tipton reported down trees and limbs, bad road conditions and fallen power poles.

- **December 1, 2007**—A strong system tracked from western Kansas to northern Wisconsin. Ice accumulations of ¼ to ¾ of an inch occurred with wind gusts up to 40 mph caused tree damage and scattered power outages. A West Branch Community School bus slid on an icy road and ended up in a ditch.
- **January 22, 2005**—A fast moving storm with sustained winds of 30 to 40 mph with gusts over 50 mph were common creating blizzard conditions in the pre dawn hours and during the morning commute across east central Iowa. Several county Sheriff's offices issued emergency alerts to media outlets indicating that travel was not recommend in their county. Numerous accidents occurred and highway crews radioed in reports of zero visibility.

Agricultural Impacts

Winter storms, cold, frost and freeze take a toll on crop production in the planning area. According to the USDA's Risk Management Agency, payments for insured crop losses in the planning area as a result of cold conditions and snow from 2004-2013 totaled $514,460 (see **Table 3.48**).

Table 3.48. Crop Insurance Claims Paid in Cedar County as a Result of Cold Conditions and Snow (2004-2013)

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2005	Corn	Cold Wet Weather	$1,652
2005	Soybeans	Cold Wet Weather	$2,061
2006	Soybeans	Cold Wet Weather	$7,375
2008	Corn	Cold Wet Weather	$273,800
2008	Soybeans	Cold Wet Weather	$24,356
2009	Corn	Cold Wet Weather	$1,695
2009	Soybeans	Cold Wet Weather	$2,463
2011	Soybeans	Cold Wet Weather	$1,416
2012	Corn	Cold Wet Weather	$33,934
2012	Soybeans	Cold Wet Weather	$1,205
2013	Corn	Cold Wet Weather	$10,740
2013	Soybeans	Cold Wet Weather	$40,782
2013	Soybeans	Cold Wet Weather	$1,448
2004	Corn	Frost	$13,663
2004	Soybeans	Frost	$3,107
2005	Corn	Frost	$4,421
2005	Soybeans	Frost	$404
2009	Soybeans	Frost	$504
2004	Corn	Snow	$8,391
2004	Soybeans	Snow	$27,590
2008	Corn	Snow	$274
2009	Soybeans	Snow	$6,766
2010	Corn	Snow	$1,603
2013	Corn	Snow	$44,811
Total			**$514,460**

Source: USDA Risk Management Agency, 2013

Probability of Future Occurrence

According to NCDC, during the 18 year period from 1996 thru 2013, the planning area experienced 81 total blizzards, winter storms, ice storms and extreme cold events. This translates to an annual probability of approximately five blizzard, winter/ice storm, or extreme cold events per year.

Probability Score: 4—Highly Likely

Vulnerability

Vulnerability Overview

The entire planning area is vulnerable to the effects of winter storm. Hazardous driving conditions due to snow and ice on highways and bridges lead to many traffic accidents and can impact the response of emergency vehicles. The leading cause of death during winter storms is transportation accidents. About 70 percent of winter-related deaths occur in automobiles due to traffic accidents and about 25 percent are from people caught outside in a storm. Emergency services such as police, fire, and ambulance are unable to respond due to road conditions. Emergency needs of remote or isolated residents for food or fuel, as well as for feed, water and shelter for livestock are unable to be met. The probability of utility and infrastructure failure increases during winter storms due to freezing rain accumulation on utility poles and power lines. People, pets, and livestock are also susceptible to frostbite and hypothermia during winter storms. Those at risk are primarily either engaged in outdoor activity (shoveling snow, digging out vehicles, or assisting stranded motorists), or are the elderly. Schools often close during extreme cold or heavy snow conditions to protect the safety of children and bus drivers. Citizens' use of kerosene heaters and other alternative forms of heating may create other hazards such as structural fires and carbon monoxide poisoning.

According to the 2013 Iowa Hazard Mitigation Plan, of the 8 hazards for which data was available to estimate annualized losses, severe winter storm ranked 6th with $2.2 million in annualized losses based on data spanning a 13-year period.

Magnitude Score: 2—Limited

Potential Losses to Existing Development

Vulnerable Buildings, Infrastructure, and Critical Facilities

Buildings with overhanging tree limbs are more vulnerable to damage during winter storms. Businesses experience loss of income as a result of closure during power outages. In general heavy winter storms increase wear and tear on roadways though the cost of such damages is difficult to determine. Businesses can experience loss of income as a result of closure during winter storms.

Loss of Use

Overhead power lines and infrastructure are also vulnerable to damages from winter storms, in particular ice accumulation during winter storm events can cause damages to power lines due to the ice weight on the lines and equipment as well as damage caused to lines and equipment from falling trees and tree limbs weighted down by ice. Potential losses would include cost of repair or replacement of damaged facilities, and lost economic opportunities for businesses.

Secondary effects from loss of power could include burst water pipes in homes without electricity during winter storms. Public safety hazards include risk of electrocution from downed power lines. Specific amounts of estimated losses are not available due to the complexity and multiple variables associated with this hazard. According to FEMA standard values for loss of service for utilities reported in the 2009 Benefit Cost Analysis Reference Guide, the economic impact as a result of loss of power is $126 per person per day of lost service. The loss of use estimates in the **Tornado/Windstorm Section 3.5.15** are provided to estimate costs associated with the loss of power in relation to the populations in each jurisdiction.

Property Losses

The total property losses reported by the NCDC for a total of 81 winter events that impacted the planning area during the 18 year time-period from 1996 thru 2013 were $1,205,000. However, damages for winter and ice storms are reported for all weather zones impacted. So, it is not possible to determine the damages from these events to just Cedar County.

USDA crop insurance claims for cold conditions and snow for the ten-year period of 2004-2013 totaled $514,460. The 2013 Iowa Crop Insurance Profile from USDA, RMA shows that 90.5 percent of crops are insured in Iowa and the adjusted losses calculate to $568,464 for the period and $56,846 in estimated annualized losses (see **Table 3.49**).

Considering the value of crops from the 2012 Census of Agriculture as baseline crop exposure, the estimated annual losses from cold conditions and snow was determined minimal compared to the value of the insurable crops.

Table 3.49. Estimated Insurable Annual Crops Lost Resulting From Cold Conditions and Snow

10-Year Winter Weather Insurance Paid	Adjusted 10-Year Winter Weather Losses (considering 90.5% insured)	Estimated Annualized Losses*	2012 Value of Crops
$514,460	$568,464	$56,846	$219,282,000

Source: Crop value is from USDA 2012 Census of Agriculture; Crop Insurance Paid is from the USDA's Risk Management Agency for 2004-2013.

*Note: This includes insurable crops that are not insured.

Increased Risk Populations

Elderly populations are considered to be at increased risk to Winter Storms and associated extreme cold events. **Table 3.28** in the Extreme Heat Profile Section provides the number of population over 65 in each jurisdiction in the planning area.

Future Development

Future development could potentially increase vulnerability to this hazard by increasing demand on the utilities and increasing the exposure of infrastructure networks.

Severe Winter Storm Hazard Summary by Jurisdiction

Although crop loss as a result of winter storm occurs more in the unincorporated portions of the planning area, the crops losses are not high since corn and soybeans are not in the ground during winter months and only get affected from unusual weather events. The density of vulnerable populations is higher in the cities. Transportation incidents related to winter storm could also impact all jurisdictions. With these vulnerabilities that apply to both urban and rural jurisdictions, the magnitude of this hazard is relatively equal. The factors of probability, warning time, and duration are also equal across the planning area. This hazard does not substantially vary by jurisdiction.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Cedar County	4	2	3	3	3.15	High
City of Bennett	4	2	3	3	3.15	High
City of Clarence	4	2	3	3	3.15	High
City of Durant	4	2	3	3	3.15	High
City of Lowden	4	2	3	3	3.15	High
City of Mechanicsville	4	2	3	3	3.15	High
City of Stanwood	4	2	3	3	3.15	High
City of Tipton	4	2	3	3	3.15	High
City of West Branch	4	2	3	3	3.15	High
Bennett School District, #603	4	2	3	3	3.15	High
Durant School District, #1926	4	2	3	3	3.15	High
North Cedar School District, #3691	4	2	3	3	3.15	High
Tipton School District #6408	4	2	3	3	3.15	High
West Branch School District #6930	4	2	3	3	3.15	High

3.5.12 Sinkholes

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
1	1	4	1	1.45	Low

Profile

Hazard Description

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, void 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. Although subsidence can be a naturally occurring hazard, the primary causes of most incidents of subsidence are human activities: underground mining of coal, groundwater or petroleum withdraw, and drainage of organic soils. Land subsidence occurs slowly and continuously over time or on occasion abruptly, as in the sudden formation of sinkholes. Sinkholes can be aggravated by flooding.

Warning Time Score: 4—Minimal or no warning time

Duration Score: 1—Less than 6 hours

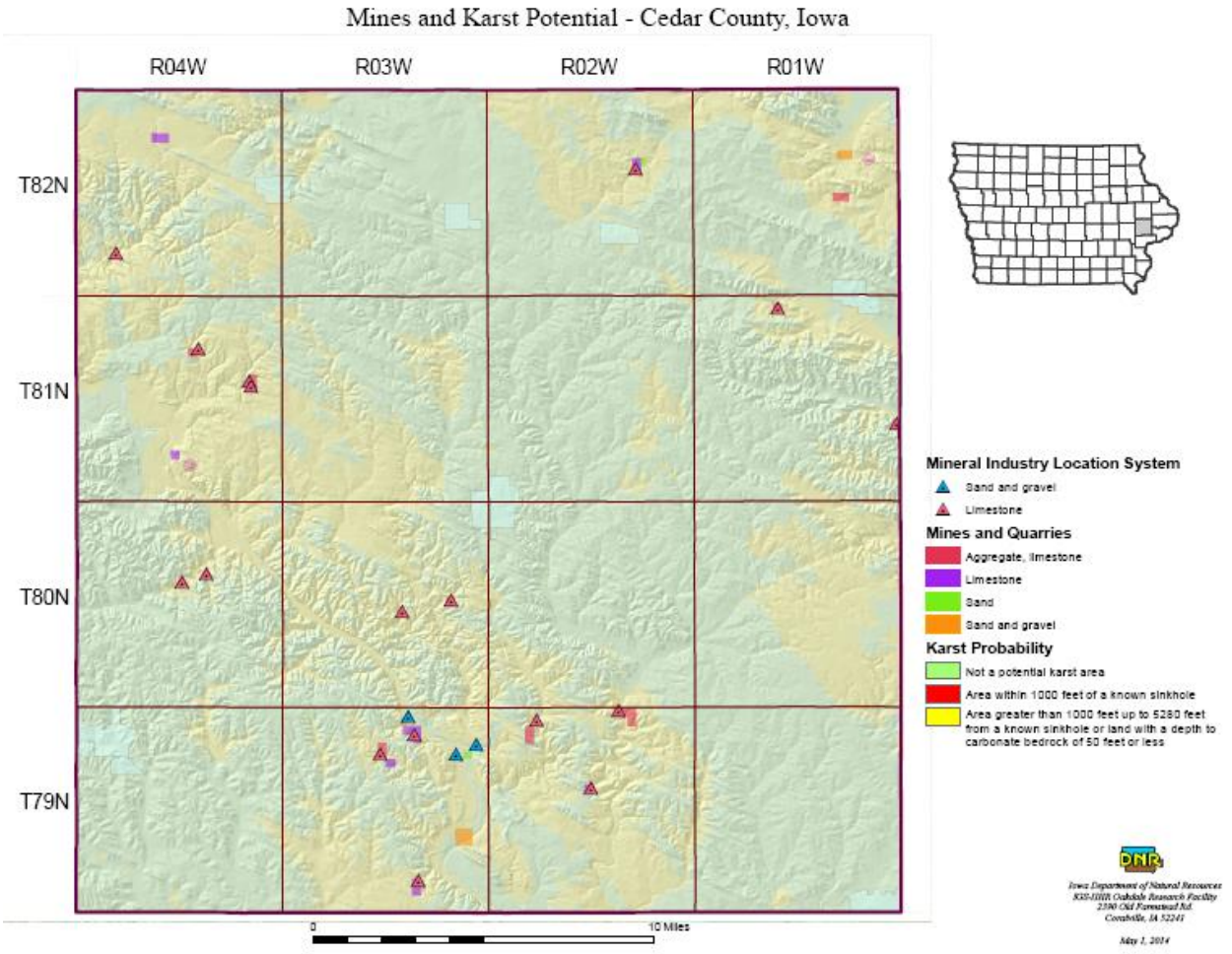
Geographic Location/Extent

According to the Iowa Department of Natural Resources, Cedar County has three levels of karst probability in the County as seen in **Figure 3.34**:

- Low karst area shaded in light green,
- Potential karst areas are shaded in light yellow with greater than 1,000 feet up to 5,280 feet from a known sinkhole or land with a depth to carbonate bedrock of 50 feet or less,
- Potential karst areas within 1,000 feet of a known sinkhole are shaded red.

Figure 3.34 also shows the locations of sand and gravel and limestone industry mines and quarries.

Figure 3.34. Mines and Karst Potential – Cedar County, IA



The Iowa Department of Natural Resources has examined where animal feeding operations are located in Iowa against the locations of known sinkhole areas and there are no known sinkhole areas at animal feeding operations in Cedar County.

Previous Occurrences
Research did not reveal any reported previous occurrences of sinkholes in the planning area.

Probability of Future Occurrence
Based on no reported previous sinkhole events, the probability of future occurrences is "unlikely".

Probability Score: 1—Unlikely

Vulnerability

Vulnerability Overview
Sand and gravel and limestone industry mines and quarries are in the planning area and sinkholes have been found in the planning area.

Magnitude Score: 1—Negligible

Potential Losses to Existing Development

Since Cedar County is considered to have a mixture of karst areas according to Iowa Department of Natural Resources, sinkholes are possible and from abandoned mines and quarries to affect existing development.

Due to the lack of information regarding previous occurrences of this hazard, it is not possible to estimate potential losses.

Future Development

Future development will increase vulnerability to this hazard.

Sinkhole Hazard Summary by Jurisdiction

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Cedar County	1	1	4	1	1.45	Low
City of Bennett	1	1	4	1	1.45	Low
City of Clarence	1	1	4	1	1.45	Low
City of Durant	1	1	4	1	1.45	Low
City of Lowden	1	1	4	1	1.45	Low
City of Mechanicsville	1	1	4	1	1.45	Low
City of Stanwood	1	1	4	1	1.45	Low
City of Tipton	1	1	4	1	1.45	Low
City of West Branch	1	1	4	1	1.45	Low
Bennett School District, #603	1	1	4	1	1.45	Low
Durant School District, #1926	1	1	4	1	1.45	Low
North Cedar School District, #3691	1	1	4	1	1.45	Low
Tipton School District #6408	1	1	4	1	1.45	Low
West Branch School District #6930	1	1	4	1	1.45	Low

3.5.13 Terrorism

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
1	3	4	1	2.05	Moderate

Profile

Hazard Description

This hazard encompasses the following sub-hazards: enemy attack, biological terrorism, agro-terrorism, chemical terrorism, conventional terrorism, cyber terrorism, radiological terrorism and public disorder. These hazards can occur anywhere and demonstrate unlawful force, violence, and/or threat against persons or property causing intentional harm for purposes of intimidation, coercion or ransom in violation of the criminal laws of the United States. These actions may cause massive destruction and/or extensive casualties. The threat of terrorism, both international and domestic, is ever present, and an attack is likely to occur when least expected.

Enemy attack is an incident that could cause massive destruction and extensive casualties throughout the world. Some areas could experience direct weapons' effects: blast and heat; others could experience indirect weapons' effect. International political and military activities of other nations are closely monitored by our federal government and the State of Iowa would be notified of any escalating military threats.

The use of biological agents against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion or ransom can be described as biological terrorism. Liquid or solid contaminants can be dispersed using sprayers/aerosol generators or by point of line sources such as munitions, covert deposits and moving sprayers. Biological agents vary in the amount of time they pose a threat. They can be a threat for hours to years depending upon the agent and the conditions in which it exists.

Agro-terrorism consists of acts to intentionally contaminate, ruin, or otherwise make agricultural products unfit or dangerous for consumption or further use. Agriculture is an important industry in Iowa and Cedar County. The introduction of a biological agent into the population of 3.9 million cattle and calves or the 13.7 billion acres of corn in Iowa would be financially devastating and would have a major impact on the food supply of the state and the nation. A major attack involving the nation's food supply could be launched in a rural area that has little capacity to respond. Potential terrorists' targets for livestock disease introduction would be concentration points, such as the state's licensed feedlots or livestock markets.

Chemical terrorism involves the use or threat of chemical agents against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion or ransom. Effects of chemical contaminants are similar to biological agents.

Use of conventional weapons and explosives against persons or property in violation of the criminal laws of the United States for purposes of intimidations, coercion, or ransom is conventional terrorism. Hazard affects are instantaneous; additional secondary devices may be used, lengthening the time duration of the hazard until the attack site is determined to be clear. The extent of damage is determined by the type and quantity of explosive. Effects are generally

static other than cascading consequences and incremental structural failures. Conventional terrorism can also include tactical assault or sniping from remote locations.

Electronic attack using one computer system against another in order to intimidate people or disrupt other systems is a cyber attack. All governments, businesses and citizens that conduct business utilizing computers face these threats. Cyber-security and critical infrastructure protection are among the most important national security issues facing our country today. As such, the Iowa Division of Criminal Investigation has a Cyber Crime Unit tasked with analysis and retrieval of digital information for investigations.

Radiological terrorism is the use of radiological materials against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion or ransom. Radioactive contaminants can be dispersed using sprayers/aerosol generators, or by point of line sources such as munitions, covert deposits and moving sprayers or by the detonation of a nuclear device underground, at the surface, in the air or at high altitude.

Mass demonstrations, or direct conflict by large groups of citizens, as in marches, protest rallies, riots, and non-peaceful strikes are examples of public disorder. These are assembling of people together in a manner to substantially interfere with public peace to constitute a threat, and with use of unlawful force or violence against another person, or causing property damage or attempting to interfere with, disrupting, or destroying the government, political subdivision, or group of people. Labor strikes and work stoppages are not considered in this hazard unless they escalate into a threat to the community. Vandalism is usually initiated by a small number of individuals and limited to a small target or institution. Most events are within the capacity of local law enforcement.

The Southern Poverty Law Center reported in 2014 there were five active hate groups in Iowa: one racist skinhead group (Aryan Strikeforce), three Ku Klux Klan groups (Fraternal White Knights of the KKK, Loyal White Knights of the KKK, and New Empire Knights of the KKK) and one National Socialist Movement group (Neo-Nazi).

Warning Time Score: 4—Minimal or no warning

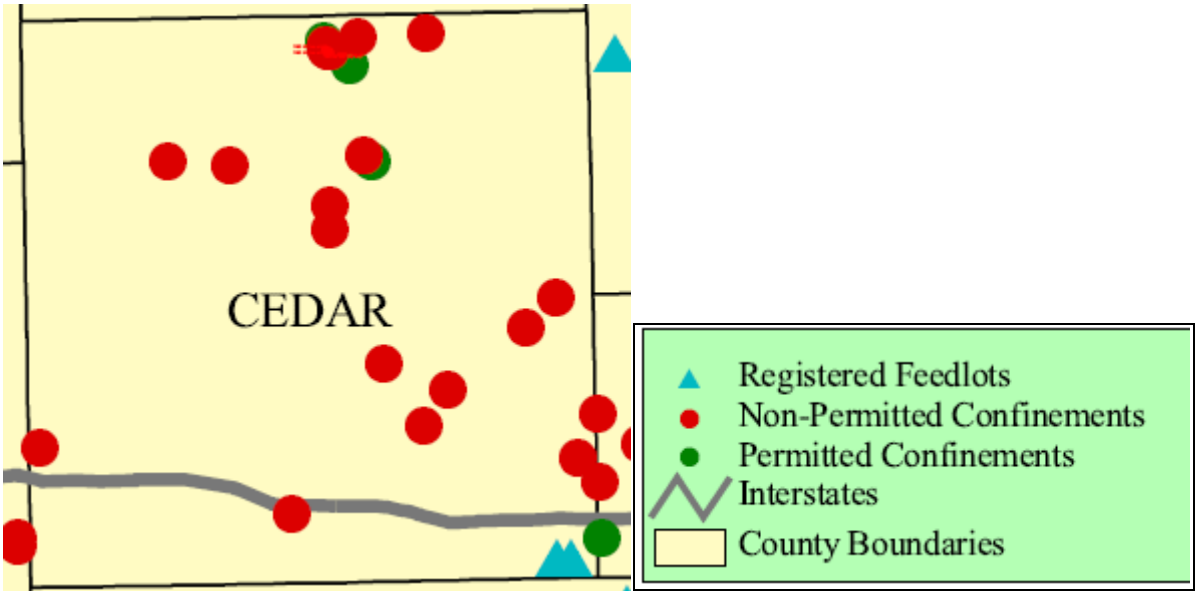
Duration Score: 4—More than 1 week

Geographic Location/Extent

The entire planning area has a low potential for terrorist activity. However, the Herbert Hoover Presidential Library & Museum attracts visitors from all over the world and there are various events throughout the County that include assembly of large crowds of people. Any venue with a large gathering of people could be a potential target for terrorists.

For agro-terrorism planning, **Figure 3.35** shows the locations of animal feeding operations in Cedar County that have greater than 200,000 lbs live weight animals.

Figure 3.35. Locations of Animal Feeding Operations in Cedar County, IA



Source: Iowa Department of Natural Resources,
http://www.iowadnr.gov/Environment/LandStewardship/AnimalFeedingOperations/Mapping.aspx

Previous Occurrences

There have not been any large-scale enemy attacks or acts of radiological terrorism in Iowa. In Iowa there have been biological and chemical agent threats, animal rights activists' vandalism and many bomb threats. In 2002, pipe bombs were found in 18 states including Iowa and six people were injured in the bombings in Iowa and Illinois. In 2005 and 2006, pipe bombs were used in attempted murder cases in two Iowa cities.

The Iowa Department of Public Safety issued an *Iowa Hate Crime by Jurisdiction Report, 1991-2007* and Cedar County had a total of three reported. Two were reported by the Cedar County Sheriff's Office and one was reported by the Tipton Police Department both in 1999.

The Iowa Department of Public Safety issued a *2009 Iowa Uniform Crime Report* showing 18 hate/bias crimes were reported statewide in 2009 and an average of 33 hate/bias crimes statewide from 2000-2009.

According to the Southern Poverty Law Center, there have not been any hate crimes incidents reported in Cedar County.

Probability of Future Occurrence

While difficult to estimate, the probability for a terrorist event is "**Unlikely**" within the next 10 years in Cedar County. The overall crime rate is relatively low in Cedar County. According to the Iowa Division of Criminal Investigation, Cedar County has had an average of 27 criminal investigations and 548 crime lab evidence cases worked during the fiscal years of 2009 through 2013. The Durant, Clarence, Mechanicsville, and Tipton Police Departments and Sheriff's Office provide law enforcement protection.

Probability Score: 1—UnLikely

Vulnerability

Overview
A terrorism event could occur in either limited area of a jurisdiction or over the entire jurisdiction at once. This hazard has the ability to directly cause substantial structural losses and potentially loss of life.

Magnitude Score: 3—Critical

Potential Losses to Existing Development
Potential losses from Terrorism include all infrastructure, critical facilities, crops, humans and animals. The degree of impact would be directly related to the type of incident and the target. Potential losses could include cost of repair or replacement of damaged facilities, lost economic opportunities for businesses, loss of human life, injuries to persons, loss of food supplies, disruption of the food supply chain, and immediate damage to the surrounding environment. Secondary effects of infrastructure failure could include public safety hazards, spread of disease, increased morbidity and mortality among the local and distant populations, public panic and long-lasting damage to the environment. Terrorism events are rare occurrences and specific amounts of estimated losses for previous occurrences are not available due to the complexity and multiple variables associated with these types of hazards. In some instances, information about these events is secure and unavailable to the public in order to maintain national security and prevent future attacks.

As discussed previously, it is difficult to quantify potential losses in terms of the jurisdictions most threatened by CBRNE (chemical, biological, radiological, nuclear, and high yield explosive) attack events due to the many variables and human element. Therefore, for the purposes of this plan, the loss estimates will take into account a hypothetical scenario. The attack scenario is staged at a speedway during a Friday night race event. The hypothetical speedway is situated on the edge of town and has approximately 800 persons in the stands, race pit area, and concession areas on any given Friday night during spring and summer.

Analysis of vulnerable populations is aided by a program developed by Johns Hopkins University in 2006 called Electronic Mass Casualty Assessment and `Planning Scenarios (EMCAPS) http://www.hopkins-cepar.org/EMCAPS/EMCAPS.html which utilizes scenarios developed by the Department of Homeland Security.

****THE FOLLOWING HYPOTHETICAL SCENARIO IS FOR INSTRUCTIONAL AND ILLUSTRATIVE PURPOSES ONLY****

Chemical Attack – Toxic Gas – Chlorine Release

***Scenario Overview*:** A bomb is attached to a tractor trailer tanker carrying compressed chlorine and enters a speedway parking lot. The entire contents of the tank escape to the atmosphere and the plume spreads to the speedway grounds and the immediate surrounding parking lot area. This particular type of attack would cause harm to humans and could render portions of the venue unusable for a short time period in order to allow for a costly clean-up. There might

also be a fear by the public of long-term contamination of the venue and subsequent boycott of events at that location and create a loss of revenue and tourism dollars.

Assumptions: (1) The population density at the event venue is approximately 800 persons around the speedway property. (2) Chlorine is toxic and may damage eyes, skin and respiratory tract. (3) The rate of "worried well" is equal to 9 times the number of infected cases.

Table 3.50. Described Losses from a Chemical Attack – Chlorine Scenario

Eye pain & swelling, headache, restricted airflow – difficulty breathing, possible chemical burns	35 persons
Eye pain & swelling, headache, rapid breathing, skin irritation	67 persons
Eye pain & swelling, headache, rapid breathing, coughing, chest pain, skin irritation	137 persons
Eye irritation, headache, throat irritation, coughing, skin irritation	190 persons
Eye irritation, headache, coughing, skin irritation	131 persons
Total "Worried Well" Cases (9 times the number of affected cases)	1,710 persons
Deaths	0 persons
Cost of Decontamination @ $12/person (assumes all persons with skin injuries will require decontamination and approximately 1/10 of the worried well will demand to be decontaminated) - total persons =731.	$8,772

Notes: Victims will require decontamination and both long and short term treatment. Events may need to be suspended at the speedway until all investigations are conducted.

Improvised Explosive Device Attack – ANFO

Scenario Overview: An Improvised Explosive Device (IED) utilizing an ammonium nitrate/fuel oil (ANFO) mixture is carried in a panel van to a parking area during a time when speedway patrons are leaving their cars and entering the stands. Potential losses with this type of scenario include both human and structural assets.

Assumptions: (1) The population density in the parking lot during the beginning and ending of the race is high, at least 1 person /100 square feet. (2) The quantity of ANFO used is 500 lbs.

Table 3.51. Described Losses from a Improvised Explosive Device Attack - ANFO

Total Dead	87 persons
Total Traumatic Injuries	151 persons
Total Urgent Care Injuries	745 persons
Injuries not Requiring Hospitalization	279 persons
Structures and Other Physical Assets (Damages would certainly occur to vehicles and depending on the proximity of other structures, damages would occur to the speedway complex itself. The exact amount of these damages is difficult to predict because of the large numbers of factors, including the type of structures nearby and the amount of insurance held by vehicle owners.)	Vehicles – Replacement cost for approximately 350 vehicles @ $10,000 per vehicle inside the 200 ft BATF described Lethal Air Blast range = $ 3,500,000 Repair / repainting cost for approximately 70 vehicles @ $ 4,000 per vehicle inside the BATF described Falling Debris Hazard = $280,000

Note: These are the numbers of persons that could be injured from an IED Attack if they are in the area.

Future Development

As public events are held at speedway, county fair ground, schools, and the Herbert Hoover Presidential Library & Museum the potential may exist for these locations to become targets of attack. With human-caused hazards such as this that can have multiple variables involved, increases in development is not always a factor in determining risk, although the physical cost of the event may increase with the increased or newly developed areas.

Terrorism Hazard Summary by Jurisdiction

The overall rating for any type of terrorism in the County is 2.05 “Moderate”. This rating score continues for the cities with over 1,000 in population, the school districts in those cities. The cities with less than 1,000 in population were given a magnitude of 2 and an overall rating score of 1.75.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Cedar County	1	3	4	1	2.05	Moderate
City of Bennett	1	2	4	1	1.75	Low
City of Clarence	1	2	4	1	1.75	Low
City of Durant	1	3	4	1	2.05	Moderate
City of Lowden	1	2	4	1	1.75	Low
City of Mechanicsville	1	3	4	1	2.05	Moderate
City of Stanwood	1	2	4	1	1.75	Low
City of Tipton	1	3	4	1	2.05	Moderate
City of West Branch	1	3	4	1	2.05	Moderate
Bennett School District, #603	1	2	4	1	1.75	Low
Durant School District, #1926	1	3	4	1	2.05	Moderate
North Cedar School District, #3691	1	2	4	1	1.75	Low
Tipton School District #6408	1	3	4	1	2.05	Moderate
West Branch School District #6930	1	3	4	1	2.05	Moderate

3.5.14 Thunderstorm with Lightning and Hail

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
4	1	3	1	2.65	Moderate

Profile

Hazard Description

A thunderstorm is defined as a storm that contains lightning and thunder which is caused by unstable atmospheric conditions. When the upper air which is cold sinks and the warm moist air rises, storm clouds or 'thunderheads' develop resulting in thunderstorms. This can occur singularly, in clusters or in lines. Severe thunderstorms most often occur in Iowa in the spring and summer, during the afternoon and evenings, but can occur at any time. Other hazards associated with thunderstorms and lightning include: heavy rains causing flash flooding (discussed separately in **Section 3.5.6**) and tornadoes and windstorms (discussed further in **Section 3.5.15**).

Lightning

All thunderstorms produce lightning which often strikes outside of the area where it is raining and is known to fall more than 10 miles away from the rainfall area. Thunder is simply the sound that lightning makes. Lightning is a huge discharge of electricity. When lightning strikes, electricity shoots through the air and causes vibrations creating the sound of thunder. Nationwide, lightning kills 75 to 100 people each year. Lightning strikes can also start building fires, wildland fires, and damage electrical systems and equipment.

Hail

According to the National Oceanic and Atmospheric Administration (NOAA), hail is precipitation that is formed when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere causing them to freeze. The raindrops form into small frozen droplets and then continue to grow as they come into contact with super-cooled water which will freeze on contact with the frozen rain droplet. This frozen rain droplet can continue to grow and form hail. As long as the updraft forces can support or suspend the weight of the hailstone, hail can continue to grow.

At the time when the updraft can no longer support the hailstone, it will fall down to the earth. For example, a ¼" diameter or pea sized hail requires updrafts of 24 mph, while a 2 ¾" diameter or baseball sized hail requires an updraft of 81 mph. The largest hailstone recorded in the United States was found in Vivian, South Dakota on July 23, 2010, measuring eight inches in diameter, almost the size of a soccer ball. Soccer-ball-sized hail is the exception, but even small pea sized hail can do damage.

Hailstorms in Iowa cause damage to property, crops, and the environment and kill and injure livestock. In the United States, hail causes more than $1 billion in damage to property and crops each year. Much of the damage inflicted by hail is to crops. Even relatively small hail can shred plants to ribbons in a matter of minutes. Vehicles, roofs of buildings and homes, and

landscaping are the other things most commonly damaged by hail. Hail has been known to cause injury to humans, occasionally fatal injury.

Based on information provided by the Tornado and Storm Research Organization, **Table 3.52** below describes typical damage impacts of the various sizes of hail.

Table 3.52. Tornado and Storm Research Organization Hailstorm Intensity Scale

Intensity Category	Diameter (mm)	Diameter (inches)	Size Description	Typical Damage Impacts
Hard Hail	5-9	0.2-0.4	Pea	No damage
Potentially Damaging	10-15	0.4-0.6	Mothball	Slight general damage to plants, crops
Significant	16-20	0.6-0.8	Marble, grape	Significant damage to fruit, crops, vegetation
Severe	21-30	0.8-1.2	Walnut	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
Severe	31-40	1.2-1.6	Pigeon's egg > squash ball	Widespread glass damage, vehicle bodywork damage
Destructive	41-50	1.6-2.0	Golf ball > Pullet's egg	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
Destructive	51-60	2.0-2.4	Hen's egg	Bodywork of grounded aircraft dented, brick walls pitted
Destructive	61-75	2.4-3.0	Tennis ball > cricket ball	Severe roof damage, risk of serious injuries
Destructive	76-90	3.0-3.5	Large orange > Soft ball	Severe damage to aircraft bodywork
Super Hailstorms	91-100	3.6-3.9	Grapefruit	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
Super Hailstorms	>100	4.0+	Melon	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

Source: Tornado and Storm Research Organization (TORRO), Department of Geography, Oxford Brookes University
Notes: In addition to hail diameter, factors including number and density of hailstones, hail fall speed and surface wind speeds affect severity.

The onset of thunderstorms with lightning and hail is generally rapid. Duration is less than 6 hours and warning time is generally 6 to 12 hours.

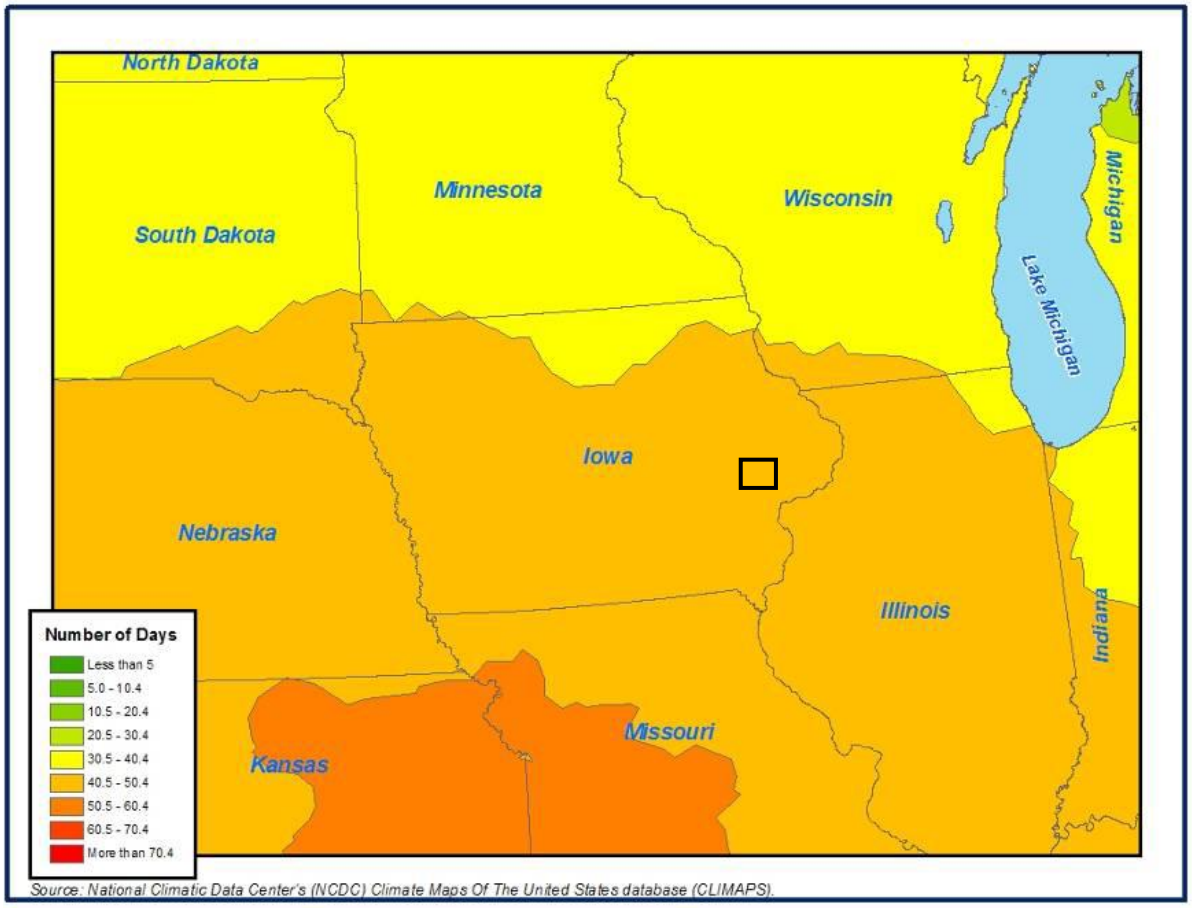
Warning Time Score: 3—6 — 12 hours

Duration Score: 1—less than 6 hours

Geographic Location/Extent

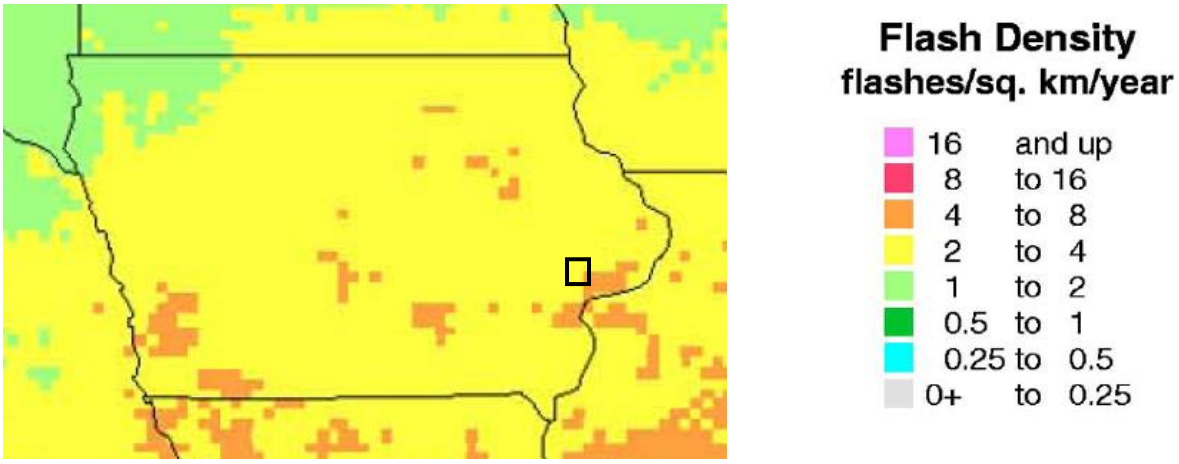
Thunderstorms and the associated hail and lightning impact the entire County with relatively similar frequency. Although, these events occur similarly throughout the planning area, they are more frequently reported in more urbanized areas. In addition, damages are more likely to occur in more densely developed urban areas. **Figure 3.36** displays the average number of days with thunder experienced throughout different areas of the county each year, showing the County experiences between 40.5 to 50.4 days with thunder per year. **Figure 3.37** shows 2 to 8 lightning strikes per square kilometer per year with both yellow and orange shaded areas.

Figure 3.36. Distribution and Frequency of Thunderstorms



Note: Black Square indicates approximate location of Cedar County

Figure 3.37. Location and Frequency of Lightning in Iowa



Source: National Weather Service, www.lightningsafety.noaa.gov/lightning_map.htm
Note: Black Square indicates approximate location of Cedar County

Previous Occurrences

Since 1969, Cedar County has been included in four presidential disaster declarations that included severe storms (see **Table 3.53**). Some of the damages that resulted in the declarations were from tornadoes and flooding that accompanied the severe weather.

Table 3.53. Presidential Disaster Declarations for Severe Storms that included Cedar County (1969-2013)

Number	Declared	Incident Period	Description
4135	07/31/2013	06/21 to 06/28/2013	Severe Storms, Tornadoes, and Flooding
4119	05/31/2013	04/17 to 04/30/2013	Severe Storms, Straight-line Winds, and Flooding
1763	5/27/2008	5/25 to 8/13/2008	Severe Storms, Tornadoes and Flooding
1518	05/25/2004	5/19 to 6/24/2004	Severe Storms, Tornadoes, and Flooding

Source: FEMA

The NCDC reported 106 total thunderstorm events for the Cedar County planning area from January 1996 thru December 2013, excluding multiple events on the same day. The events with damage search was limited to hail size of at least one inch in diameter and wind speed of at least 60 miles per hour. Of the reported events, there was $1,633,025 in total property damage and no injuries or fatalities.

Table 3.54. Thunderstorm Summary for Cedar County

Hazard type	Total Events	Events with Damage	Property Damage	Injuries	Fatalities
Hail	38	18	$313,000	0	0
Lightning	7	7	$163,025	0	0
Windstorms	61	51	$1,157,000	0	0
Totals	**106**	**76**	**$1,633,025**	**0**	**0**

Source: NCDC

Lightning

Some of the more notable damaging lightning events are described in additional detail below. Information on these events is from NCDC:

- **April 14, 2012**—As the thunderstorms moved through Cedar County, lightning struck a house in Stanwood setting it on fire.
- **September 20, 2010**—A thunderstorm moved across Lowden during the early morning hours and several homes in town sustained lightning damage.
- **June 21, 2007**—A house was struck by lightning knocking the chimney off and causing some electrical wiring damage in Clarence.
- **July 9, 2003**—An early morning thunderstorm with considerable lightning killed seven dairy cows and damaged a farm house southwest of Lowden.

Hail

Table 3.55 shows the number of hail events 0.75 inches and larger by the size of the hail.

Table 3.55. Hail Events Summarized by Hail Size

Hail Size (inches)	# of Events 1996-2013
2.75	1
2.50	1
2.00	0
1.75	6
1.50	2
1.25	3
1.00	14
0.88	10
0.75	20
Totals	**57**

Source: NCDC

Some of the more notable damaging hail events are described in additional detail below. Information on these events is from NCDC:

- **March 31, 2012—**Widespread thunderstorms across eastern Iowa. Tennis ball size (2.50 inch) hail fell in Clarence and smaller hail (1.25 inch) was recorded in Lowden. The hail damaged roofs, siding, windows and vehicles.
- **May 22, 2011**—Storms were severe producing large hail (1 inch) in Stanwood, damaging winds, and a few tornadoes.
- **August 9, 2008—**Some of the storms surpassed severe limits; producing hail the size of a penny up to the size of a ping pong ball. Tipton record hail 1 inch in size. In addition to the large hail, torrential rains also accompanied the storms.
- **August 15, 2007—**Hail 1.25 inch size fell just northeast of Tipton.
- **August 11, 2005—**Baseball sized hail damaged the home of the county emergency manager and several other homes on the east side of West Branch.
- **March 24, 2004—**Golfball hail covered the ground to the southeast of Mechanicsville.

Thunderstorm Winds

Information concerning tornadoes and windstorms, separate from thunderstorms, can be found in **Section 3.5.15**.

Some of the more notable damaging thunderstorm wind events are described in additional detail below. Information on these events is from NCDC:

- **September 19, 2013—**Numerous reports of high winds were received with wind speeds of 60 to 80 MPH. Several large trees were down in Tipton and a cattle shed at the fairgrounds was also blown down.
- **July 19, 2013—**Wind gusts estimated to be 70 mph blew down some large tree limbs and ripped off a barn roof about 5 miles south of Bennett.
- **May 22, 2011—**Wind gusts estimated to be 70 mph blew down some trees onto some buildings and vehicles on the east side of Lowden. Power lines were also downed and some streets were blocked.
- **June 18, 2010—**Wind gusts estimated to be 70 mph blew down a number of trees onto cars and power lines in Clarence.

- **June 8, 2008**—Wind gusts estimated to be 65 mph blew down some trees and power poles in Stanwood.
- **October 17, 2007**—The fire station in Lowden measured a peak gust of 62 mph during a thunderstorm, while a coop observer measured a 58 mph wind gust. Several trees were blown down in the Lowden area, and several cornfields were flattened. A machine shed was also damaged south of Lowden.
- **April 15, 2006**—A line of storms produced a severe downburst in Clarence and south of Clarence in the unincorporated area. Winds with this downburst were estimated at 83-87 knots (95-100 mph). In Clarence, Hunwardsen Fabrication lost the roof and one entire wall of their building. Other reports of damage south of town include trees down, grain bin and a gazebo were destroyed, barn roof ripped off, a 70 foot silo destroyed, sheds destroyed, livestock building rook peeled off and down power lines.
- **July 20, 2003**—Corn flattened with trees down and an out building damaged.
- **March 9, 2002**—The Tipton Country Club suffered heavy damage. A large cart shed was destroyed and blown into a parking area south of the clubhouse. Several large trees were blown down. A roof was peeled back on another shed, holes were punched in a third shed, the roof was blown off a small structure next to the pool, and approximately 9 trees were damaged or destroyed. At Country Estates, the skirting was blown off several homes, and a roof was blown off a barn.

The National Weather Service (NWS) will issue a Severe Thunderstorm Warning whenever a thunderstorm is forecasted to produce wind gusts to 58 miles per hour (50 knots) or greater and/or hail size one inch (quarter-size) diameter which can produce significant damage (source: http://www.nws.noaa.gov/oneinchhail/). **Table 3.56** shows the number of Severe Thunderstorm Watches and Warnings issued by NOAA's National Weather Service. The data is kept on Iowa Environmental Mesonet, Iowa State University Department of Agronomy website, (http://mesonet.agron.iastate.edu/vtec/search.php).

Table 3.56. National Weather Service Severe Thunderstorm Watch and Warning Issued in Cedar County, IA, 2005-April 2014

Year	Severe Thunderstorm Watch	Severe Thunderstorm Warning
So far in 2014	2	2
2013	10	17
2012	10	15
2011	8	25
2010	13	11
2009	11	10
2008	15	24
2007	12	9
2006	18	10
2005	0	11
Total	**97**	**132**

Source: Environmental Mesonet, Iowa State University Department of Agronomy website, http://mesonet.agron.iastate.edu/vtec/search.php , accessed April 2014

Although NCDC provides estimates of crop losses, crop insurance payment statistics are considered a more accurate resource for this data. According to the USDA Risk Management

Agency, insured crop losses in Cedar County as a result of hail from 2004 to 2013 totaled $275,527 (see **Table 3.57**) and $128,407 from windstorms (see **Table 3.58**). There was no crop damage reported from lightning.

Table 3.57. Crop Insurance Claims Paid in Cedar County from Hailstorms, 2004-2013.

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2004	Corn	Hail	$4,631
2007	Corn	Hail	$1,527
2008	Corn	Hail	$24,304
2008	Soybeans	Hail	$177,908
2009	Hybrid Corn Seed	Hail	$64,204
2010	Corn	Hail	$904
2011	Corn	Hail	$2,050
Total			**$275,527**

Source: USDA Risk Management Agency Crop Insurance Payment FOIA Request; USDA Risk Management Agency Iowa Crop Insurance Profile, http://www.rma.usda.gov/pubs/2012/stateprofiles/iowa11.pdf

Table 3.58. Crop Insurance Claims Paid in Cedar County from Windstorms, 2004-2013.

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2004	Corn	Wind/Excess Wind	$36,331
2007	Corn	Wind/Excess Wind	$20,673
2007	Hybrid Corn Seed	Wind/Excess Wind	$9,136
2007	Soybeans	Wind/Excess Wind	$207
2010	Corn	Wind/Excess Wind	$4,242
2011	Corn	Wind/Excess Wind	$57,819
Total			**$128,407**

Probability of Future Occurrence

NCDC-reported damaging lightning events occurred 7 times from 1996 thru 2013. Since lightning accompanies thunderstorms, it can be assumed that lightning occurs more often than damages are reported. These rates of occurrence are expected to continue in the future.

Based on NCDC data, there have been 38 separate hail events in an 18 year period, producing an average of two hail events each year in Cedar County. When limiting the probability analysis to hail events producing hail one inches and larger, there have been 18 separate events (separate days) in an 18 year period. Based on this history, there can be a severe hail event every year making the probability for damaging hail "highly likely" in any given year.

Probability Score: 4—Highly Likely

Vulnerability

Overview

In general, assets in the County are vulnerable to thunderstorms winds, lightning and hail including people, crops, vehicles, and built structures. According to the 2013 Iowa Hazard Mitigation Plan, of the 8 hazards for which data was available to estimate annualized losses, thunderstorm with lightning and hail ranked 4th with $30 million in annualized losses based on

data spanning a 17-year period. Although this hazard results in high annual losses, generally private property insurance and crop insurance cover the majority of losses. Considering insurance coverage as a recovery capability and therefore mitigation of devastating impacts to the economy, the overall impact on jurisdictions is reduced; therefore, this hazard's magnitude score to the planning area is "negligible".

Potential Losses to Existing Development

Most lightning damages occur to electronic equipment located inside buildings. But structural damage can also occur when a lightning strike causes a building fire. In addition, lightning strikes can cause damages to crops if fields light on fire. Communications equipment and warning transmitters and receivers can also be knocked out by lightning strikes. There have not been any fatalities in Cedar County from lightning strikes.

Thunderstorm winds and hail can cause damage to property, vehicles, trees, and crops.

Property and Crop Losses

Table 3.59 provides the estimated annualized property damages resulting from Thunderstorms, including lightning, hail and wind. This annualized damage has been compared to the total building exposure for Cedar County and the level of damage is minimal compared to the value of building exposure. Building Exposure values are based on parcel data provided by the Cedar County GIS Department and Muscatine County GIS.

Table 3.59. Estimated Annualized Property Damages Resulting from Severe Thunderstorms (Hail/Lightning/Wind, 1996-2013)

Building Exposure	Hail/Lightning/Thunderstorm Wind Property Damages	Annualized Property Damages
$1,581,681,078	Hail - $313,000 Lightning - $163,025 Wind - $1,157,000 Total $1,633,025	$90,724

Source: Building Exposure, Cedar County GIS Department and Muscatine County GIS 2014; Hail, Lightning, & Thunderstorm Wind Property Damage from NCDC records

Table 3.60 provides the insured crop losses for resulting from hail and wind. The insured loss has been adjusted to estimate losses to all insurable crops by considering that 90.5 percent of insurable crops in the State were insured (2013 Iowa Crop Insurance Profile from USDA's Risk Management Agency).

Table 3.60. Estimated Insurable Annualized Crop Damages Resulting from Severe Thunderstorms (Hail//Wind)

Crop Exposure (2012)	Insurance Paid (2004-2013)	Adjusted Crop Damages	Annualized Adjusted Crop Damages
$219,282,000	Hail -$275,527 Wind -$128,407 Total -$403,934	$446,336	$44,634

Source: Crop Exposure is from Iowa State University, University Extension, 2007; Insurance paid is from USDA's RMA; Statewide Crop insurance Coverage is from USDA's RMA Iowa Crop Insurance Profile.
Note: This includes insurable crops that are not insured.

Future Development

The Cedar County Economic Development Commission encourages new businesses in the County and with new businesses it is likely to increase vulnerability to wind, lightning and hail. Additional development means more households and businesses vulnerable to damages from severe thunderstorms, lightning and hail.

Thunderstorm, Lightning and Hail Hazard Summary by Jurisdiction

The following hazard summary table shows how this hazard varies by jurisdiction. Although thunderstorms winds, lightning and hail occur at similar rates in all parts of the planning area, damages are more likely in the incorporated areas that are more densely developed. Therefore, the magnitude level for these areas was determined to be two.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Cedar County	4	1	3	1	2.65	Moderate
City of Bennett	4	2	3	1	2.95	Moderate
City of Clarence	4	2	3	1	2.95	Moderate
City of Durant	4	2	3	1	2.95	Moderate
City of Lowden	4	2	3	1	2.95	Moderate
City of Mechanicsville	4	2	3	1	2.95	Moderate
City of Stanwood	4	2	3	1	2.95	Moderate
City of Tipton	4	2	3	1	2.95	Moderate
City of West Branch	4	2	3	1	2.95	Moderate
Bennett School District, #603	4	2	3	1	2.95	Moderate
Durant School District, #1926	4	2	3	1	2.95	Moderate
North Cedar School District, #3691	4	2	3	1	2.95	Moderate
Topton School District #6408	4	2	3	1	2.95	Moderate
West Branch School District #6930	4	2	3	1	2.95	Moderate

3.5.15 Tornado/Windstorm

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
4	3	3	1	3.25	High

Profile

Hazard Description
This hazard section discusses both tornado and windstorm.

Tornado: The NWS defines a tornado as "a violently rotating column of air extending from a thunderstorm to the ground." It is usually spawned by a thunderstorm and produced when cool air overrides a layer of warm air, forcing the warm air to rise rapidly. Often, vortices remain suspended in the atmosphere as funnel clouds. When the lower tip of a vortex touches the ground, it becomes a tornado and a force of destruction.

Tornadoes are the most violent of all atmospheric storms and are capable of tremendous destruction. Wind speeds can exceed 250 miles per hour and damage paths can be more than one mile wide and 50 miles long. Tornadoes have been known to lift and move objects weighing more than 300 tons a distance of 30 feet, toss homes more than 300 feet from their foundations, and siphon millions of tons of water from water bodies. Tornadoes also generate a tremendous amount of flying debris or "missiles," which often become airborne shrapnel that causes additional damage. If wind speeds are high enough, missiles can be thrown at a building with enough force to penetrate windows, roofs, and walls. However, the less spectacular damage is much more common.

Windstorm: Windstorms for purposes of this plan refer to other non-tornadic damaging winds of thunderstorms including downbursts, microbursts, and straight-line winds. Downbursts are localized currents of air blasting down from a thunderstorm, which induce an outward burst of damaging wind on or near the ground. Microbursts are minimized downbursts covering an area of less than 2.5 miles across. They include a strong wind shear (a rapid change in the direction of wind over a short distance) near the surface. Microbursts may or may not include precipitation and can produce winds at speeds of more than 150 miles per hour. Straight-line winds are generally any thunderstorm wind that is not associated with rotation. It is these winds, which can exceed 100 mph, which represent the most common type of severe weather and are responsible for most wind damage related to thunderstorms. Since thunderstorms do not have narrow tracks like tornadoes, the associated wind damage can be extensive and affect entire (and multiple) counties. Objects like trees, barns, outbuildings, high-profile vehicles, and power lines/poles can be toppled or destroyed, and roofs, windows, and homes can be damaged as wind speeds increase.

Strong winds can occur year-round in Iowa. These winds typically develop with strong pressure gradients and gusty frontal passages. The closer and stronger two systems are, (one high pressure, one low pressure) the stronger the pressure gradient, and therefore, the stronger the winds are. Objects such as trees, barns, outbuildings, high-profile vehicles, and power

line/poles can be toppled or destroyed, and roofs, windows, and homes can be damaged as wind speeds increase. Downbursts can be particularly dangerous to aviation.

The NWS can issue High Wind Watch, High Wind Warning, and Wind Advisory to the public. The following are the definitions of these issuances:

- High Wind Watch—This is issued when there is the potential of high wind speeds developing that may pose a hazard or is are life-threatening.
- High Wind Warning—The 1-minute surface winds of 35 knots (40 mph) or greater lasting for one hour or longer, or winds gusting to 50 knots (58 mph) or greater, regardless of duration, that are either expected or observed over land.
- High Wind Advisory—This is issued when high wind speeds may pose a hazard. Sustained winds 25 to 39 mph and/or gusts to 57 mph.

Warning Time Score: 3—6 to 12 hours

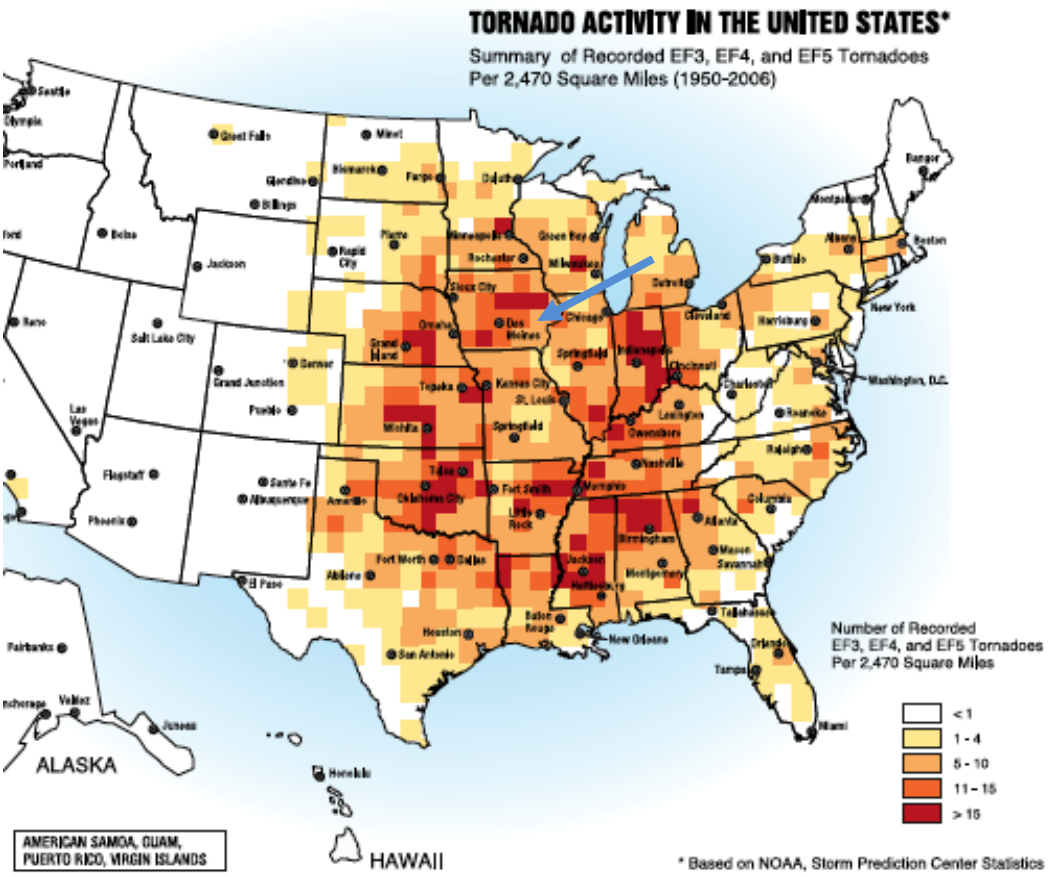
Duration Score: 1—less than 6 hours

Geographic Location/Extent

Iowa is located in a part of the United States where tornadoes are a common occurrence. Iowa has experienced 1,517 tornadoes from 1980 through 2011 (32 year period) with 86 percent of them being rated F0 and F1, 14 percent rated F2 through F5. Only one F5 rated tornadoes have occurred in Iowa during this timeframe (Parkersburg in 2008). Since 1980, there have been on average 47 tornadoes per year in Iowa. Most tornadoes occurred in May and June but can occur during any month. Also mid afternoon until around sunset is the peak time of day for tornado activity. There have been 763 injuries and 26 deaths attributable to tornadoes (source: National Weather Service, Iowa Tornado Climatology Report 1980-2011).

Tornadoes can occur in the entire planning area. **Figure 3.38** illustrates the number of F3, F4, and F5 tornadoes recorded in the United States per 3,700 square miles between 1950 and 2006. Cedar County is in the section with orange shading, indicating 5 to 15 tornadoes of this magnitude during this 57-year period.

Figure 3.38. Tornado Activity in the United States



Source: FEMA 320, Taking Shelter from the Storm, 3rd edition
Note: Blue arrow is approximate location of Cedar County

Tornadoes are classified according to the EF- Scale (the original F – Scale was developed by Dr. Theodore Fujita, a renowned severe storm researcher). The Enhanced F- Scale (see **Table 3.61**) attempts to rank tornadoes according to wind speed based on the damage caused. This update to the original F scale was implemented in the U.S. on February 1, 2007.

Table 3.61. Enhanced F Scale for Tornado Damage

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

Source: The National Weather Service, www.spc.noaa.gov/faq/tornado/ef-scale.html

The wind speeds for the EF scale and damage descriptions are based on information on the NOAA Storm Prediction Center as listed in **Table 3.62**. The damage descriptions are summaries. For the actual EF scale it is necessary to look up the damage indicator (type of structure damaged) and refer to the degrees of damage associated with that indicator. Information on the Enhanced Fujita Scale's damage indicators and degrees of damage is located online at www.spc.noaa.gov/efscale/ef-scale.html.

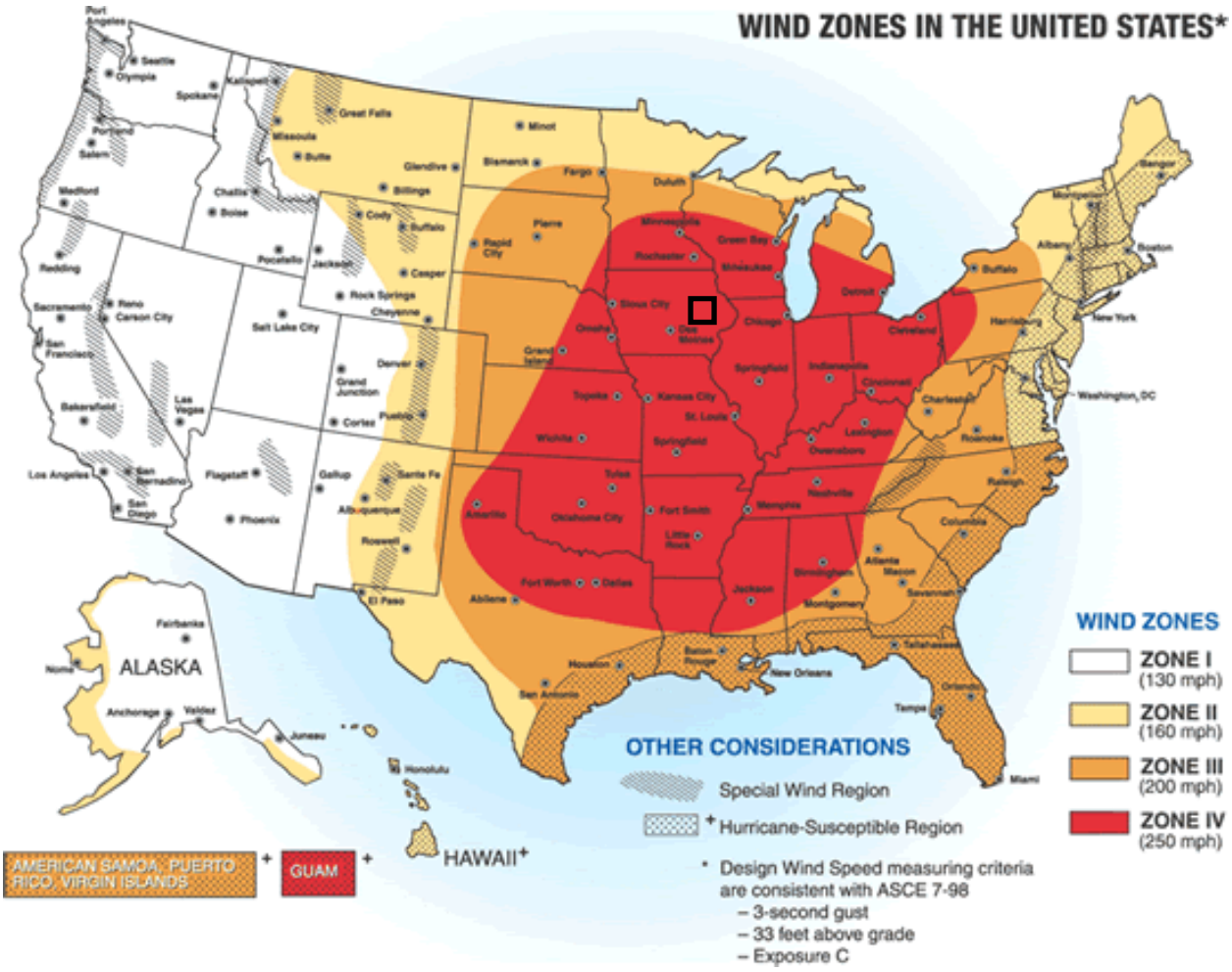
Table 3.62. Enhanced Fujita Scale with Potential Damage

Enhanced Fujita Scale			
Scale	Wind Speed (mph)	Relative Frequency	Potential Damage
EF0	65-85	53.5%	Light. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e. those that remain in open fields) are always rated EF0).
EF1	86-110	31.6%	Moderate. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	10.7%	Considerable. Roofs torn off well constructed houses; foundations of frame homes shifted; mobile homes complete destroyed; large trees snapped or uprooted; light object missiles generated; cars lifted off ground.
EF3	136-165	3.4%	Severe. Entire stores of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	0.7%	Devastating. Well-constructed houses and whole frame houses completely levelled; cars thrown and small missiles generated.
EF5	>200	<0.1%	Explosive. Strong frame houses levelled off foundations and swept away; automobile-sized missiles fly through the air in excess of 300 ft.; steel reinforced concrete structure badly damaged; high rise buildings have significant structural deformation; incredible phenomena will occur.

Source: NOAA Storm Prediction Center

All of Cedar County is susceptible to high wind events. The County is located in Wind Zone IV, which is susceptible to winds up to 250 mph. All of the participating jurisdictions are vulnerable to this hazard. **Figure 3.39** shows the wind zones of the United States based on maximum wind speeds; the entire state of Iowa is located within wind zone IV, the highest inland category.

Figure 3.39. Wind Zones in the United States



Source: FEMA; http://www.fema.gov/plan/prevent/saferoom/tsfs02_wind_zones.shtm
Note: Black square indicates approximate location of Cedar County

The advancement in weather forecasting has provided for the ability to predict severe weather that is likely to produce tornadoes days in advance. Tornado watches can be delivered to those in the path of these storms several hours in advance. Lead time for actual tornado warnings is about 30 minutes. Tornadoes have been known to change paths very rapidly, thus limiting the time in which to take shelter. Tornadoes may not be visible on the ground if they occur after sundown or due to blowing dust or driving rain and hail.

Previous Occurrences

Tornadoes

According to statistics reported by the NCDC, Cedar County had 31 recorded tornado events from 1950 to 2013. Of these, 1 was F4, 1 was F3, 7 were F2, 9 were F1 and EF1, and 13 were F0. These tornadoes caused 1 fatality, 20 injuries, over $8.6 Million in property damages, and over $90,000 in crop damages. **Table 3.63** summarizes these events.

Table 3.63. Recorded Tornadoes in Cedar County, 1950 - 2013

Date	Location	Length (miles)	Width (yards)	Magnitude	Fatalities	Injuries	Property Damage	Crop Damage
6/1/2007	Lime City	1.05	75	EF1	0	0	$0	$0
7/20/2003	Clarence	2.4	440	F1	0	0	$1,000,000	$30,000
6/18/1998	Mechanicsville	0.1	0.2	F0	0	0	$0	$0
5/15/1998	Downey	15	400	F3	0	2	$1,750	$0
5/18/1997	Mechanicsville	3	50	F1	0	0	$0	$0
4/30/1997	Durant	3	20	F0	0	0	$10,000	$0
8/22/1996	Lowden	0.3	20	F0	0	0	$0	$0
7/27/1995	Lowden	0.1	20	F0	0	0	$0	$50
7/27/1995	Bennett	0.1	25	F0	0	0	$1,000	$1,000
7/27/1995	Atalissa To	7.5	100	F2	0	0	$500,000	$60,000
5/9/1995	Cedar Bluff	7	100	F2	0	0	$500,000	$0
5/9/1995	Mechanicsville	0.5	50	F0	0	0	$60,000	$0
11/29/1991	Cedar Co.	1	30	F1	0	0	$25,000	$0
7/22/1991	Cedar Co.	0.1	13	F0	0	0	$25,000	$0
3/22/1991	Cedar Co.	10	80	F2	0	0	$250,000	$0
3/22/1991	Cedar Co.	0.1	20	F1	0	0	$2,500	$0
3/8/1990	Cedar Co.	0.1	23	F0	0	0	$2,500	$0
5/8/1988	Cedar Co.	7	90	F2	0	0	$2,500,000	$0
4/2/1988	Cedar Co.	2.5	20	F1	0	0	$250,000	$0
8/21/1987	Cedar Co.	1	20	F1	0	0	$250,000	$0
6/22/1984	Cedar Co.	0	33	F0	0	0	$0	$0
6/17/1984	Cedar Co.	0.5	40	F1	0	0	$25,000	$0
7/1/1983	Cedar Co.	15	50	F1	0	1	$250,000	$0
5/20/1982	Cedar Co.	0	33	F0	0	0	$250	$0
5/20/1982	Cedar Co.	0	33	F0	0	0	$30	$0
5/20/1982	Cedar Co.	0	33	F0	0	0	$250	$0
5/20/1982	Cedar Co.	0	33	F0	0	0	$250	$0
4/28/1974	Cedar Co.	2.3	100	F2	0	16	$250,000	$0
4/11/1965	Cedar Co.	70.2	200	F4	1	0	$2,500,000	$0
6/7/1961	Cedar Co.	5.1	200	F2	0	1	$25,000	$0
5/21/1957	Cedar Co.	8.9	100	F2	0	0	$250,000	$0
Totals					**1**	**20**	**$8,678,530**	**$91,050**

Source: National Climatic Data Center

Table 3.64 shows the number of Tornado Watches and Warnings issued by NOAA's National Weather Service. The data is kept on Iowa Environmental Mesonet, Iowa State University Department of Agronomy website, (http://mesonet.agron.iastate.edu/vtec/search.php).

Table 3.64. National Weather Service Tornado Watches and Warnings, 2005-April 2014

Year	Tornado Watch	Tornado Warning
So far in 2014	0	1
2013	5	2
2012	1	0
2011	3	1
2010	8	0
2009	5	0
2008	14	2
2007	4	3
2006	3	5
2005	1	0
Total	**44**	**14**

Source: Environmental Mesonet, Iowa State University Department of Agronomy website, http://mesonet.agron.iastate.edu/vtec/search.php , accessed April 2014

Cedar County has been included in two presidential disaster declarations that involved tornadoes since 1988. Descriptions of notable previous tornado events are provided below:

FEMA-4135-DR-IA—Severe Storms, Tornadoes, and Flooding, *Declared July 31, 2013; Incident Period June 21 to June 28, 2013.*
FEMA-*1763-DR-IA—Severe Storms, Tornadoes, & Flooding*, *Declared May 27, 2008; Incident Period May 25 to August 13, 2008*. The primary damages in Cedar County associated with this declaration were for severe storms and flooding.
FEMA-1518-DR-IA—Severe Storms, Tornadoes, & Flooding, *Declared May 25, 2004; Incident Period May 19 to June 24, 2004*. The primary damages in Cedar County associated with this declaration were for severe storms and flooding.

Windstorms

Previous Occurrences
According to the NCDC database, there were 103 high wind events in Cedar County from 1996 to 2013. During this time period there were no reported deaths or injuries and an estimated $1.3 Million in property damages. Recorded wind gusts ranged from a high of 83 knots to a low of 39 knots. **Table 3.65** provides a summary of the wind speeds reported for the wind events. Many of the wind events reported to NCDC occurred on the same day. When counting only events that occurred on different days, there were 86 separate events in this 18 year period.

Table 3.65. Reported Wind Speeds, NCDC Events from 1996 to April 2013

Wind Speed	# of Events
83 kts.	1
80 kts.	2
78 kts.	1
75 kts.	1
74 kts.	1
70 kts.	3
65 kts.	5
63 kts.	1
61 kts.	14
61 kts.	12
60 kts.	2
57 kts.	7
56 kts.	7
55 kts.	1
54 kts.	1
53 kts.	1
52 kts.	29
51 kts.	2
50 kts.	6
47 kts.	1
39 kts.	2
Not Reported	3

Source: NCDC

Cedar County has been included in one presidential disaster declaration that involved straight-line winds. Summaries of notable damaging events are provided below:

FEMA-4119-DR-IA—Sever Storms, Straight-line Winds, and Flooding, *Declared May 31, 2013; Incident Period April 17 to 30, 2013.*

Table 3.66 shows the insurable crop insurance claims paid in Cedar County as a result of windstorms.

Table 3.66. Crop Insurance Claims Paid in Cedar County from Windstorms, 2004-2013.

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2004	Corn	Wind/Excess Wind	$36,331
2007	Corn	Wind/Excess Wind	$20,673
2007	Hybrid Corn Seed	Wind/Excess Wind	$9,136
2007	Soybeans	Wind/Excess Wind	$207
2010	Corn	Wind/Excess Wind	$4,242
2011	Corn	Wind/Excess Wind	$57,819
Total			**$128,407**

Source: USDA Risk Management Agency Crop Insurance Payment FOIA Request; USDA Risk Management Agency Iowa Crop Insurance Profile, http://www.rma.usda.gov/pubs/2012/stateprofiles/iowa11.pdf

Probability of Future Occurrence

The NCDC reported 31 tornadoes in Cedar County in a 64 year time period, which calculates to 48 percent chance of a tornado in any given year.

With the 14 NWS tornado warnings issued for Cedar County from 2005 thru April 2014 there have been an average of 1.5 tornado warnings per year during these 9.3 years of data.

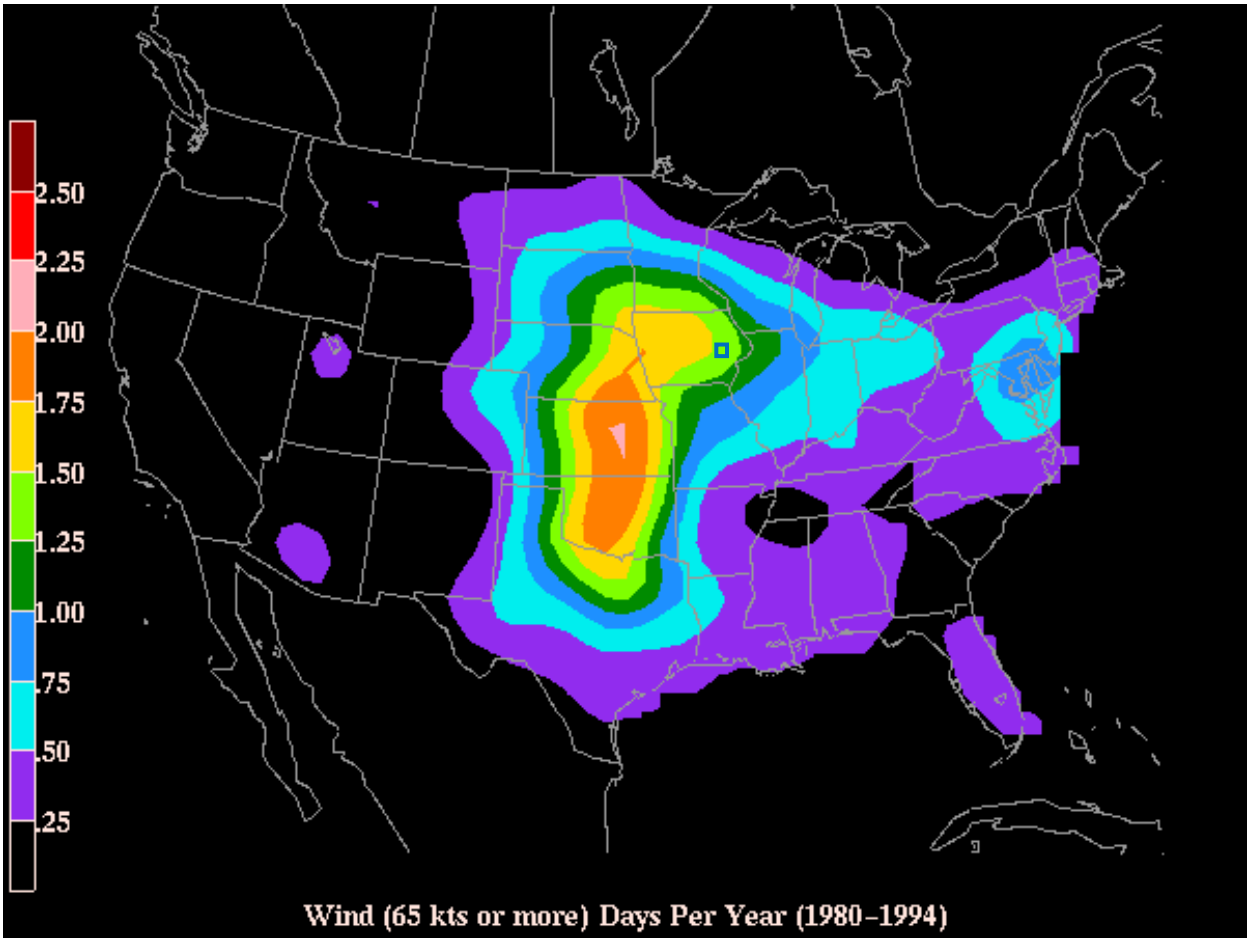
Therefore, it is a high probability that some portion of Cedar County will experience tornado activity in any given year.

According to NCDC, there were 86 separate high wind events from 1996 to 2013 (18 year period) in Cedar County. Based on this data, an average of 4.7 high wind events occur in Cedar County each year.

Probability Score: 4—Highly Likely

Figure 3.40 below shows the probability of a windstorm event (65 knots or greater) in the U.S. The Cedar County planning area is colored lime green showing that 65+ knot winds are probable to occur 1.25 to 1.50 times a year.

Figure 3.40. Annual Windstorm Probability (65+ knots), United States 1980-1994



Source: NSSL, http://www.nssl.noaa.gov/users/brooks/public_html/bigwind.gif;
Note: Blue square indicates approximate location of Cedar County

Vulnerability

Overview

Cedar County is located in a region of the U.S. with high frequency of dangerous and destructive tornadoes and is referred to as "Tornado Alley". **Figure 3.41** is based on areas where dangerous tornadoes are most likely to take place.

Figure 3.41. Tornado Alley in the U.S.

Source: http://www.tornadochaser.net/tornalley.html

Light frame structures, such as mobile homes, outbuildings and sheds are considered especially vulnerable to damage from tornadoes.

According to the 2013 Iowa Hazard Mitigation Plan, of the 8 hazards for which data was available to estimate annualized losses, tornadoes ranked 3rd with $36 million in annualized losses based on data spanning a 63-year period.

Due to the potential for damaging tornadoes in the planning area, the magnitude was determined to be a 3, critical.

Magnitude Score: 3—Critical

Potential Losses to Existing Development

In Cedar County, the NCDC estimate for past property damages resulting from tornadoes from 1950 – 2013 (64 years) was $8,678,530. This translates to an annualized loss of amount of $135,602. For windstorms, NCDC loss estimates were $1,356,600 from 1996 to 2013 (18 years). This translates to an annualized loss of $75,367. Combined tornado and windstorm annualized losses calculate to $210,969.

To estimate vulnerability to tornadoes, a potential tornado scenario was analyzed for each jurisdiction in the planning area. The scenario chosen was an F1/EF1 tornado with wind speed of approximately 100 mph. From the NCDC reports, it was determined that there have been 9 F1 tornadoes in Cedar County since 1950. Of all tornadoes reported by NCDC since 1950, the average length was 3 miles long with an average width of 80 yards.

To provide estimated damage results from an F1/EF1 tornado with these dimensions, a hypothetical tornado track was considered at a 45 degree angle running through the approximate center of each jurisdiction in the planning area. For Unincorporated Cedar County and the incorporated cities, the parcel data provided by Cedar County GIS Department was

utilized as the basis for determining damage estimates. Separate analyses were not conducted for the public school districts. Since the public school districts have a relatively small number of buildings, it was not possible to apply this same type of random tornado path scenario to provide meaningful results.

With the infinite variables associated with tornado occurrences such as wind speed, direction, length, width, time on the ground, etc., it is not possible to accurately estimate future losses. However, this methodology provides loss estimates for a defined scenario. Utilizing GIS data with associated building values considers variations in density of the built environment as well as variations in values. Although it is not possible to accurately predict tornado losses, this analysis demonstrates how the impacts of specific tornado scenario would vary among jurisdictions in Cedar County.

Once the number and values of buildings within the hypothetical tornado track were determined, a 10 percent damage calculation was made. This damage percent is based on information from the NOAA Storm Prediction Center, which estimates that a F1/EF1 tornado of this magnitude would severely strip roofs; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.

Table 3.67 provides the results of the analysis in terms of the number and value of buildings in the scenario tornado path and estimated losses in Cedar County. A planning area total was not calculated as this scenario is not meant to indicate that these damages would occur simultaneously.

Table 3.67. F/EF 1 Tornado Scenario Loss Estimates for Jurisdictions in Cedar County

Jurisdiction	# of Buildings in Path	Building Types	Total Building Values in Path	10% Loss Estimate
Unincorporated County	18	10-A, 3-C, 5-R	$624,610	$62,461
City of Bennett	20	7-C, 13-R	$747,290	$74,729
City of Clarence	25	2-C, 23-R	$1,540,970	$154,097
City of Durant	12	12-R	$1,832,840	$183,284
City of Lowden	23	2-C, 21-R	$1,206,670	$120,667
City of Mechanicsville	21	4-C, 17-R	$1,505,680	$150,568
City of Stanwood	24	8-C, 16-R	$1,550,380	$155,038
City of Tipton	74	15-C, 59-R	$6,727,280	$672,728
City of West Branch	12	2-A, 3-C, 7-R	$610,480	$61,048

Source: AMEC Analysis of parcel data from Cedar County GIS Department; A=Agricultural, C=Commercial, R=Residential

Loss of Use

Overhead power lines and infrastructure are also vulnerable to damages from windstorms. Potential losses would include cost of repair or replacement of damaged facilities, and lost economic opportunities for businesses. Public safety hazards include risk of electrocution from downed power lines. Specific amounts of estimated losses are not available due to the complexity and multiple variables associated with this hazard. The electric power loss of use estimates provided in **Table 3.68** below were calculated using FEMA's Standard Values for Loss of Service for Utilities published in the June 2009 *BCA Reference Guide*. These figures are used to provide estimated costs associated with the loss of power in relation to the populations

in Cedar County's jurisdictions. The loss of use estimates for power failure associated with windstorms is provided as the loss of use cost per person, per day of loss. The estimated loss of use provided for each jurisdiction represents the loss of service of the indicated utility for one day for 10 percent of the population. It is understood that in rural areas, the typical loss of use may be for a larger percentage of the population for a longer time during weather extremes. These figures do not take into account physical damages to utility equipment and infrastructure.

Table 3.68. Loss of Use Estimates for Power Failure

Jurisdiction	2013 Population Estimate	Estimated Affected Population 10%	Electric Loss of Use Estimate ($126 per person per day)
Unincorporated County	7,097	710	$89,422
City of Bennett	396	40	$4,990
City of Clarence	961	96	$12,109
City of Durant*	1,832	183	$23,083
City of Lowden	780	78	$9,828
City of Mechanicsville	1,129	113	$14,225
City of Stanwood	673	67	$8,480
City of Tipton	3,199	320	$40,307
City of West Branch*	2,326	233	$29,308
Total		**1,839**	**$231,752**

Source: Loss of Use Estimates from FEMA BCA Reference Guide, 2009; Population Estimates, Iowa State University of Science and Technology, Iowa Community Indicators Program
*Data is for entire incorporated area, including portion(s) in adjacent counties.
**Data is for Cedar County portion of incorporated area only.

Crop Losses

Crop insurance payments for the period from 2004-2013 were $128,407 for wind damage. Considering that 90.5 percent of insurable crops are insured in Iowa (2013 Iowa Crop Insurance Profile, USDA, RMA), the adjusted losses calculate to $141,886 for all insurable crops for the period. This results in an average annual loss of $14,187 to insurable crops as a result of wind damage

Future Development

Public buildings such as schools, government offices, as well as other buildings with a high occupancy and mobile home parks should consider inclusion of a tornado saferoom to shelter occupants in the event of a tornado.

Windstorm is primarily a public safety and economic concern, and the planning area is located in a region with very high frequency of occurrence. Windstorm can cause damage to structures and power lines which in turn create hazardous conditions for people. Debris flying from high wind events can shatter windows in structures and vehicles and can harm people that are not adequately sheltered.

Although windstorms occur frequently in the planning area and damages to property occur, much of the damage is generally covered by private insurance. This results in less impact to individuals and the community since recovery is facilitated by insurance.

Tornado/Windstorm Hazard Summary by Jurisdiction

The magnitude was rated as a level 3 for all the participating jurisdictions as they are all vulnerable to tornado and windstorm damage. The factors of probability, warning time, and duration are also equal across the planning area. This hazard does not substantially vary by jurisdiction.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Cedar County	4	3	3	1	3.25	High
City of Bennett	4	3	3	1	3.25	High
City of Clarence	4	3	3	1	3.25	High
City of Durant	4	3	3	1	3.25	High
City of Lowden	4	3	3	1	3.25	High
City of Mechanicsville	4	3	3	1	3.25	High
City of Stanwood	4	3	3	1	3.25	High
City of Tipton	4	3	3	1	3.25	High
City of West Branch	4	3	3	1	3.25	High
Bennett School District, #603	4	3	3	1	3.25	High
Durant School District, #1926	4	3	3	1	3.25	High
North Cedar School District, #3691	4	3	3	1	3.25	High
Tipton School District #6408	4	3	3	1	3.25	High
West Branch School District #6930	4	3	3	1	3.25	High

3.5.16 Transportation Incident

Hazard Score Calculation					
Probability	Magnitude/Severity	Warning Time	Duration	Weighted Score	Level
4	2	4	1	3.10	High

Profile

Hazard Description

This hazard encompasses the following: air transportation, highway transportation, and railway transportation. The transportation incidents can involve any mode of transportation that directly threatens life and which results in property damage and/or death(s)/injury(s) and/or adversely impact a community's capabilities to provide emergency services. Incidents involving buses and other high occupancy vehicles could trigger a response that exceeds the normal day-to-day capabilities of response agencies.

An air transportation incident may involve a military, commercial or private aircraft. Air transportation is playing a more prominent role in transportation as a whole. Airplanes and helicopters are used to transport passengers for business and recreation as well as thousands of tons of cargo. A variety of circumstances can result in an air transportation incident; mechanical failure, pilot error, enemy attack, terrorism, weather conditions and on-board fire can all lead to an air transportation incident.

Highway transportation incidents are very complex. Contributing factors can include a roadway's design and/or pavement conditions (e.g. rain, snow and ice), a vehicle's mechanical condition (e.g. tires, brakes, lights), a driver's behavior (e.g. speeding, inattentiveness and seat belt usage), the driver's condition (e.g. alcohol use, age-related conditions, physical impairment) and driver inattention by using a wireless device. In fact, the driver's behavior and condition factors are the primary cause in an estimated 67 percent of highway crashes and a contributing factor in an estimated 95 percent of all crashes.

A railway transportation incident is a train accident that directly threatens life and/or property, or adversely impacts a community's capabilities to provide emergency services. Railway incidents may include derailments, collisions and highway/rail crossing accidents. Train incidents can result from a variety of causes; human error, mechanical failure, faulty signals, and/or problems with the track. Results of an incident can range from minor "track hops" to catastrophic hazardous material incidents and even human/animal casualties. With so many miles of track in Iowa, vehicles must cross the railroad tracks at numerous at-grade crossings.

Warning Time Score: 4—Minimal or no warning

Duration Score: 1—Less than 6 hours

Geographic Location/Extent

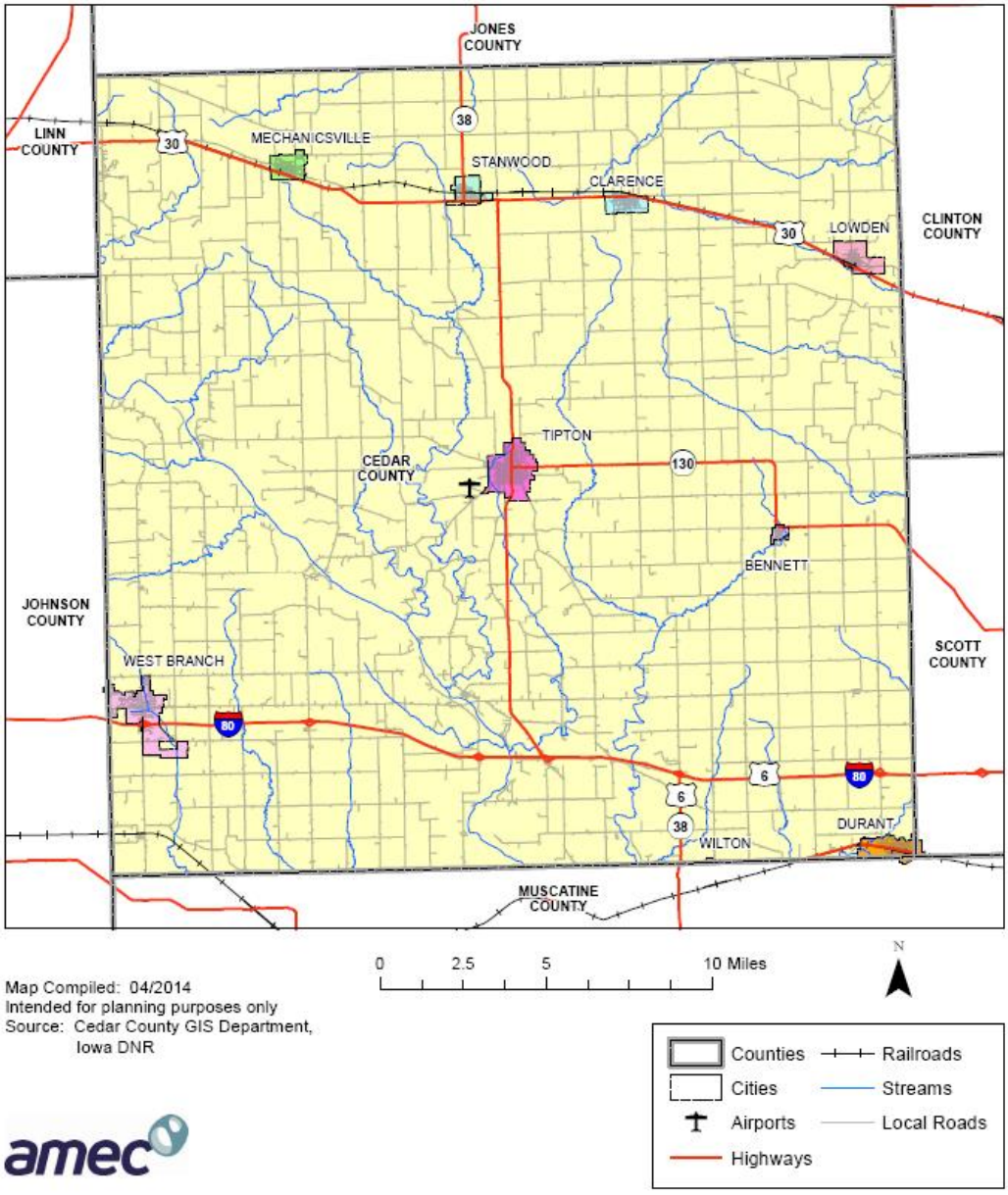
The entire planning area is subject to transportation incidents and all participating jurisdictions are affected. The major transportation routes include Interstate 80, US Highways 6 and 30, Iowa State Highways 38 and 130.

The Mathews Memorial Airport in Tipton is the only airport in the County. There are no heliports in the County.

Cedar County has two railroads one being a Class I, the Union Pacific (UP) Railroad Company, and one Class II railroad, the Iowa Interstate Railroad (IAIS). The UP parallels Highway 30 and connects the jurisdictions of Lowden, Clarence, Stanwood, and Mechanicsville. The IAIS travels through Durant, enters Muscatine County, and reenters Cedar County north of West Liberty on its way to Downey.

Figure 3.42 shows all the transportation routes in Cedar County.

Figure 3.42. Cedar County Transportation Routes & Airports



Previous Occurrences

Air Transportation Incidents:

There have not been any Cedar County aviation incidents reported to the National Transportation Safety Board (NTSB) in the last 50 years. For information and details about other air transportation incidents in Iowa, see http://planecrashmap.com/list/ia/.

Highway Transportation Incidents:

The Iowa Department of Transportation's Office of Traffic and Safety maintains traffic crash statistics and location maps by county and cities in Iowa. **Table 3.69** shows the most recent available number of crashes categorized by the following: fatal, major, minor, possibility unknown, property damage only. The data is reported for Cedar County unincorporated and for the cities of Bennett, Clarence, Durant, Lowden, Mechanicsville, Stanwood, Tipton, and West Branch. Eighty-three percent of all crashes in Cedar County occurred on rural roads during the 2009-2013 timeframe.

Table 3.69. All Crashes in Cedar County, 2009-2013

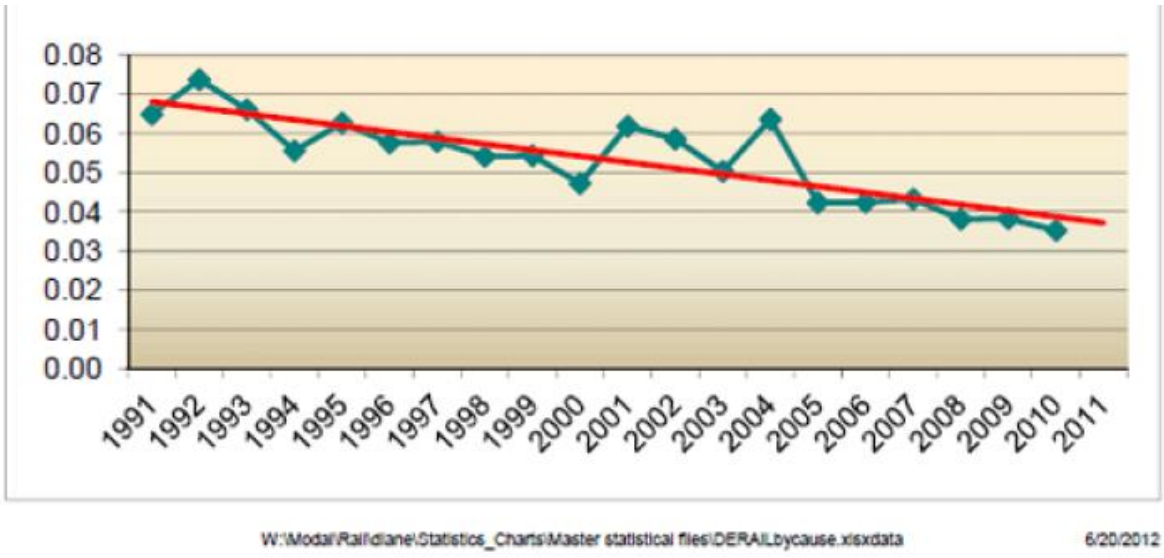
Crashes					
Crashes	**Fatal**	**Major**	**Minor**	**Possibility Unknown**	**Property Damage Only**
Cedar County (unincorporated)					
1,370	14	27	106	126	1,097
City of Bennett					
6	0	0	0	0	6
City of Clarence					
27	0	0	2	2	23
City of Durant					
24	0	1	2	2	19
City of Lowden					
19	1	3	1	1	13
City of Mechanicsville					
29	0	2	0	4	23
City of Stanwood					
25	0	1	1	3	20
City of Tipton					
102	0	0	4	13	85
City of West Branch					
52	0	1	3	4	44
Total Countywide					
1,654	15	35	119	155	1,330

Source: Iowa Department of Transportation's Office of Traffic and Safety

Railway Transportation Incidents

According to the Federal Railroad Administration's Office of Safety Analysis, there have not been any train derailments in Cedar County since 1999. In that year, two train derailments occurred, one was caused by extreme wind velocity and one was caused by a bolt hole crack or break. Throughout Iowa, rail car traffic has increased but the number of derailments in relationship to the traffic is trending downward according to the Iowa Department of Transportation (see **Figure 3.43**).

Figure 3.43. Derailments in Iowa per Million Rail Car Miles, 1991-2011.



Source: Iowa Department of Transportation, http://www.iowadot.gov/about/Derailments.html

As of 2013, Iowa has 5,157 highway-rail crossings in the State. There has not been an incident in Cedar County since 2011. **Table 3.70** shows the highway–railroad grade crossing accidents that occurred at public and private crossings in Cedar County from 2005-2013.

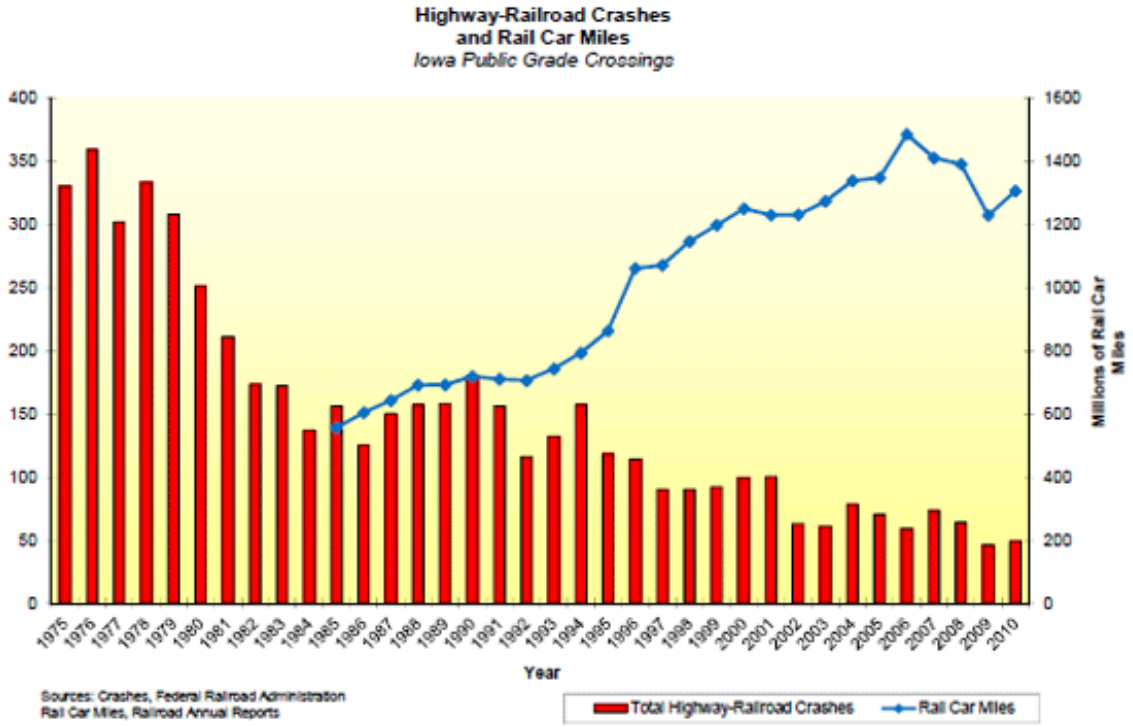
Table 3.70. Highway-Rail Accidents at Public and Private Crossings in Cedar County, 2005-2013

Year	# of Accidents	Injuries
2013	0	0
2012	0	0
2011	2	1
2010	0	0
2009	0	0
2008	0	0
2007	0	0
2006	0	0
2005	1	0

Source: Federal Railroad Administration's Office of Safety Analysis, http://safetydata.fra.dot.gov/officeofsafety/default.aspx

Figure 3.44 shows the significant decline in highway-railroad crashes from 1975 to 2010 compared to the increased miles that rail cars are traveling.

Figure 3.44. Highway-Railroad crashes in Iowa, 1975-2010



Source: Iowa Department of Transportation, http://www.iowadot.gov/about/RailHighwayCrossing.html

Probability of Future Occurrence

A major transportation incident can occur at any time, even though traffic engineering, inspection of traffic facilities, and land use management of areas adjacent to roads and highways has increased, incidents continue to occur. As the volume of traffic on the county roads, highways and interstates increases, the number of traffic accidents will likely also increase. The combination of large numbers of people on the road, farm equipment, wildlife, unpredictable weather conditions, potential mechanical problems and human error always leaves the potential for a transportation accident.

Based on the available information, the probability of air transportation, highway, or railway incident that directly threatens life and which results in property damage and/or death(s)/injury(s) and/or adversely impact a community's capabilities to provide emergency services is **"Highly Likely"** with greater than 33 percent likelihood to occur in any given year.

Probability Score: 4—Highly Likely

Vulnerability

Overview

Transportation incidents can almost always be expected to occur in specific areas, on or near airports, roadways, railroads, or other transportation infrastructure. The exception is air transportation incidents can occur anywhere. However, it is difficult to predict the magnitude of any specific event because these types of events are accidental and the circumstances surrounding these events will impact the extent of damage or injuries that occur. Rural road transportation incidents, which are the most common, generally involve isolated impacts to a few vehicles and persons per incident.

Magnitude Score: 2—Limited

Potential Losses to Existing Development

The U.S. Department of Transportation Federal Highway Administration issued a technical advisory in 1994 providing suggested estimates of the cost of traffic crashes to be used for planning purposes. These figures were converted from 1994 dollars to 2014 dollars using an annual inflation rate of 2.85 percent. The costs are listed below in **Table 3.71.**

Table 3.71. Costs of a Traffic Crash

Severity	Cost per injury (in 2014 dollars $)
Fatal	$4,171,814
Evident Injury	$57,762
Possible Injury	$30,487
Property Damage Only	$3,209

Source: U.S. Department of Transportation Federal Highway Administration Technical Advisory T 7570.2, 1994. Adjusted to 2014 dollars.

Using the traffic crash costs per type of severity from **Table 3.71**, the total costs of traffic crashes is figured in **Table 3.72** for Cedar County and several incorporated cities from 2009-2013. Based on this analysis, the estimated average annual cost of all types of traffic accidents for the planning area was $14,806,927.

Table 3.72. Costs of Traffic Crashes in Cedar County, 2009-2013

	Fatal Crash	Major Crash (Evident Injury)	Minor Crash (Possible Injury)	Crash with Property Damage Only
Cedar County (unincorporated)				
Number of incidents	15	35	119	1,330
Total Cost	$62,577,210	$2,021,670	$3,627,953	$4,267,970
Average Annual Cost	$12,515,442	$404,334	$725,591	$853,594
City of Bennett				
Number of incidents	0	0	0	6
Total Cost	$0	$0	$0	$19,254
Average Annual Cost	$0	$0	$0	$3,851
City of Clarence				
Number of incidents	0	0	2	23
Total Cost	$0	$0	$60,974	$73,807
Average Annual Cost	$0	$0	$12,194	$14,761
City of Durant				
Number of incidents	0	1	2	19

	Fatal Crash	Major Crash (Evident Injury)	Minor Crash (Possible Injury)	Crash with Property Damage Only
Total Cost	$0	$57,762	$60,974	$60,971
Average Annual Cost	$0	$11,552	$12,195	$12,194
City of Lowden				
Number of incidents	1	3	1	13
Total Cost	$4,171,814	$173,286	$30,487	$41,717
Average Annual Cost	$834,363	$34,657	$6,097	$8,343
City of Mechanicsville				
Number of incidents	0	2	0	23
Total Cost	$0	$115,524	$0	$73,807
Average Annual Cost	$0	$23,104	$0	$14,761
City of Stanwood				
Number of incidents	0	1	1	20
Total Cost	$0	$57,762	$30,487	$64,180
Average Annual Cost	$0	$11,552	$6,097	$16,045
City of Tipton				
Number of incidents	0	0	4	85
Total Cost	$0	$0	$121,948	$272,765
Average Annual Cost	$0	$0	$24,390	$54,553
City of West Branch				
Number of incidents	0	1	3	44
Total Cost	$0	$57,762	$91,461	$141,196
Average Annual Cost	$0	$11,552	$1,829	$28,239

Sources: U.S. Department of Transportation Federal Highway Administration Technical Advisory T 7570.2, 1994. Adjusted to 2014 dollars and Iowa Department of Transportation's Office of Traffic and Safety, http://www.iowadot.gov/crashanalysis/index.htm?

Estimated losses as a result of air transportation and railway transportation are not available for this analysis.

Future Development

The closest passenger airport for Cedar County residents is in the neighboring Linn County at the Eastern Iowa Airport. This airport had a total of 1,042,291 annual passengers in 2013 which is an increase of 57,117 from 2012. The Iowa Aviation System Plan, 2010-2030 makes recommendations for future development at the Eastern Iowa Airport (source: http://www.iowadot.gov/aviation/data_driven/publications/System_plan_reports/SPRCID.pdf).

According to the Iowa Department of Transportation, there is resurfacing work being done on U.S. 30 Highway in Cedar and Clinton Counties from April 2014 to October 2014 as well as pavement rehab and bridge deck overlay on I-80 in Cedar County in 2014.

Transportation Hazard Summary by Jurisdiction

All jurisdictions within the planning area are at risk to some kind of transportation incident. Higher vulnerability occurs with the jurisdictions within close proximity of the interstate and highways and railways respectively. The jurisdictions of Bennett, Clarence, Lowden, Mechanicsville, Stanwood, Tipton and West Branch have increased vulnerability to transportation incidents on the interstate and highways and Clarence, Lowden, Durant, Mechanicsville, and Stanwood to railroad incidents. All jurisdictions are susceptible to airplane

crashes. The City of Bennett and the Bennett School District were given a magnitude rating of 1 since they had less than 10 crashes in the 5-year reporting data and they do not have any railroads or federal highways through the jurisdiction.

Jurisdiction	Probability	Magnitude	Warning Time	Duration	Score	Level
Cedar County	4	2	4	1	3.10	High
City of Bennett	4	1	4	1	2.80	Moderate
City of Clarence	4	2	4	1	3.10	High
City of Durant	4	2	4	1	3.10	High
City of Lowden	4	2	4	1	3.10	High
City of Mechanicsville	4	2	4	1	3.10	High
City of Stanwood	4	2	4	1	3.10	High
City of Tipton	4	2	4	1	3.10	High
City of West Branch	4	2	4	1	3.10	High
Bennett School District, #603	4	1	4	1	2.80	Moderate
Durant School District, #1926	4	2	4	1	3.10	High
North Cedar School District, #3691	4	2	4	1	3.10	High
Topton School District #6408	4	2	4	1	3.10	High
West Branch School District #6930	4	2	4	1	3.10	High

3.6 Hazard Analysis Summary

This section provides a tabular summary of the hazard ranking for each jurisdiction in the planning area.

Table 3.73. Hazard Ranking Summary by Jurisdiction

Jurisdiction	Dam Failure	Drought	Earthquakes	Expansive Soils	Extreme Heat	Flash Flood	Grass/Wildland Fire	Hazardous Materials Incident	Radiological Incident	River Flood	Severe Winter Storm	Sinkholes	Terrorism	Thunderstorm/Lightning/Hail	Tornado/Windstorm	Transportation Incident
Cedar County	L	M	L	L	L	M	M	H	M	H	H	L	M	M	H	H
City of Bennett	N/A	M	L	L	L	L	M	M	M	H	H	L	L	M	H	M
City of Clarence	N/A	M	L	L	L	L	M	H	M	N/A	H	L	L	M	H	H
City of Durant	L	M	L	L	L	L	M	H	M	M	H	L	M	M	H	H
City of Lowden	N/A	M	L	L	L	M	M	H	M	M	H	L	L	M	H	H
City of Mechanicsville	N/A	M	L	L	L	M	M	H	M	N/A	H	L	M	M	H	H
City of Stanwood	N/A	M	L	L	L	M	M	H	M	N/A	H	L	L	M	H	H
City of Tipton	N/A	M	L	L	L	M	M	H	M	M	H	L	M	M	H	H
City of West Branch	L	M	L	L	L	L	M	H	M	H	H	L	M	M	H	H
Bennett School District, #603	N/A	M	L	L	L	L	L	L	M	N/A	H	L	L	M	H	M
Durant School District, #1926	N/A	M	L	L	L	L	L	L	M	N/A	H	L	M	M	H	H
North Cedar School District, #3691	N/A	M	L	L	L	M	L	L	M	N/A	H	L	L	M	H	H
Tipton School District #6408	N/A	M	L	L	L	M	L	L	M	N/A	H	L	M	M	H	H
West Branch School District #6930	N/A	M	L	L	L	L	L	L	M	N/A	H	L	M	M	H	H