DOC#2020-0289

MUSCATINE

Public Safety Building, 312 E. Fifth St.
Muscatine, IA 52761
(563) 263-9233
Fax (563) 263-5534

FIRE DEPARTMENT

MEMORANDUM

TO: Gregg Jenkins, City Administrator
Cinda Hilger, Administrative Secretary
Jerry Ewers, Fire Chief

FROM: Mike Hartman, Assistant Fire Chief

DATE: August 13, 2020

SUBJECT: Council Meeting Agenda – Adopt Resolution / Hazard Mitigation Plan

INTRODUCTION:

We are requesting the City of Muscatine to adopt a resolution for the approval and adoption of the updated Muscatine County Multi-Jurisdiction Local Hazard Mitigation Plan. Cities are required to adopt the plan in order to be eligible for future FEMA funding, according to the Disaster Mitigation Act of 2000.

BACKGROUND:

Every five years the county Hazard Mitigation Plan must be updated, reviewed, and approved by local jurisdictions. The Hazard Mitigation Planning Committee finished the update and review and now request that the participating jurisdictions adopt the Plan. The Plan details a total of 17 hazards that may occur in Muscatine County and outlines the City of Muscatine's goals and mitigation actions; however FEMA Region VII has stressed that the City of Muscatine is under no financial obligation to carry out any or all of the mitigation actions. There is no cost to the City of Muscatine in adopting the Plan. Examples of projects funded by FEMA include but are not limited to buyouts of flood-prone properties, elevation of properties in the floodplain, and construction of tornado safe rooms.

RECOMMENDATION/RATIONALE:

We are requesting that City Council adopts this resolution for the Hazard Mitigation Plan so Muscatine is able to be eligible for and obtain future FEMA funding.

ATTACHMENTS:

1. Muscatine County Multi-Jurisdiction Local Hazard Mitigation Plan Resolution

Resolution Number # 2020-0289

A RESOLUTION OF THE CITY OF MUSCATINE IN SUPPORT OF THE APPROVAL AND ADOPTION OF THE MUSCATINE COUNTY MULTI-JURISDICTION LOCAL HAZARD MITIGATION PLAN

RESOLUTION

WHEREAS, the City of Muscatine, with the assistance from Muscatine County and the Bi-State Regional Commission (BSRC) has gathered information and prepared the Muscatine County Multi-Jurisdictional Hazard Mitigation Plan; and,

WHEREAS, the Muscatine County Multi-Jurisdictional Hazard Mitigation Plan has been prepared in accordance with FEMA requirements at 44 C.F.R. 201.6; and,

WHEREAS, those municipalities within Muscatine County that have participated in the multi-jurisdictional plan update process will each pass their own resolutions to approve and adopt the plan; and

WHEREAS, the Plan process has been subject to public review and comment during its development; and

NOW, THEREFORE BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF MUSCATINE, IOWA, that Muscatine City Council hereby approves and adopts the Muscatine County Multi-Jurisdiction Local Hazard Mitigation Plan as approved by FEMA as this jurisdiction's Multi-Hazard Mitigation Plan.

PASSED, APPROVED, AND ADOPTED this 20th day of August, 2020.

_____

Diana Broderson, Mayor

Attest:

_____

Greg Jenkins, City Administrator

Jurisdiction: **Muscatine County**	**Title of Plan:** Muscatine County Multi-Jurisdictional Hazard Mitigation Plan	**Date of Plan:** 2020
Local Point of Contact: Brian Wright	**Address:** 414 E. Third Street Muscatine, IA 52761	
Title: EMA Director		
Agency: Muscatine Co. Emergency Management		
Phone Number: 563-288-3909	**E-Mail:** Brian.wright@co.muscatine.ia.us	
Funding Source: Self funded		
State Reviewer:	**Title:**	**Date:**
FEMA Reviewer:	**Title:**	**Date:**
Date Received in FEMA Region VII		
Plan Not Approved		
Plan Approvable Pending Adoption		
Plan Approved		

Jurisdiction:	NFIP Status*	
	Y	**NP**
Muscatine County	Y	
City of Atalissa	Y	
City of Conesville		NP
City of Fruitland	Y	
City of Muscatine	Y	
City of Nichols	Y	
City of West Liberty	Y	
City of Wilton	Y	

*** Notes: Y = Participating NP = Not Participating in NFIP S- Sanctioned R-Rescinded**

SECTION 1: REGULATION CHECKLIST

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT A. PLANNING PROCESS			
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))	Chapter 2, pages 3-9, and Appendices 2-1 and 2-2, pages 155-183	✓	
A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))	Chapter 2, pages 3-6, and Appendices 2-3 and 2-4, pages 185-191	✓	
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))	Chapter 2, pages 6-7, and Appendices 2-5 and 2-6, pages 193-199	✓	
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))	Chapter 2, pages 7-9	✓	
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))	Chapter 5, page 149	✓	
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))	Chapter 5, pages 145-146	✓	
ELEMENT A: REQUIRED REVISIONS			

1. REGULATION CHECKLIST Regulation (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT			
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))	Chapter 3, pages 11-95 and 121-129	✓	
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))	Chapter 3, pages 11-95	✓	
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))	Chapter 3, pages 11-95	✓	
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))	Chapter 3, pages 67-72, and Chapter 4, Table 4-2, pages 137-144	✓	
ELEMENT B: REQUIRED REVISIONS			
ELEMENT C. MITIGATION STRATEGY			
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))	Chapter 3, pages 121-129, and Chapter 5 Table 5-1, pages 147-148	✓	
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))	Chap. 3, pg. 121-129, Chap. 4, Table 4-2, pg. 137-144, and Chap. 5, Table 5-1, pg. 147-148	✓	
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))	Chapter 4, pages 131-144, and Appendix 4-1, pages 215-230	✓	
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))	Chapter 4, pages 131-144, and Appendix 4-1, pages 215-230	✓	
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))	Chapter 4, pages 131-144, and Appendix 4-1, pages 215-230	✓	
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))	Chapter 5, pages 146-148	✓	
ELEMENT C: REQUIRED REVISIONS			

1. REGULATION CHECKLIST Regulation (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (applicable to plan updates only)			
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))	Chapter 3, pages 116-120	✓	
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))	Chapter 4, Tables 4-1 and 4-2, pages 135-144	✓	
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))	Chapter 3, pages 13-16, and Chapter 4, pages 131-144	✓	
ELEMENT D: REQUIRED REVISIONS			
ELEMENT E. PLAN ADOPTION			
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))	Not yet; resolutions planned to follow plan approval (draft resolution, Appendix 1-1, page 153)		
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))	Not yet; resolutions planned to follow plan approval (draft resolution, Appendix 1-1, page 153)		

ELEMENT E: REQUIRED REVISIONS

Written proof that all jurisdictions' governing bodies have formally adopted the plan (usually a resolution) must be submitted to FEMA. *See Local Multi-Hazard mitigation Planning Guidance (July 2008) pages 17-18.*

Note: If the plan is not adopted by a participating jurisdiction, that jurisdiction would not be eligible for project grants under the following hazard mitigation assistance programs: HMGP, PDM, FMA, and SRL.

PENDING APA

SECTION 2: PLAN ASSESSMENT

A. Plan Strengths and Opportunities for Improvement

This section provides a discussion of the strengths of the plan document and identifies areas where these could be improved beyond minimum requirements.

Element A: Planning Process

Plan Strengths

Opportunities for Improvement

Element B: Hazard Identification and Risk Assessment

Plan Strengths

Opportunities for Improvement

Element C: Mitigation Strategy

Plan Strengths

Opportunities for Improvement

B. Resources for Implementing Your Approved Plan

A variety of mitigation resources are available to communities. The Iowa Homeland Security & Emergency Management website: http://www.iowahomelandsecurity.org/disasters/hazard_mitigation.html provides planning and project related information as well as details on how major FEMA mitigation programs are implemented in the State.

HSEMD's training website provides information on upcoming training opportunities within the State: http://homelandsecurity.iowa.gov/training/.

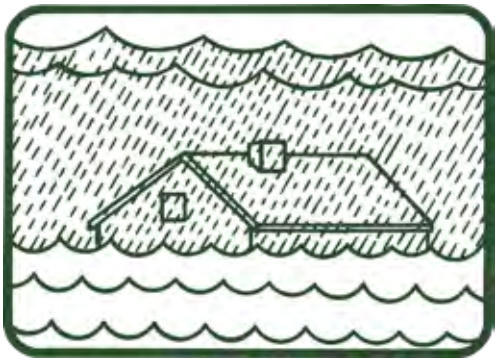
Review of the FEMA HMA guidance (FY11 is the most current) is also encouraged as guidance provides information about application and eligibility requirements. This guidance is available from http://www.iowahomelandsecurity.org/grants/HMA.html or through FEMA's grant applicant resources page at http://www.fema.gov/government/grant/hma/grant_resources.shtm.

The FEMA Hazard mitigation planning site http://www.fema.gov/plan/mitplanning/index.shtm contains the official guidance to meet the requirements of the Stafford Act, as well as other resources and procedures for the development of hazard mitigation plans.

Various funding programs are available from several state and federal agencies to assist local jurisdictions in accomplishing their mitigation activities and goals. A detailed listing of programs, information on each program, and contact information is also available from the 2010 State Hazard Mitigation Plan.

Muscatine County
Iowa

Multi-Jurisdictional Hazard Mitigation Plan



2020

Muscatine County

Multi-Jurisdictional

Hazard Mitigation Plan

2020

This document was prepared by:

TABLE OF CONTENTS

LIST OF MAPS

1 PREREQUISITES

Adoption by the Local Governing Body

Muscatine County has acted as the lead jurisdiction in a multi-jurisdictional plan process for the county and its constituent participating municipalities. As such, Muscatine County has adopted this Multi-Jurisdiction Local Hazard Mitigation Plan process and document in such form as it is approved by FEMA review. A copy of the signed resolution as adopted on September ___, 2020 is included in Appendix 1-2.

Multi-Jurisdictional Plan Adoption

The following incorporated municipalities participated in the Multi-Jurisdiction Local Hazard Mitigation planning process with Muscatine County in order to receive individual approval of the plan. A draft resolution was provided as a sample for municipalities as shown in Appendix 1-1. Each jurisdiction has adopted the plan process and document as dated below. A copy of each signed resolution as adopted is included in an Appendix 1-2.

Participating Jurisdiction	Date of Plan Adoption
City of Atalissa	
City of Conesville	
City of Fruitland	
City of Muscatine	
City of Nichols	
City of West Liberty	
City of Wilton	

Multi-Jurisdictional Planning Participation

In addition to Muscatine County, incorporated municipalities within the county participated in the local hazard mitigation plan process as listed above except for the City of Stockton and the City of Durant. The City of Stockton elected not to participate in the plan. The City of Durant was not included in the Muscatine County Hazard Mitigation Plan as the largest portion of Durant lies outside of the county. The City of Durant was contacted as part of the plan advisory group regarding information about the plan process. School districts within Muscatine County (Muscatine CSD, West Liberty CSD, Wilton CSD, and the Eastern Iowa Community College – Muscatine Campus) also were invited to participate in the planning process, but each elected to not participate after attending the initial meeting to get more information.

The remaining participating jurisdictions took part in the planning process as more fully described in the "Planning Process" section. At the initial kick-off meeting held August 19, 2019, the planning committee discussed and determined what would constitute satisfactory participation in the plan process, consisting of the following: designate a primary contact; attend two out of the three planning meetings; submit required information such as list of critical facilities, development trends, and any changes to the jurisdiction since the last plan; score identified hazards from the jurisdictions perspective and explain any changes from previous plan; provide input and review of jurisdiction's risk assessment; report on progress toward previous mitigation actions; submit prioritized mitigation actions; review and comment on the plan draft;

and adopt the plan pending FEMA's approval. All of the of the above listed jurisdictions met the necessary requirements to be considered a participating jurisdiction.

Each jurisdiction designated a primary contact and assigned staff to attend meetings as part of the core planning committee. The planning committee was responsible for directing staff research, reviewing document drafts, and approving the plan process and final document. In addition to attendance at meetings, local jurisdictions responded to requests for data and provided information when conditions in an individual jurisdiction varied from the entire county-wide planning area. Local jurisdictions also discussed the planning process at their respective council meetings, invited public input at these meetings, and assisted with public outreach efforts.

2 PLAN PROCESS

Muscatine County, acting as the lead jurisdiction in the multi-jurisdictional plan process, coordinated with Bi-State Regional Commission to guide the preparation of a local hazard mitigation plan that meets the requirements of the Disaster Mitigation Act of 2000. To assure compliance with the process for developing the plan document, the Local Mitigation Plan Review Crosswalk from FEMA dated August 20, 2018 was used for guidance in meeting the requirements of the plan. A proposed timeline for the update process was also developed in consultation with the Iowa Department of Homeland Security and Emergency Management.

The first meeting of the Planning Committee was held on August 19, 2019. This was an introductory meeting for the municipal and school district representatives. Bi-State staff presented a PowerPoint outline of the plan requirements as outlined in FEMA guidance, making particular note of multi-jurisdictional requirements for individual participating communities. A copy of the PowerPoint presentation is included as Appendix 2-1. The Planning Committee members were also presented with data collected on hazards that had occurred in Muscatine County since the completion of the previous plan was completed in 2015. The Planning Committee agreed upon a schedule of alternating committee meetings and email/phone coordination, and outlined a strategy for public involvement across the county.

This PowerPoint presentation was subsequently repeated and recorded on the Muscatine Campus of the Eastern Iowa Community College, and a link to an online video of the presentation (https://www.youtube.com/watch?v=KFAIlmlIdso) was placed on the Muscatine County Emergency Management webpage for both the Planning Committee and members of the public to access.

Who was Involved

Mr. Brian Wright, Emergency Management Director for Muscatine County, was designated as lead staff for Muscatine County in development of the plan and served as the principal contact person for Bi-State staff. Mr. Wright made the initial contact with constituent municipalities in Muscatine County regarding planning participation. It was determined by staff to follow a direct representation model. Bi-State Regional Commission was brought on board to support the plan process, and to research and write the plan document. The core Planning Committee is made up of staff and representatives of seven participating municipalities in addition to Muscatine County as follows:

City of Atalissa

City of Conesville

City of Fruitland

City of Muscatine

City of Nichols

City of West Liberty

City of Wilton

Muscatine County

School districts within Muscatine County were contacted and invited to participate. Muscatine Community School District, Wilton Community School District, West Liberty Community School District, and the Eastern Iowa Community College – Muscatine Campus all sent representatives to the August 19 meeting to learn more about the process. Although none of the school districts decided to participate, they did offer support for the planning process, most notably in the form of hosting, recording, and broadcasting a public meeting at Eastern Iowa Community College, and provided information as requested.

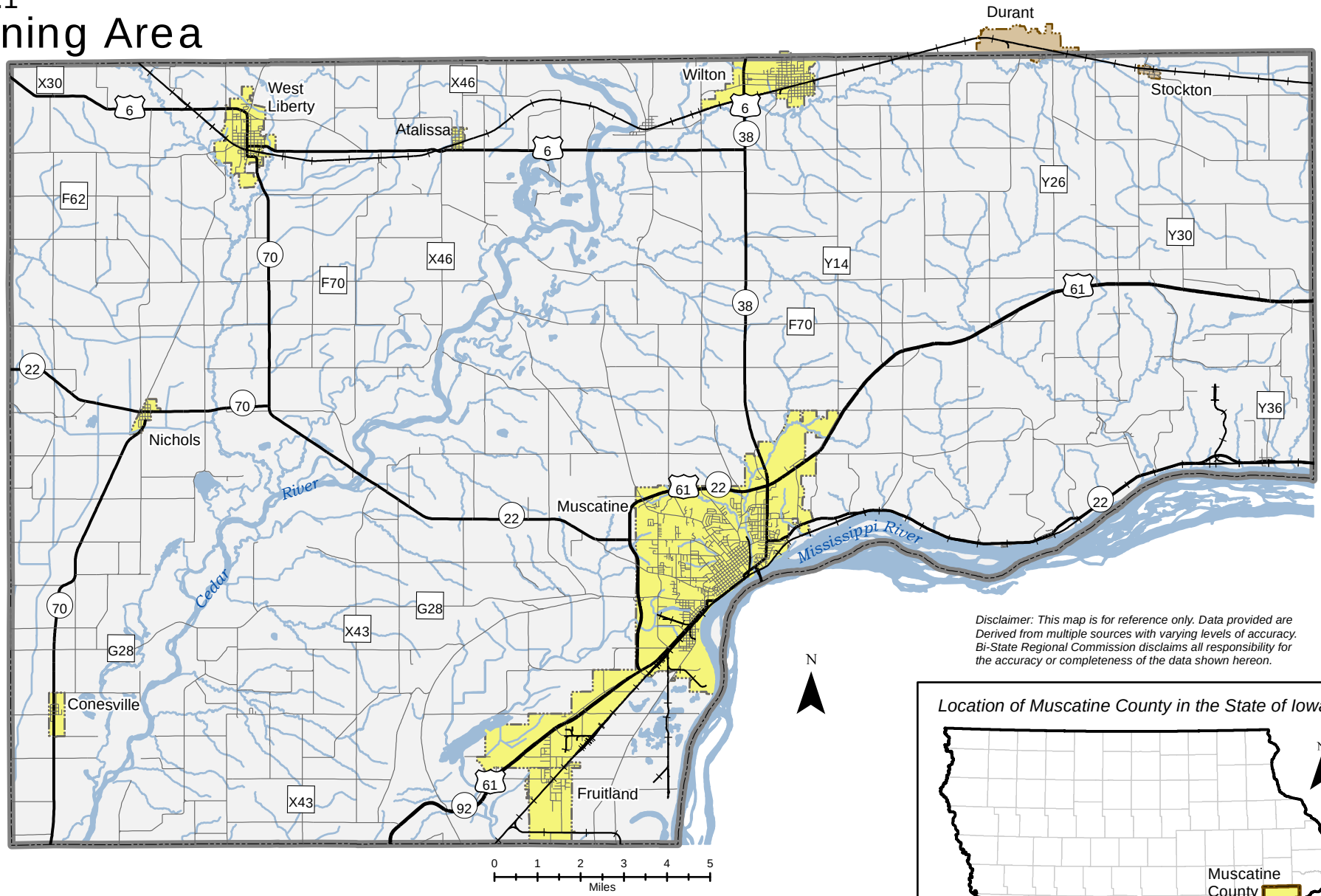
It was determined that the municipalities that agreed to participate in the multi-jurisdictional plan would designate a primary contact for all correspondence. This would follow the direct representation model as suggested in FEMA guidance for multi-jurisdictional plans. This primary contact, or another designated official or staff person, would attend planning meetings and form the core Planning Committee. The Planning Committee was be responsible for guiding decisions about the contents of the plan in relation to FEMA guidance and for reviewing staff-prepared documents. Since Planning Committee members also represented communities looking for individual FEMA approval of the multi-jurisdictional plan, they are also responsible for noting any variation from the overall planning area for their community. Members of the Planning Committee and staff are listed in Appendix 2-2. This includes primary contacts and other community representatives who attended meetings.

Planning Area and Map

The planning area includes all of Muscatine County with participation of constituent municipalities as described above. A base map of the planning area was developed as follows (Map 2-1 on page 5) showing jurisdictional boundaries and indicating which are participating in the plan process. The base map includes rivers and water bodies; highways, major roadways, railroads; and streams and creeks. This map was subsequently used to overlay identified hazard areas, vulnerable facilities, and other features with a geographic reference in sections of the plan document that follow.

Map 2.1

Planning Area



Disclaimer: This map is for reference only. Data provided are Derived from multiple sources with varying levels of accuracy. Bi-State Regional Commission disclaims all responsibility for the accuracy or completeness of the data shown hereon.

N

Location of Muscatine County in the State of Iowa

Map prepared by:

Bi-State Regional Commission

October 2019

Geographic Sources:
Roads - Iowa DOT (2019)
Corporate Limits - MAGIC (2019)
County Boundary - IA DNR
Water Features - USGS
State - TIGER Line (2018)

- Participating Communities
- Corporate Boundaries
- County Boundary
- River / Waterbody
- Highway / Major Road
- Road
- Railroad
- Stream / Creek

Advisory Group

In addition to the Planning Committee, a broader list of community groups and agencies was developed using FEMA guidance to add more participation and expertise to the planning process. Representatives were invited to participate in the planning process in an advisory capacity. They would be available to staff as resources in their respective areas of interest and provide an additional layer of review in development of document drafts. A sample list of possible contacts was brought to the Planning Committee at its first meeting, and an invitation list of contacts was further developed based on their suggestions. As noted in the "Prerequisites" section, the Cities of Stockton and Durant were included on the Advisory Group as neighboring communities, since they were not actively participating in the plan process. The school districts were also included in the Advisory Group once they declined to participate in the plan itself but offered to provide input as requested. A copy of the invitation letter is included as Appendix 2-3, and a list of agencies contacted is included as Appendix 2-4. Media contacts were included in the Advisory Group invitation, which provided another opportunity for public information and participation. As a result of these efforts, the National Weather Service sent a representative to a Planning Committee meeting to participate in the discussion and rating of area hazards.

Public Involvement

At its first kick-off meeting, the Planning Committee discussed public involvement and participation. It was agreed that all the scheduled Planning Committee meetings would be open to the public and that participating jurisdictions would discuss the planning process in their respective council meetings. Muscatine County would make use of its website to provide information about the planning process, including meeting information and schedule, links to related mitigation information and plan guidance, and draft document sections for review and comment. Participating jurisdictions were encouraged to make use of their own websites to link to this information.

So as to assure formal notification of public participation in the plan, the Bi-State Regional Commission published notice of meetings on at least two occasions, once during plan draft development and once prior to adoption of the plan. Publication of such notices were included in the Muscatine Journal, a daily newspaper with countywide circulation. Copies of the notices are included in Appendix 2-5. Participating jurisdictions also were encouraged to share the recorded public meeting, available online, on their websites.

In order to create more opportunities for public participation, the Planning Committee requested that any public meetings hosted by the Bi-State Regional Commission be duplicated in the eastern and western halves of the county. Accordingly, the first public meeting with formal notification was held September 12, 2019 in the Public Library in West Liberty, Iowa, and was followed by a second meeting on September 17 on the campus of the Eastern Iowa Community College in the City of Muscatine. Information was distributed that all subsequent meetings of the planning committee would be considered open to the public.

Another pair of advertised public meetings were held in the eastern and western ends of the county to provide the public an opportunity to review the draft plan and ask questions in an open forum. The first of these meetings was held on February 11, 2020 in Musser Public Library in Muscatine followed by a meeting held February 13, 2020, in the Public Library in West Liberty.

Both libraries retained copies of the draft plan to make them available for further public review following the meetings, with instructions for the members of the public as to whom to contact with comments and suggestions. A copy of the instructions left with the draft is included in Appendix 2-6. In addition, a draft copy of the plan was made available for the public to review on the Muscatine County website. Prior to the County Board's consideration of adoption of the plan, the county will hold a final public hearing.

Existing Planning Mechanisms

In addition to the persons included in the planning process, many written resources, existing plans, studies, reports, and technical information were reviewed and incorporated into the plan process as appropriate. Technical resources used to develop the hazard profiles are referenced to each profiled hazard, but general references of note include:

- FEMA Local Hazard Mitigation Plan Review Crosswalk from the 2015 Muscatine County Multi-Jurisdictional Hazard Mitigation Plan
- FEMA State and Local Mitigation Planning How-To Guides
- 2010 and 2013 State of Iowa Hazard Mitigation Plans
- Iowa Hazard Analysis and Risk Assessment

Participating jurisdictions were asked to inventory and review existing planning and technical documents within their own communities that could be incorporated into the plan. Table 2-1 summarizes documents reviewed by individual jurisdiction and which of those documents were utilized within the plan.

There was only one addition to the list from the 2015 *Muscatine County Multi-Jurisdictional Hazard Mitigation Plan*, though it was of especial importance to the hazard mitigation planning process. During the previous plan update, the City of Muscatine and the U.S. Army Corps of Engineers was in the process of drafting an Urban Levee System Evaluation of Flooding Scenarios for three hypothetical levee breach locations in Muscatine County. The final determinations of that evaluation were accordingly available for consideration in the 2020 plan update. The findings and implications of that report are discussed in more detail in the Levee Failure section of the Risk Assessment chapter of this document, on page 11.

Table 2-1
Record of Review

Existing Program/Policy/ Technical Documents	Did Jurisdiction Review Document? (Yes/No)	Reviewed Plan Authors and Incorporated in Plan? (Yes/No)
Comprehensive Plan 2014	Yes	Yes
Watershed Protection Plan	Yes	Yes
Emergency Response Plan	Yes	Yes
Emergency Management Plan	Yes	Yes
Zoning Ordinance	Yes	Yes
Mobile Home Park and Travel Trailer Park Ord.	Yes	Yes
Subdivision Ordinance	Yes	Yes
Building Codes	Yes	Yes
Floodplain Management Ord.	Yes	Yes
Onsite Wastewater Treatment and Disposal Systems Ord.	Yes	Yes
Site Plan Review Requirements	Yes	Yes
Flood Insurance Study (1986)	Yes	Yes
Existing Land Use Map	Yes	Yes
Elevation Certificates	Yes	
Muscatine County Trails Plan	Yes	Yes
Iowa Region 9 Long Range Transportation Plan	Yes	Yes
Bi-State Region Transit Development Plan	Yes	Yes
Comprehensive Economic Development Strategy	Yes	Yes
Well Ordinance	Yes	Yes
Public Education on Location of Storm Shelters	Yes	Yes
Land Use Plan 2003	Yes	Yes
Comprehensive Plan 2002 and 2013	Yes	Yes
Flood Insurance Study 1986	Yes	Yes
Mississippi River Consensus Plan 1997	Yes	No
Capital Improvement Plan	Yes	No
Urban Levee System Evaluation of Flooding Scenarios	Yes	Yes

Table 2-1 (continued)

Existing Program/Policy/ Technical Documents	Did Jurisdiction Review Document? (Yes/No)	Reviewed Plan Authors and Incorporated in Plan? (Yes/No)
City Disaster Plan	Yes	Yes
Zoning Ordinance	Yes	No
Subdivision Ordinance	Yes	No
Building Codes	Yes	Yes
Floodplain Management Ordinance	Yes	Yes
Stormwater Management Ordinance	Yes	Yes
Site Plan Review Ordinance	Yes	No
Landscape Code	Yes	No
Solid Waste Regulations	Yes	Yes
Hazardous Waste Regulations	Yes	Yes
Architectural Review Guidelines	Yes	No
Historic Preservation Program	Yes	No
Downtown Development Program	Yes	No
Long-Range Transportation Plan	Yes	Yes
Existing Land Use Map	Yes	Yes
Elevation Certificates	Yes	No
Flood Insurance Study 1986	Yes	Yes
Building Codes	Yes	No
Zoning Ordinances	Yes	No
Flood Insurance Study 1986	Yes	Yes
Comprehensive Plan 2006	Yes	Yes
Comprehensive Plan 2003	Yes	Yes
Zoning Ordinances	Yes	No
Emergency Response Plan	Yes	Yes
Subdivision Regulations	Yes	No
Critical Facilities Map	Yes	Yes
Existing Land Use Map	Yes	Yes

3 RISK ASSESSMENT

Identifying Hazards

Because the possible hazards to be addressed in mitigation planning differ among major resources, a comparison list was developed to guide the Planning Committee discussion, shown in Table 3-1. The second column lists natural hazards from FEMA *State and Local Mitigation Planning, How-To Guide*, "Understanding Your Risks: Identifying Hazards and Estimating Losses," FEMA 386-2, August 2001. The third column comes from the 2013 *Iowa Hazard Mitigation Plan*. The fourth column comes from the *Muscatine County Multi-Jurisdictional Hazard Mitigation Plans* adopted in 2015 and, following discussion of the hazards, used again for the 2020 plan.

Table 3-1
Comparison of Hazards Addressed by Respective Mitigation Plans

TYPE	FEMA	Iowa Hazard Mitigation Plan 2013	Muscatine County Hazard Mitigation Plan 2015 & 2020
Natural		Animal/Plant/Crop Disease	
	Avalanche		
	Coastal Erosion		
	Coastal Storm		
	Dam Failure	Levee/Dam Failure	Dam Failure
			Levee Failure
	Drought	Drought	Drought
	Earthquake	Earthquake	Earthquake
	Expansive Soils	Expansive Soils	Expansive Soils
	Extreme Heat	Extreme Heat	Extreme Heat
	Flood	Flash Flooding	Flash Flooding
		River Flooding	River Flooding
	Hailstorm	Thunderstorm/Lightning/Hail	Hailstorms
			Thunderstorm & Lightning
	Hurricane		
	Land Subsidence	Sinkholes	Land Subsidence/Sink Holes
	Landslide	Landslide	Landslide
	Severe Winter Storm	Severe Winter Storms	Severe Winter Storms
	Tornado	Tornados/Windstorm	Tornadoes
	Windstorm		Windstorms
	Tsunami		
	Volcano		
	Wildfire	Grass/Wild Fire	Grass or Wild-land Fire
Technological		Hazardous Materials Incident	Hazardous Materials Incident
		Human Disease	
		Infrastructure Failure	
		Radiological Incident	
		Transportation Incident	
Human Caused		Terrorism	

The initial 2010 Planning Committee eliminated some hazards from further profiling because they do not occur in the planning area or their effects are not considered significant in relation to other hazards. Table 3-2 lists these hazards and provides a brief explanation for their elimination.

Table 3-2
Hazards Not Profiled in the Plan

Hazard	Explanation for Omission
Avalanche	There are no mountains in the planning area.
Coastal Erosion	The planning area is not near coastal areas.
Coastal Storm	The planning area is not near coastal areas.
Hurricane	The planning area is not near coastal areas.
Tsunami	The planning area is not near coastal areas.
Volcano	There are no volcanic mountains in the planning area.

In addition to the natural hazards, which are required for consideration in the local hazard mitigation plan, there are other technological and human-caused hazards recommended for examination. FEMA guidance distinguishes between technological hazards as accidental events and terrorism as intentional acts.

The 2013 *Iowa Hazard Mitigation Plan* identifies and profiles five Technological hazards.

Hazardous Materials Incident	Human Disease
Infrastructure Failure	Radiological Incident
Transportation Incident	

Technological hazards include those that can arise from activities such as the manufacture, transportation, storage, or use of hazardous materials. Planning guidance suggests that it be assumed that technological emergencies are accidental and that their consequences are unintended.

The 2013 *Iowa Hazard Mitigation Plan* identifies and profiles one “Human-Caused Hazard.”

Terrorism

This hazard encompasses a wide variety of human-caused threats including enemy attack, biological terrorism, agro-terrorism, chemical terrorism, conventional terrorism, cyber terrorism, radiological terrorism, and public disorder. This includes the use of multiple outlets to 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.

For the initial *Muscatine County Multi-Jurisdictional Hazard Mitigation Plan*, only one Technological Hazard was included – "Hazardous Materials Incident." The six additional human-caused hazards in the state plan were considered in detail in the 2015 plan update process. The Planning Committee decided not to include any additional manmade hazards in the plan update at that time, but to note these as secondary effects of natural hazards when

appropriate. For example, an impact of "Severe Winter Storms" may be damage to power lines with resulting power outages.

For the 2020 plan, the Planning Committee began by reviewing the hazards previously included in the 2015 plan and the data collected on hazardous weather events and hazardous spills that had occurred in the intervening years. The planning committee also reviewed the list of hazards that had not been included in the previous update. The data collected for the 2020 update did not suggest a previously unidentified susceptibility to these hazards. Therefore, the planning committee elected to use the same list of 16 "Natural Hazards" and 1 "Human-Caused Hazard" for Muscatine County. (The "Land Subsidence" and "Sinkhole" hazard profiles were once again combined as they are very similar hazards and can be addressed together.)

These hazards are listed below and profiled in further detail in the next section.

Dam Failure	Drought
Earthquake	Expansive Soils
Extreme Heat	River Flood
Flash Flood	Hailstorm
Thunderstorm & Lightning	Landslide
Levee Failure	Severe Winter Storm
Sinkholes and Land Subsidence	Tornado
Grass or Wild-land Fire	Windstorm
Hazardous Materials Incident	

Profiling Hazards

The Planning Committee elected to once again profile hazards similarly to the "Hazard Analysis and Risk Assessment" in the 2013 *Iowa Hazard Mitigation Plan*. Each profile contains information on:

Definition	Description including extent
Historical Occurrence	Probability (of future events)
Magnitude and Severity	Warning Time
Duration	

This format mirrors the 2015 plan and the hazard profiles have been updated with current information.

The hazard profiles are provided for the entire Muscatine County planning area, though some (most notable levee failure) affect some jurisdictions more directly than others. As part of the multi-jurisdictional participation of this plan, additions or exceptions from the planning area are noted to the extent available and as needed within the profile as well as each individual jurisdiction's community profile.

Prioritizing Hazards

To evaluate the potential severity of the identified hazards, the Planning Committee was presented with data collected on hazardous events to have occurred since the last hazard mitigation plan update in 2015. This data was used to update and refine the hazard profiles, which the planning committee also reviewed. Each hazardous event included information on

which jurisdictions were impacted, and each jurisdiction was asked to score the hazards based on their own local perspective and the data specific to their communities.

The scoring methodology used by each jurisdiction was the method outlined in the 2013 *Iowa Hazard Mitigation Plan*. This method was selected because it was already familiar to most of the participating jurisdictions, having been used in the previous update process to the Muscatine County hazard mitigation planning process. The methodology, which is described in more detail in Appendix 3-1, uses a 4-point scale to score each of the four categories in the hazard profile worksheet. The scores are then weighted as follows:

(Probability x 0.45) + (Magnitude/Severity x 0.30) + (Warning Time x 0.15) + (Duration x 0.10) = Final Hazard Score

This provides a quantifiable system of analyzing the hazards within a flexible range and provides a consistent basis of analysis in each of the profile categories when a number of different representatives are scoring.

The intention of this scoring process was to provide a starting point for a discussion to determine the countywide hazard scores based on the initial risk assessments made by each participating jurisdiction. Once each jurisdiction had submitted their scores, the scores were averaged together to give a rough sense of how the hazards might be ranked countywide. A comparison of this initial ranking and the hazard rankings from the 2015 plan, as shown in Table 3-3, was presented to the planning committee.

Table 3-3
Rank Order Based on Weighted Scoring from Highest to Lowest

High		
1	Tornado	3.25
2	Severe Winter Storm	3.04
3	Thunderstorm & Lightning	2.94
4	Windstorm	2.81
5	Flash Flood	2.81
6	River Flood	2.80
Medium		
7	Hailstorm	2.41
8	Drought	2.41
9	Hazardous Materials	2.39
10	Extreme Heat	2.18
11	Levee Failure	2.00
12	Grass & Wild-land Fire	2.00
Low		
13	Earthquake	1.90
14	Dam Failure	1.59
15	Sinkholes & Land Subsidence	1.53
16	Landslide	1.35
17	Expansive Soils	1.13

High		
1	Tornado	3.01
2	Thunderstorm & Lightening	2.89
3	Windstorm	2.74
4	Severe Winter Storm	2.55
5	Flash Flood	2.50
6	Grass & Wild-land Fire	2.40
Medium		
7	Extreme Heat	2.25
8	Hazardous Materials	2.10
9	Hailstorm	2.06
10	River Flood	2.00
11	Drought	1.88
12	Earthquake	1.77
Low		
13	Levee Failure	1.74
14	Sinkholes & Land Subsidence	1.54
15	Dam Failure	1.39
16	Landslide	1.35
17	Expansive Soils	1.23

The planning committee met together along with a meteorologist from the National Weather Service, Rich Kinney, and once again reviewed the data on recent hazards as well as a table containing the averaged scores to determine the final rankings.

Mr. Kinney offered suggestions as to adjusting the probability ratings for some of the hazards based on current data regarding occurrence. He also suggested some hazards could be grouped together based on the likelihood of co-occurrence. Tornados, windstorms, flash flooding, and river flooding, for example, all have more severe impacts than thunderstorms and so should receive a higher ranking, but they all occur as secondary effects of severe thunderstorms, so logically thunderstorms could be grouped with them.

At the same time, the Planning Committee reviewed the general descriptions of the priority groups used in 2015. They decided to keep the definitions the same, using High, Medium, and Low as the priority designations. The definitions are:

High Priority: These hazards have a higher likelihood of occurrence and unacceptable consequences. They are candidates for immediate focus in mitigation planning and for eliminating unacceptable risk factors.

Medium Priority: These hazards should be addressed, but have a lower priority or are longer term in focus. For the Medium Priority, emphasis is on risk reduction.

Low Priority: These hazards have a less significant level of risk, for which baseline protection is adequate, or that are considered to be largely beyond the scope of local mitigation efforts.

Using these priority definitions, local knowledge of hazard occurrence and risk, and the meteorologist's feedback, the numerical rankings were adjusted slightly from Table 3-3. The final hazard rankings are shown in Table 3-4. The table also denotes the initial top five hazard scores for each community, shown in gray. In the final ranking, all of the top five concerns for each individual jurisdiction are included within the hazards designated as either High or Medium Priorities for the county as a whole.

Table 3-4
Countywide and Individual Jurisdiction Hazard Scores

		Countywide Hazard Ranking	Atalissa	Conesville	Fruitland	Muscatine	Nichols	West Liberty	Wilton	Muscatine County
High Priority Hazards	Tornado	1	3.25	3.25	2.65	4	2.4	3.55	2.15	2.8
	Windstorm	2	2.95	3.35	1.3	3.1	3.3	3	2.2	2.7
	Flash Flood	3	2.6	2.35	1.85	3.4	2.35	3	2.2	2.25
	River Flood	4	1	1.3	2.5	2.95	1	3	1.3	2.95
	Thunderstorm & Lightning	5	3.05	3.35	1.3	2.8	3.3	2.9	3.1	3.3
	Levee Failure	6	1	1.45	2.5	2.65	2.35	1.1	1.3	1.6
Medium Priority Hazards	Severe Winter Storm	7	2.3	2.1	2.1	2.55	3.15	3.15	2.4	2.65
	Hazardous Materials	8	1.45	2.15	1.45	3	2.85	1.55	1.95	2.4
	Drought	9	1.75	2.05	2.05	1.75	2.05	2.35	1.75	1.3
	Grass & Wild-land Fire	10	2.35	3.3	1.45	1.45	2.75	2.4	2.65	2.85
	Extreme Heat	11	2.1	2.95	1.65	2.1	2.55	1.95	2.75	1.95
	Hailstorm	12	2.2	1.45	1.75	2.35	2.3	2.15	2.2	2.1
Low Priority Hazards	Landslide	13	1.3	1.45	1	1.9	1	1.1	1.55	1.5
	Expansive Soils	14	1.5	1.3	1	1	1	1.1	1.45	1.5
	Sinkholes & Land Subsidence	15	1.75	1.55	1	1.45	1	2	2.05	1.5
	Dam Failure	16	1	1	1	2.65	1	1.2	1.75	1.5
	Earthquake	17	1.75	1	1	2.35	2.05	2.35	1.75	1.9

The final priority rankings group tornados, windstorms, flash flooding, river flooding, thunderstorms, and levee failure together as High Priority hazards. Although the data suggests a levee failure would directly impact the communities of Muscatine and Fruitland while other communities would remain outside the floodwaters, the Planning Committee elected to rank such a failure as a High Priority in recognition of the City of Muscatine and surrounding areas as a hub of economic activity for the county. As a result, all communities in Muscatine County would be impacted either directly or indirectly by a levee failure.

Severe winter storms, hazardous material spills, drought, grass and wild-land fire, extreme heat, and hail were ranked as Medium Priority hazards. The Planning Committee elected to lower severe winter storms from a high to medium priority hazard on the basis that although likely to occur, the impacts of such events were not of the same magnitude as tornadoes or flooding events. Similarly, grass and wild-land fires were designated as Medium Priority hazards despite a high initial score on the basis that such events, which are more likely to occur within the rural parts of the county and be quickly contained, impact a comparatively smaller proportion of the population within Muscatine County, and are likely to be of a short duration.

The Planning Committee placed landslides at the top of the Low Priority hazards, noting that although there had only been a single area in the county to experience a landslide to date, the data suggested this could be a growing concern in the future. Expansive soils were noted next as a related hazard, followed by sinkholes/land subsidence, dam failure, and earthquakes as low priority hazards.

The Planning Committee agreed to focus on High Priority hazards in developing the mitigation strategy for the countywide planning area. The High Priority hazards contain the greatest and immediate threat to the planning area. However, individual participating jurisdictions may have scored the hazards differently from the planning area based on local knowledge of community characteristics and vulnerabilities. Grass and wild-land fires are generally of more concern to the rural communities surrounded by more open land than the larger metropolitan area of Muscatine, for example. Similarly, a levee failure has a higher potential direct impact for Muscatine and Fruitland than other communities within the county. Where applicable, such considerations are noted in the “Multi-Jurisdictional Assessment” section.

These final priority rankings are noted on the hazard profile worksheets that follow.

Hazard Profile Worksheets

Dam Failure

Dam failure is the uncontrolled release of impounded water resulting in downstream flooding, which can affect life and property. Flooding, earthquakes, blockages, landslides, lack of maintenance, improper operation, poor construction, vandalism, or terrorism cause dam failures. Dams are constructed for a variety of uses, including flood control, erosion control, water supply impoundment, hydroelectric power generation, and recreation.

Dams are classified into three categories based on the potential risk to people and property should a failure occur. The classification may change over time because of development downstream from the dam since its construction. Older dams may not have been built to the standards of its new classification. The Iowa Department of Natural Resources defined hazard classifications are listed below.

High Hazard: Dams are classified as High Hazard when located in an area where failure may create a serious threat of loss of human life.

Moderate Hazard: A Moderate Hazard classification is assigned to a dam located in an area where failure may damage isolated homes or cabins, industrial or commercial buildings, or moderately traveled roads or railroads or interrupt major utility services without substantial risk of loss of human life. In addition, structures where the dam and its impoundment are themselves of public importance, such as dams associated with public water supply systems, industrial water supply, public recreation, or is an integral feature of a private development complex are also classified as a Moderate Hazard.

Low Hazard: Dams are classified as Low Hazard if located in an area where damages from a failure would be limited to loss of the dam, livestock, farm outbuildings, agricultural lands, and lesser-used roads, and where loss of human life is considered unlikely.

Dam hazard potential classifications have nothing to do with the material condition of a dam, only the potential for death or destruction due to the size of the dam, the size of the impoundment, and the characteristics of the area downstream of the dam. The Iowa Department of Natural Resources tracks all dams in the State of Iowa with a height of at least 25 feet or a total storage of at least 50-acre feet of water. The inventory excludes all dams less than 6 feet high regardless of storage capacity and dams less than 15-acre feet of storage regardless of height.

Dam failure probability can be reduced with increased attention to sound design, quality construction, and continued maintenance and inspection. It is important to consider that by 2020, 85% of the dams in the United States will be more than 50 years old (the design life of a dam). In Iowa, 41% of dams will be more than 50 years old in 2020. This reflects the need to consider and encourage dam failure emergency action plans for high and significant hazard dams. In the 2013 *Iowa Hazard Mitigation Plan*, the State Hazard Mitigation Team (SHMT) analysis evaluated the probability that a dam failure in Iowa has a low chance of occurrence in any given year.

Fifteen dams are identified in Muscatine County according the Iowa Department of Natural Resources (IDNR). Nine of those dams are listed with Low Hazard potential. These dams are

generally for small and privately-owned ponds used for fishponds or recreation and are located in undeveloped or agricultural areas. Six of the dams are identified with Moderate Hazard potential. The county has one federal navigation dam on the Mississippi River. This U.S. Army Corps of Engineers (USACE) Lock and Dam #16 is listed in the National Inventory of Dams (NID). USACE listed the federal dams in the category of Moderate (significant) hazard related to navigational use. Dam #16 is a roller dam with rollers that are lifted or lowered to maintain the river water level needed for navigation. Generally, the flood wave caused by a catastrophic breach of a navigation dam would be contained in the existing floodway channel, and there would not be extensive flooding or major loss of life. During times of river flooding the rollers are lifted out of the river and no longer act as a dam. As a result, Lock & Dam #16 is listed with a Low Hazard potential in the IDNR list. The planning area contains no dams classified as High Hazard dams.

The IDNR Dam Safety Program Management Tools or USACE lists dams classified as Moderate Hazards below. For security and safety concerns, the map of dams and levees within Muscatine County has not been included.

HON Dam (City of Muscatine)
Leutzinger-Lowe Watershed Site M-1
Muscatine County Roadgrade Dam 14-77-1E (Montpelier)
Muscatine Power & Water Dam
Southlawn Addition Dam
Whispering Pines Dam

Inundation areas for the county's 15 dams are not available at this time, but will be included in future plan updates as they become available. Data on the costs associated with specific dam failures is not available at this time.

Probability. There have been two historical occurrences of dam failure in the State of Iowa. One occurred in 1968 in Waterloo when the Virden Creek Dam failed. The incident claimed one life, and the dam is no longer in existence. The second occurrence happened at the Lake Delhi Dam near Delhi, Iowa in July of 2010. The 92-year-old dam was overtopped due to what is believed to be record water inflow to the lake. The failure occurred during historic reservoir levels, which resulted in a first filling situation for the untested portion of the dam embankment located above the concrete core wall, according to the IDNR. One of the three floodgates was also not fully functional and could not be opened all the way. The record inflow exposed long dormant design deficiencies and unrepaired maintenance problems. The breach caused significant property loss, an evacuation of as many as 700 near the dam, as well as severe economic effects to the tourism industry in the area. No dam failures have occurred in Muscatine County.

Magnitude and Severity. People and property along streams are most vulnerable. Facilities and lives considerable distances from the actual impoundment are not immune from the hazard. Depending on the size and volume of the impoundment as well as the channel characteristics, a flash flood can travel a significant distance. As inundation areas are identified, more information that is specifically related to vulnerability and the severity of effects will be obtained and incorporated into the plan.

The area affected following a dam failure would be limited to those areas in and near the floodplain. People and property outside the floodplain could also be affected depending on the proximity to the dam and the height above the normal stream level.

The severity of damage could range from property damage, if a small subdivision impoundment failed, all the way to multiple deaths, injuries, and extensive property damage if a large high hazard dam, such as a Saylorville Reservoir, failed upstream of Des Moines. Operations could be affected by communications loss, critical facility damage/destruction, etc. Worst-case scenario could involve whole subdivisions being swept away by the fast flowing water.

Warning Time. A dam failure can be immediate and catastrophic leaving little or no time to warn those downstream of the imminent hazard. With maintenance and monitoring, weak areas and possible failure points can be identified allowing time for evacuation and securing of the dam. Most dams are only inspected periodically, thus allowing problems to go undetected until a failure occurs.

Duration. Response to the effects of a dam failure is extensive and requires wide-ranging recovering efforts for reconstruction of the original flood control structures.

Muscatine County Multi-Jurisdictional Hazard Priority Ranking: #16, Low Priority

Sources	
State of Iowa	*Iowa Hazard Mitigation Plan, 2010 and 2013*
Iowa Department of Natural Resources	*Dam Safety Program, Jan. 2013*
Muscatine County	*Muscatine County Multi-Jurisdictional Hazard Mitigation Plan 2015*
Local sources	*USACE, Rock Island District*
Association of State Dam Safety Officials	*Case Study- Lake Delhi Dam Breach - Two Perspectives*

Drought

Drought is a period of prolonged lack of precipitation for weeks at a time producing severe dry conditions. Four types of drought are relevant to Iowa:

Meteorological drought – Refers to precipitation deficiency
Hydrological drought – Refers to declining surface water and groundwater supplies
Agricultural drought – Refers to soil moisture deficiencies
Socioeconomic drought – Refers to when physical water shortages begin to affect people

Iowa experiences mainly agricultural and meteorological drought because of low soil moisture or decline in recorded precipitation.

Droughts can be spotty or widespread and last from weeks to a period of years. A prolonged drought can have a serious economic impact on a community. Increased demand for water and electricity may result in shortages of resources. Moreover, food shortages may occur if agricultural production is damaged or destroyed by a loss of crops or livestock. While droughts are generally associated with extreme heat, droughts can and do occur during cooler months.

One measure of the magnitude of drought is provided by the Palmer Drought Severity Index (PDSI), which provides a scale of differences from the standard soil moisture conditions as follows:

Palmer Classifications	
Index	**Definition**
4.0 or more	Extremely wet
3.0 to 3.99	Very wet
2.0 to 2.99	Moderately wet
1.0 to 1.99	Slightly wet
0.5 to 0.99	Incipient wet spell
0.49 to -0.49	Near normal
-0.5 to 0.99	Mild drought
-1.0 to -1.99	Mild drought
-2.0 to -2.99	Moderate drought
-3.0 to -3.99	Severe drought
-4.0 or less	Extreme drought

The National Drought Mitigation Center has a Drought Severity Classification system that takes into account the Palmer Drought Index, soil moisture, streamflow, and the Standardized Precipitation Index. It also looks at droughts as both short-term and long-term. Following is a table explaining the classification system and a graph showing droughts from 2000 until March 2015.

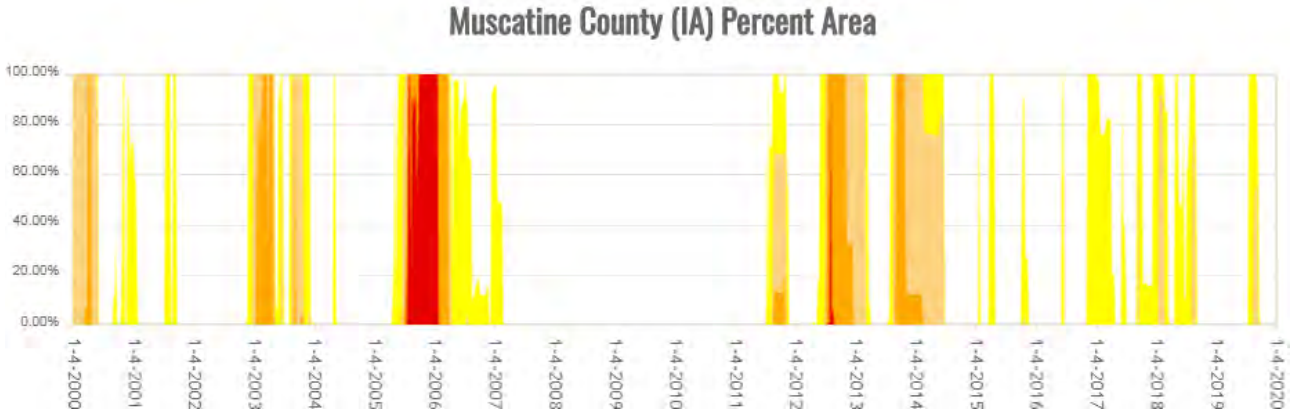
Drought Severity Classification

		Ranges					
Category	Description	Possible Impacts	Palmer Drought Index	CPC Soil Moisture Model (Percentiles)	USGS Weekly Streamflow (Percentiles)	Standardized Precipitation Index (SPI)	Objective Short and Long-term Drought Indicator Blends (Percentiles)
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered	-1.0 to -1.9	21-30	21-30	-0.5 to -0.7	21-30
D1	Moderate Drought	Some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; voluntary water-use restrictions requested	-2.0 to -2.9	11-20	11-20	-0.8 to -1.2	11-20
D2	Severe Drought	Crop or pasture losses likely; water shortages common; water restrictions imposed	-3.0 to -3.9	6-10	6-10	-1.3 to -1.5	6-10
D3	Extreme Drought	Major crop/pasture losses; widespread water shortages or restrictions	-4.0 to -4.9	3-5	3-5	-1.6 to -1.9	3-5
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies	-5.0 or less	0-2	0-2	-2.0 or less	0-2

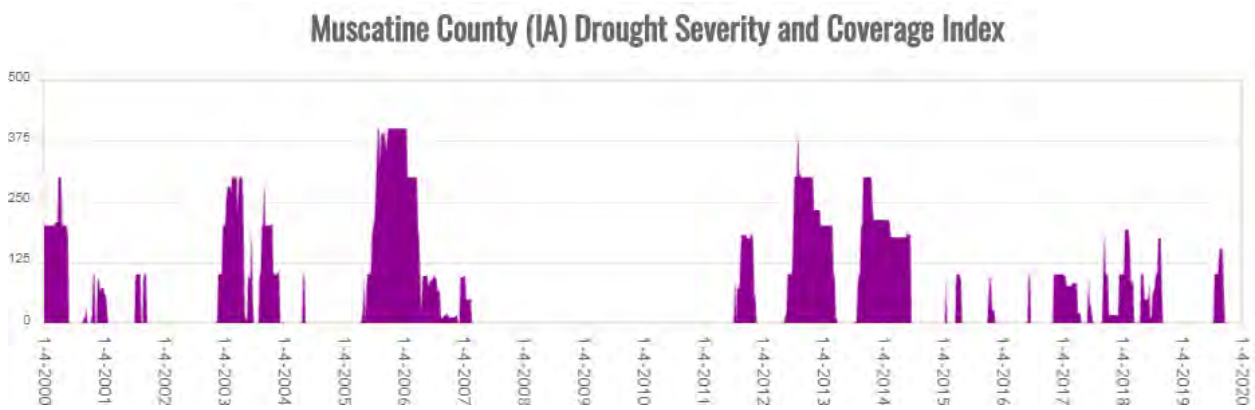
Short-term drought indicator blends focus on 1-3 month precipitation. Long-term blends focus on 6-60 months. Additional indices used, mainly during the growing season, include the USDA/NASS Topsoil Moisture, Keetch-Byram Drought Index (KBDI), and NOAA/NESDIS satellite Vegetation Health Indices. Indices used primarily during the snow season and in the West include snow water content, river basin precipitation, and the Surface Water Supply Index (SWSI). Other indicators include groundwater levels, reservoir storage, and pasture/range conditions.

The chart below shows percent of Muscatine County land area in one of the five drought severity classifications listed above for years 2000-2019. Since 2015, an abnormally dry period or periods have occurred each year. This seems to be a pattern change from prior periods. These dry periods have lasted for several months in some recording years and cover the entire county. However, these dry spells are bookended by periods of sometimes-excessive precipitation. The severity of droughts in the last five years has been relatively low.

2000-2019



2000-2019



According to the National Climatic Data Center, there have been four notable drought periods reported for Muscatine County between 01/01/1995 and 02/28/2019. Noticeable droughts include:

August 1995: A statewide drought, the dry weather conditions combined with well above normal temperatures produced the fourth warmest August in Iowa's history. Yield losses were greatest over southern Iowa where plantings were delayed by excessive spring rainfall. The dry conditions resulted in deterioration of corn and soybean crops.

August 2003: A moderate to severe drought developed in August 2003. According to the Iowa State Climatologist, August 2003 was the driest on record with a statewide average of only 0.96 inches of rainfall (3.23 inches below the normal). These weather conditions placed extreme stress on corn and soybeans, which are in their main development stage of growing in August. Crop yields were reduced by 10% for corn and 30% for soybeans.

July 2005 – March 2006: The drought of 2005-2006 began with below normal precipitation in June 2005, creating an official drought by July 2005. The drought conditions combined with high heat created unfavorable growing conditions for crops. By August 2005, Iowa's governor declared most of eastern Iowa an Agricultural Disaster Area. November 2005 marked the 10th consecutive month with below normal precipitation with the eastern ⅔ of Iowa in the Extreme Drought category. By March 2006, the drought begun to shrink in size and scope and by April 2006 precipitation was near normal. Total precipitation for 2005 was 17.86 inches (normal is 38.04 inches).

Summer 2012 - March 2013: The drought of 2012 was a result of above average temperatures and little to no precipitation. The average precipitation for June 1-August 16 was 5.68 inches, or -5.22 inches from the normal amount (normal is 10.90 inches at the Davenport Station). By August 2012, USDA had declared Muscatine County along with 42 other counties in Iowa. (On August 7, 2012, Muscatine County was listed as a D3–Extreme Drought conditions by the National Drought Mitigation Center). By the beginning of 2013, Muscatine County's drought condition had improved. On March 19, 2013, the county was listed as D0–Abnormally Dry conditions.

August 2013 to June 2014: After a wet start to the summer of 2013, a change in atmospheric conditions lead to less precipitation falling across the region from July through September. This lack of precipitation caused severe drought conditions to develop that were not fully alleviated until the middle of June 2014.

2015-2019: Muscatine County experienced several periods of dry weather during these years. In early July 2016, a period of no rain leads to reports of potential reduction in crop yields and the need to supplement water to livestock. In 2017, it was reported that grass was brown, and temporary burn bans were in place in the county.

March 3, 2015-April 28, 2014: 100% of the county was in moderate drought.

October 2015- November 2015: About 90% of the county was in moderate drought.

June 2016: For two weeks, 100% of the county was in moderate drought.

November 15, 2016-April 25, 2017: The county was in moderate drought.

June 13, 2017-July 4, 2017: A portion of the county was in drought.

September 2017-October 2017: 100% of the county was in drought. This number was reduced to about 16% from October 17, 2017 through December 12, 2017 when the drought increased to 100% again. Moderate drought then lasted from January 1, 2018 to February 13, 2018 for over 90% of the state.

Probability. Dry periods and drought are part of normal climate fluctuations in Iowa. Climatic variability can bring dry conditions to the region for up to years at a time. According to the National Drought Mitigation Center, periods of severe to extreme drought in the Upper Mississippi Basin occur cyclically, about once every ten years. The 2013 *Iowa Hazard Mitigation Plan* estimates that the statewide probability of future droughts of magnitude -3.0 to -3.9 on the Palmer Drought Severity Index is between 10% and 19% in any given year.

Magnitude/Severity. Severe drought affects all living organisms. All flora and fauna become stressed under a prolonged drought. Many animals that rely on surface water for drinking or habitat will become stressed as they search for water sources. Fish in ponds may die as water levels retreat, oxygen is depleted, and water temperature increase. Industries such as agriculture, agribusiness, and consumers (if the drought lasted long enough or affected a large area) would be affected. Supplemental water may need to be supplied to livestock as streams and ponds go dry. Increased irrigation of crops may be needed. A drought limits the ability to produce goods and provide services. Because citizens draw their drinking water from surface water and groundwater sources, a prolonged severe drought may affect all citizens, if there were to be a dramatic drop in the stream flow coupled with the drop in the water table. Those on shallow wells may run out of water and find the need to dig the well deeper or lower the pump. Increased number of grass and wildfire may occur due to the volume of dry vegetation. Fire suppression can also become a problem due to the possible lack of water. According to the 2013 *Iowa Hazard Mitigation Plan*, Muscatine County has an annual loss estimate of $1.736 million due to drought conditions. The Environmental Working Group's Farm Subsidy Database for 2015-2019 reports that the only Miscellaneous Disaster Payments made to Muscatine County occurred in 2017 for $4,511.00.

Category	Drought Impacts in Iowa
D0	Corn shows drought stress; soil is dry
D1	Soybeans abort pods; corn test weights are struggling
	Grasses are brown; more grass fires occur; burn bans are issued
	Pond levels decline
D2	Dryland corn has extremely low yields; commodity shortages are noted; livestock is stressed
	Fire danger is high
	Fewer mosquitoes are observed
	Surface water levels are low; algae blooms increase; voluntary water conservation is requested
D3	Pastures are dry; producers sell cattle; crops are tested for toxins; crops have pest infestation
	Seasonal allergies are worse; farmers are stressed about high feed prices
	Trees drop leaves; acorns are underdeveloped
	Warm water leads to fish kills; streambeds are low to dry
D4	Row crop yields and forage production have significant impacts
	Extreme measures are taken to conserve water
	Aquatic invertebrates in waterways increase

Warning Time. Drought warning is based on a complex interaction of many different variables, water uses, and consumer needs. Drought warning is directly related to the ability to predict the occurrence of atmospheric conditions that produce the physical aspects of drought, primarily precipitation and temperature. Many variables affect the outcome of climatic interactions. This makes it difficult to predict a drought in advance. In fact, an area may already be in a drought before it is even recognized. While the warning of the drought may not come until the drought is already occurring, the secondary effects of a drought may be predicted and warned against weeks in advance.

Duration. From the historical records for the State of Iowa, most droughts occur for at least one month at a time. It is dependent on the climatic situation at the time of the drought.

Muscatine County Multi-Jurisdictional Hazard Priority Ranking: #9, Medium Priority

Sources	
Environmental Working Group Farm Subsidy Database	*https://farm.ewg.org/*
State of Iowa, IHSEMD *Iowa Hazard Mitigation Plan, 2013*	*https://www.homelandsecurity.iowa.gov/disasters/hazard_mitigation.html*
National Drought Mitigation Center - University of Nebraska/Lincoln	*http://drought.unl.edu/Home.aspx*
National Climatic Data Center	*http://www.ncdc.noaa.gov/stormevents/*
National Weather Service, Quad Cities	*https://www.weather.gov/dvn/*
Natural Resources Defense Council	*http://www.nrdc.org/water/your-soil-matters/*
NOAA, NWS Climate Prediction Center	*https://www.cpc.ncep.noaa.gov/products/Drought/*

Sources	
FEMA	*http://www.ready.gov/drought*
National Integrated Drought Information System	*http://www.drought.gov/portal/server.pt/community/drought_gov/202*
U.S. Drought Monitor	*http://droughtmonitor.unl.edu/*
American Red Cross	*https://www.redcross.org/get-help/how-to-prepare-for-emergencies/types-of-emergencies/drought.html*

Earthquake

An earthquake is any shaking or vibration of the earth that may impose a direct threat to life and property. The breaking and shifting of the rock beneath the surface of the Earth causes an earthquake. The shaking produced by the earthquake can cause buildings, bridges, and other structures to collapse and disrupt gas, electric, and phone services. Earthquakes also have the potential to trigger landslides, flash floods, and fires. There are three general classes of earthquakes–tectonic, volcanic, and artificially produced.

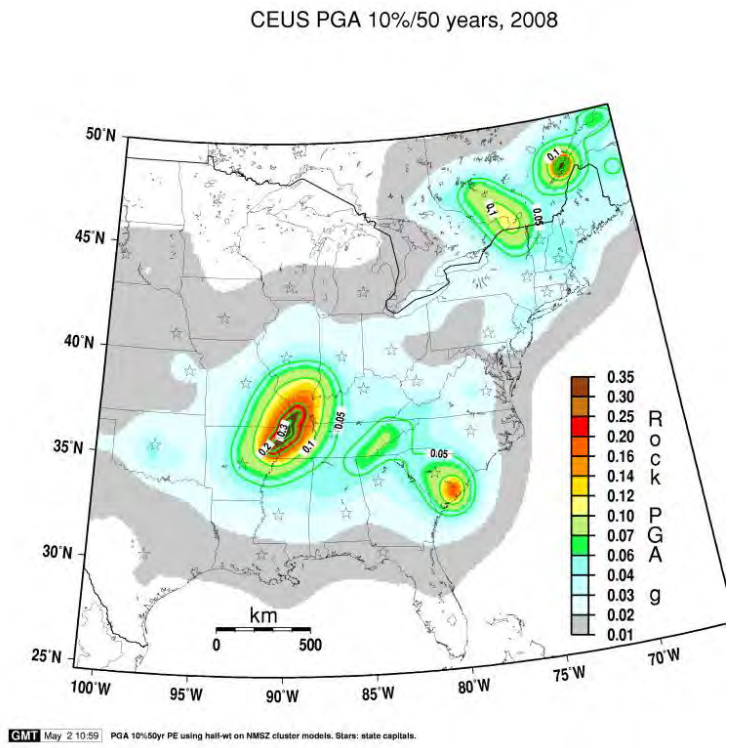
The effect of an earthquake on the surface of the Earth is called the intensity. The intensity scale takes into consideration responses such as people awakening, movement of furniture, and destruction. The scale currently used in the United States is the Modified Mercalli Intensity Scale. This scale, developed in 1931, contains 12 levels of increasing intensity, ranked by observed effects.

Modified Mercalli Intensity Scale	
LEVEL	**DEFINITION**
I	Not felt except by a very few under especially favorable conditions.
II	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing cars may rock slightly. Vibrations are similar to the passing of a truck. Duration estimated.
IV	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed, walls make cracking sound. Sensation is like a heavy truck striking building. Standing motor cars rocked noticeably.
V	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage is slight.
VII	Damage is negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage occurs in poorly built or badly designed structures, and some chimneys break.
VIII	Damage slight in specially-designed structures; well-designed frame structures thrown out of plumb. Damage is great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Damage considerable in specially-designed structures; well-designed frame structures thrown out of plumb. Damage is great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
XII	Damage is total. Lines of sight and level are distorted. Objects are thrown into the air.

Source: Iowa Geological Survey (http://www.igsb.uiowa.edu/earthqua/MERCALLI.htm)

Muscatine County is located in seismic risk zone 0, which is an area with very low probability of damaging ground motion. This does not mean that the area is not vulnerable to earthquake effects. In Iowa, most structures were not built to earthquake standards. However, the relatively low magnitude of a possible quake, property damage would be minor foundational damage. The most vulnerable structures are those built on poorly consolidated substrate, especially floodplain materials.

The following 2008 USGS map shows that Iowa is located in low risk zones on the Peak Ground Acceleration Map for the New Madrid Fault.



According to the State of Iowa Geological Survey, there have been 13 earthquakes in the state between 1867 and 2019, and none have occurred in Muscatine County. The largest earthquake in the State of Iowa occurred in neighboring Scott County (and the State of Iowa) in the City of Davenport on November 12, 1934. That earthquake registered as a VI on the Modified Mercalli Intensity Scale.

Being near the Mississippi River, Muscatine County would also feel vibrations from earthquakes with epicenters in Illinois or from the New Madrid seismic zone. The most recent of these was on April 18, 2008 when a magnitude 5.2 earthquake occurred in the Wabash Valley Seismic Zone, located to the north of the New Madrid seismic zone. The earthquake and subsequent aftershocks were felt widely throughout the central United States with as much as a Mercalli magnitude IV through Illinois and surrounding states to the east.

Probability. Seismologists attempt to forecast earthquakes size and frequency based on data from previous events. In the New Madrid seismic zone, this analysis is difficult because there are few historic moderate to large earthquakes, and the active faults are too deeply buried to monitor effectively. According to the USGS, the chance of a magnitude 6 or higher earthquake in the next 50 years is 25-40% based on the history of past earthquakes in the New Madrid fault zone. The 2013 *Iowa Hazard Mitigation Plan* analysis estimated the probability of future earthquakes in Iowa at less than 10%.

Magnitude/Severity. Most structures built in Muscatine County and in the State of Iowa are not built to earthquake standards, although the effect of a possible earthquake will most likely be of

low intensity resulting in mainly foundational damage. The most vulnerable structures in the county would be those built on poorly consolidated substrate, especially floodplain materials. Muscatine County could experience vibrations similar to the passing of a heavy truck–rattling of dishes, creaking of walls, and swinging of suspended objects. Fatalities would be very rare, with injuries limited to falls and injury from unsecured objects.

Warning Time. Earthquake prediction is an inexact science, and even in well-monitored areas with scientific instruments, scientists very rarely predict earthquakes.

Duration. Due to the limited effects to Iowa, response to the occurrence of an earthquake would likely be in support of nearby states utilizing mutual aid agreements; in-state response would likely be very limited.

Muscatine County Multi-Jurisdictional Hazard Priority Ranking: #17, Low Priority

Sources	
State of Iowa, IHSEMD	*Iowa Hazard Mitigation Plan, 2010 and 2013*
Iowa Geological Survey Bureau	*http://www.igsb.uiowa.edu/browse/earthqua/earthqk2.htm*
U.S. Geological Survey	*http://earthquake.usgs.gov/regional/ceus/*
U.S. Geological Survey Seismic Map	*http://www.igsb.uiowa.edu/browse/earthqua/ubc_map.htm*

Expansive Soils

Expansive soils are soils and soft rock that tend to swell or shrink excessively due to changes in moisture content. Expansive soils contain minerals such as clays that are capable of absorbing water. When they absorb water they increase in volume, and the more water they absorb the more their volume increases. Expansions of ten percent or more are uncommon. This change in volume can exert enough force on a building or other structure to cause damage.

Ratings are dependent on the clay content of the soils. Soils that have a linear ability to be extended greater than 3% are of concern for dwellings with basements. In combination with areas of slope, floodplain, and hydric soils, future development should consider the suitability and limitations of soils, especially for dwellings with basements.

Expansive soils will also shrink when they dry out. This shrinkage can remove support from buildings or other structures and result in damaging subsidence. Fissures in the soil can also develop. These fissures can facilitate the deep penetration of water when moist conditions or runoff occurs. This produces a cycle of shrinkage and swelling that places repetitive stress on structures.

The American Society of Civil Engineers estimates that ¼ of all homes in United States have some damage caused by expansive soils. In a typical year in the United States, they cause a greater financial loss to property owners than earthquakes, floods, tornadoes, and hurricanes combined.

Because of slow occurrence of this geological hazard, no specific shrink-swell event causing damage has been documented in Muscatine County; however, it has been noted that expansive soils may be a factor in damage to roads and underground piping and conduits that occurs over time. Map 3-1 on page **Error! Reference source not found.**33 was prepared from soil data from the USDA NRCS Soil Data Mart. The map shows soils in Muscatine County with color gradation according to shrink-swell potential. Shrink-swell potentials are determined by the percentage of Linear Extensibility. Linear Extensibility of less than 3% has low potential, and 3% to 6% has moderate potential. These are shown by the lighter colors on the map. A linear extensibility of 6% to 9% has high shrink-swell potential, and the map shows this in the orange and brown colors. Various soils have different degrees of shrink-swell potential dependent on depth, which cannot be shown on a two-dimensional map. Generally, the soils that have the higher shrink-swell potential in Muscatine tend to be located upland of the major river floodplain areas and largely in undeveloped agricultural open space. An exception is the area shown in orange in the northwest portion of the Muscatine Island area. In addition, the Wilton area appears to have a concentration of the soils with low to high shrink-swell potential.

Probability. When expansive soils are present, they will generally not cause a problem if their water content remains constant. The situation where greatest damage occurs is when there are significant or repeated moisture content changes. In the 2013 *Iowa Hazard Mitigation Plan*, the SHMT evaluated the probability of future expansive soils events in Iowa at between 10-19% chances in any one year.

Magnitude/Severity. There are few direct human effects. Effects commonly involve swelling clays beneath areas covered by buildings and slabs of concrete and asphalt, such as those used in construction of highways, walkways, and airport runways. The most extensive damage from

expansive soils occurs to highways and streets. Houses and one-story commercial buildings are more apt to be damaged by soil expansion than are multi-story buildings, which usually are heavy enough to counter expansion pressures. The most obvious manifestations of damage to buildings are sticking doors, uneven floors, and cracked foundations, floors, walls, ceilings, and windows. Damage to the upper floors of the building can occur when motion in the structure is significant. Utilities could be affected because of constant pushing and pulling resulting in cracks, breaks, and severing of underground infrastructure. Since this a naturally occurring phenomenon, environmental effects would be limited to spills and leaks of containment facilities. Individual owners of buildings and facilities would feel economic and financial effects. These would occur over time and would not be a one-time impact. Building code requirements may impose undue burden on construction to ensure proper performance of buildings and utilities in areas with expansive soils.

Warning Time. This is consistent with other geologic hazards that occur slowly over time.

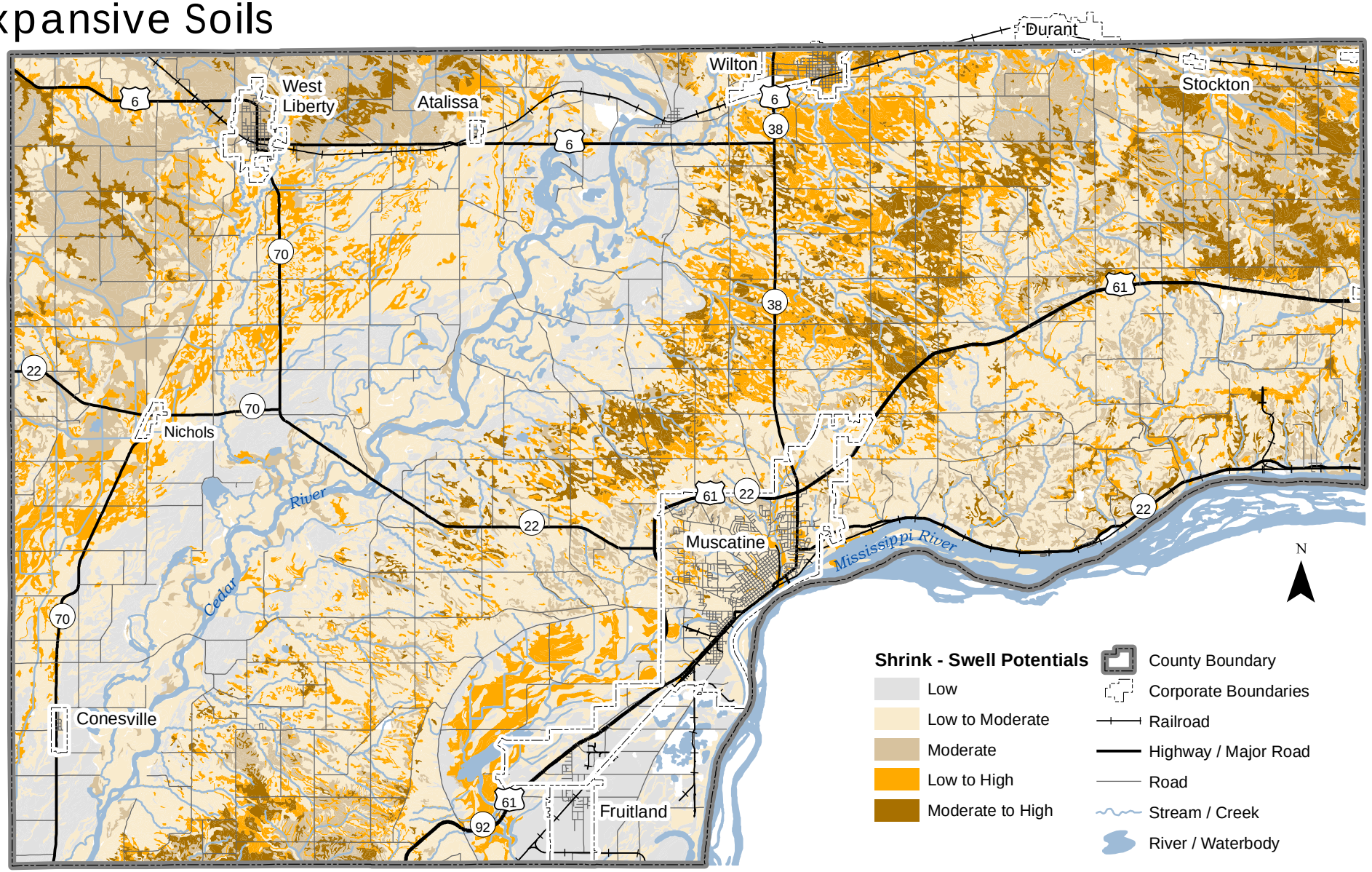
Duration. The response time to damage that is caused by expansive soils depends largely on the extent of the damage and when the damage is first noticed. Damage can be mitigated on new construction with proper building technique for the soil type and moisture level. Damage can be mitigated on existing buildings by incorporating some of the same types of techniques used in new construction. This may take longer and cost more than new construction.

Muscatine County Multi-Jurisdictional Hazard Priority Ranking: #14, Low Priority

Sources	
State of Iowa	*Iowa Hazard Mitigation Plan, 2010 and 2013*
Natural Resources Conservation Service (NRCS)	*http://soils.usda.gov*
NRCS	***http://websoilsurvey.nrcs.usda.gov/app***
NRCS	*Using Soil Survey to Identify Areas With Risks and Hazards to Human Life and Property Expanding - Soils and Shrink-Swell Potential- 2004* By Phil Camp, State Soil Scientist, Arizona, USDA, NRCS
Geology.com	Expansive Soil and Expansive Clay - *The hidden force behind basement and foundation problems*

Map 3.1

Expansive Soils



0 1 2 3 4 5
Miles

Disclaimer: This map is for reference only. Data provided are Derived from multiple sources with varying levels of accuracy. Bi-State Regional Commission disclaims all responsibility for the accuracy or completeness of the data shown hereon.

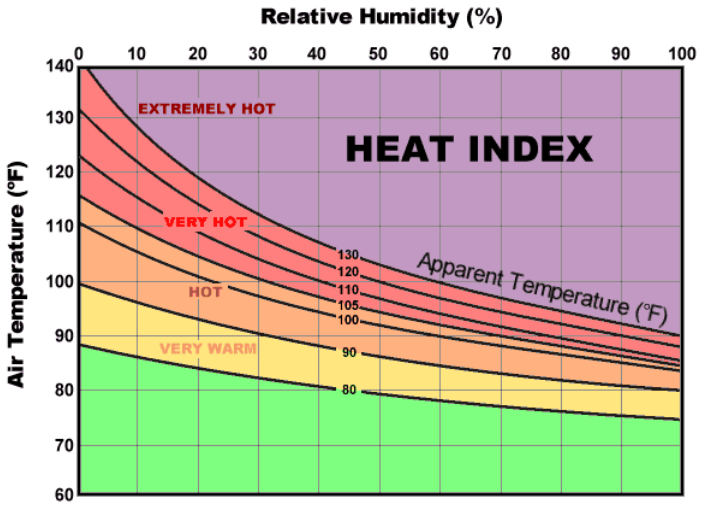
Roads - Iowa DOT (2019)
Corporate Limits - MAGIC (2019)
County Boundary - IA DNR
Water Features - USGS
Soil - USDA NRCS Soil Data Mart

Shrink-Swell Potentials are determined by the percentage of Linear Extensibility. Linear Extensibility of less than 3% has low potential, 3%-6% has moderate potential, 6%-9% has high potential. Various soils have different potentials dependent upon depth. For more detailed information please refer to the Physical Soil Properties Report for Muscatine County, IA.

Map prepared by:
Bi-State Regional Commission
October 2019

Extreme Heat

An extreme heat event is characterized as a prolonged period of excessive heat and humidity. Conditions for extreme heat are defined by summertime weather that is substantially hotter and/or more humid than average for a location at that time of year. This includes temperatures (including heat index) in excess of 100°F or at least three successive days of 90°+ F. The heat index is a number in degrees Fahrenheit that tells how hot it really feels when relative humidity and air temperature are calculated together. Exposure to full sunshine can increase the heat index by at least 15°F.



A **Heat Advisory:** A heat index of 100°F* or higher is expected for a period of 3 hours or more. A heat advisory shall be continued through the overnight hours, following a day with excessive heat, if the heat index is not expect to fall below "around 75°F." A heat advisory can be issued for a heat index less than 100°F when the cumulative effect of successive days of near advisory heat leads to potentially life threatening conditions.

An **Excessive Heat Warning:** A heat index of 105°F* or higher is expected for a period of 3 hours or more. An excessive heat warning shall be continued through the overnight hours, following a day with excessive heat, if the heat index is not expected to fall below "around 75°F." An excessive heat warning can be issued for a heat index less than 105°F when the cumulative effect of successive days of near warning heat leads to life threatening conditions.

**The criteria listed above may be deviated from occasionally depending on the impacts to the public. For example, a heat product may be issued for lower temperatures or Heat Index values early in the season.*

Extreme heat can impose stress on humans and animals. Heatstroke, sunstroke, cramps, exhaustion, and fatigue are possible with prolonged exposure or physical activity due to the body's inability to dissipate the heat. Urban areas are particularly at risk because of air stagnation and large quantities of heat absorbing materials such as streets and buildings. Extreme heat can also result in distortion and failure of structures and surfaces such as roadways and railroad tracks.

Incidents of extreme heat are likely to cover a large area. Urban areas pose additional risks in these occurrences when stagnant atmospheric conditions of the heat wave trap pollutants, adding to the stresses of hot weather. The following available information from the National Climatic Data Center and National Weather Service gives an indication of the magnitude and variety of such events. There have been five notable excessive heat events in Muscatine County since 1950;however, 1936 is still the all-time warmest July on record with 11 days in a row with temperatures over 100° F and an average monthly temperature of 85.0° F (monthly average for July is 75.4,° per readings at the Quad City International Airport station).

July 1995: This event covered all of Iowa from July 12 through the evening of July 14, causing three fatalities and $3.8 million in damage. Dew points ranged from the upper 70s to the middle 80s for much of the time, with the highest dew points in the eastern half of the state. High temperatures were between 98° and 108°F, and the highest temperature of 109°F was recorded in Council Bluffs. Most weather stations across the state broke the century record over the two-day period. The three fatalities were reported in Des Moines, Marshalltown, and Burlington. Two of the fatalities were elderly people. The majority of property damage losses were in the form of livestock.

July 1997: Excessive heat indices of 105 to 110 were reached in the eastern half of the state during this event, which lasted through July 27. The highest temperatures were recorded on July 26 when record-setting high minimum temperatures were also experienced. The Quad Cities Bix 7 Run was also on July 26, and the heat caused 12 injuries and 1 fatality. Minimum property damage was experienced in the form of livestock.

July 1999: This event lasted July 19-31. Many heat advisories and warnings were issued for portions of eastern Iowa during this period. Temperatures around 100°F combined with dew points in the 70s produced heat indices of 105° to 125°F. Although no fatalities were reported in Iowa, 19 people in Illinois and 27 people in Missouri died from heat-related factors over this period.

August 2000: No injuries, fatalities, or property damage were reported with this event that spread over middle and eastern Iowa. Temperatures topped out in the lower to middle 90s. These hot temperatures combined with high humidity resulted in dangerous heat indices of 105° to 115°F during the afternoon.

July 2012: The average temperature was 80.7°F, which makes this the sixth warmest July on record. There were 22 days with temperatures at or above 90°F, with five of those days at or above 100°F. The hottest day reported was on July 7 with a temperature of 104°F and heat indexes of 105-115°F.

The NCDC storm events no longer report extreme heat, and the closest substitute was excessive heat. Excessive heat event documentation covers a much shorter time series, but is the best data available. No excessive heat episodes are listed in the NCDC report for Muscatine County for 2015 through September 30, 2019. The latest event reported is the 2012 event listed above.

Probability. Based on historical information, Iowa will likely experience about 26 days a year with temperatures above 90°F. There is a very good chance that there will be a period of three consecutive days or more with temperatures in the 90s. It is also common for the temperature to hit 100°F or more once every three years during the summer months. The 2013 *Iowa Hazard Mitigation Plan* estimated that the probability of an extreme heat occurrence is between 10% and 19% in any given year.

Muscatine County averaged 4 day above 95°F per year 2000-2018. Five of those years had no days above 95 degrees. There were 11 days above 95 degrees in both 2011 and 2013. The year 2012 had 18 days above 95 degrees. Muscatine County averaged 20 nights with temperatures at 70°F or above from 2000-2018. In 2011, the county had the most nights above 70 degrees at 33.

Magnitude/Severity.

Heat Index/Apparent Temperature (°F)	Possible Heat Disorders for People in High Risk Groups
130°F or Higher	Heat/Sunstroke HIGHLY LIKELY with continued exposure
105°F - 130°F	Sunstroke, heat cramps, or heat exhaustion LIKELY, and heatstroke POSSIBLE with prolonged exposure and/or physical activity
90°F - 105°F	Sunstroke, heat cramps, or heat exhaustion POSSIBLE with prolonged exposure and/or physical activity
80°F - 90°F	Fatigue POSSIBLE with prolonged exposure and/or physical activity

Extreme heat can impose threats on humans and animals. The chart to the right shows the risks that are possible at each Heat Index level. People without access to air-conditioned spaces, are more susceptible to heat risks. The 2013 *Iowa Hazard Mitigation Plan* does not show a dollar amount for damages related to extreme heat for Muscatine County. The National Climatic Data Center Storm Event Database does not have any reported property or crop damage reports for extreme heat for Muscatine County.

According to the 2013 *Iowa Hazard Mitigation Plan,* extreme heat can pose a threat to livestock and crops. High temperatures have been shown to reduce summer milk production, impair immunological and digestive function of animals, and increase mortality of livestock. In July 2011, according to The Iowa Cattlemen's Association, approximately 4,000 cattle died due to extreme heat. In 1995, livestock-related economic losses due to heat stress were estimated to be $31 million in Iowa. Extreme heat can also cause pavement to buckle and rupture. A 2011 article states that in a typical year, Iowa DOT maintenance equipment operators spend 2,000 to 4,000 hours making temporary repairs of pavement blowups and another 6,000 hours replacing these pavement sections, costing an average of $400,000 annually

Warning Time. As with other weather phenomena, periods of extreme heat are predictable within a few degrees within 3 days or so. Variations in local conditions can affect the actual temperature within a matter of hours. The National Weather Service initiates alert procedures when the heat index is expected to exceed 105°F for at least two consecutive days.

Duration. The State of Iowa Hazard Mitigation Team has estimated that extreme heat events are likely to exceed one week in duration based on the review of past extreme heat events in the state.

Muscatine County Multi-Jurisdictional Hazard Priority Ranking: #11, Medium Priority

Sources	
State of Iowa, IHSEMD	*Iowa Hazard Mitigation Plan, 2010 and 2013*
National Climatic Data Center	*http://www.ncdc.noaa.gov/stormevents/*
National Weather Service - Quad Cities, IA/IL Office	*http://www.crh.noaa.gov/dvn/*
Iowa Public Health Tracking Portal	*https://tracking.idph.iowa.gov/Environment/Climate/High-Heat-Data*

Flash Flood

A flash flood is an event occurring with little to no warning where water levels rise at an extremely fast rate. Flash flooding results from intense rainfall over a brief period, sometimes combined with rapid snowmelt, ice jam release, frozen ground, saturated soil, or impermeable surfaces. 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 that can reach full peak in only a few minutes and allows little time or no time for protective measures to be taken by those in its path. Flash flood waters move at very fast speeds and can roll 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.

Magnitude of flash flooding varies by watershed based on the effects of amounts of rain over time. The following available information from the National Climatic Data Center gives an indication of the magnitude of such events:

Event Date	Location	Amount of Rainfall
08/16/1997	Muscatine	0.91 inches in 15 minutes
07/21/1998	Muscatine County	4 inches
10/17/1998	Muscatine	3.50 inches
05/18/2000	Muscatine County	2 to 3 inches per hour
02/24/2001	Muscatine County	1 to 1.5 inches on frozen ground
06/22/2007	Muscatine, Nichols, and West Liberty	4 to 8 inches over 72-hr period

Precipitation extremes recorded at Muscatine, IA station:

- Highest daily rainfall: 9.51 inches on June 7, 1967
- Highest monthly rainfall: 13.73 inches in June 1990
- Highest annual precipitation: 74.50 inches in 1851. Recorded at the Muscatine City Waterworks by the Waterworks Superintendent.

Floods are the most common and widespread of all natural disasters except fire. In Iowa, as much as 21 inches of rain has fallen in a 24-hour period. The National Climatic Data Center identifies 25 events in Muscatine County between 08/09/1993 and 07/31/2012 as flash flooding or urban/small stream flooding due to periods of intense rainfall. Ten of the flash flood or urban flood events listed were located in the City of Muscatine where effects range from minor street flooding to roads being impassable. Notable events in the county include:

May 9-10, 1996: Urban flooding and county road washouts occurred across a large area of eastern Iowa.

August 16, 1997: Rainfall of 0.91 inches in 15 minutes was reported. Highway 61 bypass was impassible.

October 17, 1998: Heavy rainfall across eastern Iowa sent creeks, rivers, and streams to near or slightly above bank full. Total rainfall for the day was recorded as 3.50 inches at Muscatine. State marching band competitions at Muscatine High School were cancelled.

February 24, 2001: Rainfall amounts commonly recorded between 1 to 1.5 inches across the county fell on frozen ground. The quick runoff led to numerous reports of street and small stream flooding. Several rivers across the region, including the Cedar River, were out of their banks.

June 22, 2007: Several rounds of heavy rain-producing showers across eastern Iowa covered and/or closed roads in western Muscatine County, including Highway 6. Water also topped part of the levee between Nichols and West Liberty.

June 23, 2010: Heavy rains resulted in flash flooding in Muscatine County during the late afternoon and evening. Some vehicles were stalled out in over a foot of floodwater in downtown Muscatine. In Nichols, some streets were temporarily closed due to flooding. Parts of Highway 6 between West Liberty and Atalissa, and County Road F58 between Durant and Stockton were closed due to flooding.

May 3, 2012: Multiple streets in the City of Muscatine were reported to be flooded with up to two feet of water on the northeast side of Muscatine. Widespread ponding of water was also reported.

June 30, 2014: The entire town of Atalissa in Muscatine County was flooded with water one-foot deep in places. Highway 6 was closed west of town.

May 4, 2015: Heavy rains resulted in Muscatine having water one-foot deep over Mississippi River Drive.

July 7, 2015: Heavy rains closed local roads in Muscatine, including Highway 22 and several streets downtown. Flash flooding was reported around the City Hall.

June 21, 2018: Thunderstorms produced water that was quickly flowing over roads up to three feet deep. Several vehicles were stalled. One person was swept off their feet and nearly escaped being swept into a drainage ditch full of fast moving water.

September 1, 2018: Flash flooding with 3-6 inches of rain. The dispatch center reported multiple roads with high water in Muscatine. Multiple vehicles were reported stalled with water several feet deep in some locations. Local estimate was for three inches of rain in town.

May 29, 2019: Heavy rains fell on completely saturated soils causing significant flash flooding. Water was over Highway 22 at Fairport in Muscatine County closing the road.

Probability. As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Urbanization increases runoff two to six times over what would occur on natural terrain. Portions of the land within Muscatine County are very developed with significant amounts of impervious surfaces. As more development occurs in the watersheds, the amount of runoff produced also increases. Unless measures are taken to reduce the amount of runoff produced (or slow its movement), flash floods will continue to occur and possibly increase. In certain areas, aging storm sewer systems were not designed to carry the capacity currently needed to handle the increased storm runoff. This combined with rainfall trends (that are moving upwards) and rainfall extremes (that are patterning higher) all demonstrate the high likelihood, yet unpredictable nature of flash flooding in Muscatine County.

The State Hazard Mitigation Team (SHMT) evaluation in the 2013 *Iowa Hazard Mitigation Plan* concluded that it is highly likely that a flash flood will affect Iowa in any given year. Using NCDC data for the Muscatine County area, an average of 1.3 flash flooding events are likely to occur in any given year.

Magnitude and Severity. Flash floods occur in all 50 states in the U.S. Particularly at risk are those in low-lying areas; close to dry creek beds or drainage ditches; or near water or downstream from a dam, levee, or storage basin. People and property with insufficient storm sewers and other drainage infrastructure can also be put at risk because the drains cannot rid the area of the runoff quickly enough. Nearly half of all flash flood fatalities are auto-related. Motorists often try to traverse water-covered roads and bridges and are swept away by the current. Six inches of swiftly moving water can float a full-sized automobile. Recreational vehicles and mobile homes located in low-lying areas can also be swept away by water. The National Climatic Data Center Storm Event Database lists total property damage for flash flood events from 1997-2019 in Muscatine County as $55,000. This damage estimate is only listed for four of the events in the database. Actual damage costs from flash flooding are most likely a much higher number.

Areas in a floodplain, downstream from a dam or levee, or in low-lying areas can certainly be affected by flash flooding. People and property located in areas with narrow stream channels, saturated soil, in areas with impermeable surfaces, or areas of steep slope are likely to be affected in the event of significant rainfall. Unlike areas affected by river/stream flood, flash floods can affect areas a good distance from the stream itself. Flash flood prone areas are not particularly tied to areas adjacent to rivers and streams. Streets can become swift-moving rivers, and basements can become deathtraps because flash floods can fill them with water in a matter of minutes. As noted in the *City of Muscatine, Iowa Comprehensive Plan (2002)*: "Existing and new development located on bluffs and steep slopes throughout the City contribute to flash flooding. This has been an ongoing problem for properties located along Mad Creek…" Refer to Map 3-3 on page 59 for areas of slope 15% or greater.

Warning Time. Flash floods may be unpredictable, but there are factors that can point to the likelihood of the occurrence of a flash flood in the area. Flash floods occur within a few minutes or hours of excessive rainfall, a dam or levee failure, or a sudden release of water held by an ice jam. Weather surveillance radar is being used to improve monitoring capabilities of intense rainfall. Knowledge of the watershed characteristics, modeling, monitoring, and warning systems increase the predictability of flash floods. Depending on the location in the watershed, warning times can be increased. The National Weather Service (NWS) forecasts the height of flood crests, the data, and the time the flow is expected to occur at a particular location.

Duration. The response to the effects of flash flooding in Iowa is short due to the nature of the hazard.

Muscatine County Multi-Jurisdictional Hazard Priority Ranking: #3, High Priority

Sources	
Iowa Homeland Security Emergency Management Division (HSEMD)	*Iowa Hazard Mitigation Plan, 2010 and 2013*
National Climatic Data Center	http://www.ncdc.noaa.gov/oa/climate/severeweather/extremes.html
American Red Cross	http://www.redcross.org/services/prepare/0,1082,0_240_,00.html

Sources	
Federal Emergency Management Agency (FEMA)	http://www.fema.gov/hazard/flood/index.shtm
Local Sources: City of Muscatine	Comprehensive Plan 2002, ref. Page 60 and Chapter 4 of 2013 plan

Grass or Wildland Fire

A grass or wild-land fire is an uncontrolled fire that threatens life and property in either a rural or a wooded area. Grass and wild-land fires can occur when conditions are favorable, such as during periods of drought when natural vegetation would be drier and subject to combustibility.

Keetch and Byram (1968) designed a drought index specifically for fire potential assessment. It is a number representing the net effect of evapotranspiration and precipitation in producing cumulative moisture deficiency in deep duff and upper soil layers. It is a continuous index relating to the flammability of organic material in the ground. The Keetch-Byram Drought Index (KBDI) attempts to measure the amount of precipitation necessary to return the soil to full field capacity. It is a closed system and represents a moisture regime from zero to 8 inches of water through the soil layer. At 8 inches of water, the KBDI assumes saturation. Zero is the point of no moisture deficiency, and 800 is the maximum drought that is possible. At any point along the scale, the index number indicates the amount of net rainfall that is required to reduce the index to zero or saturation. The inputs for KBDI are weather station latitude, mean annual precipitation, maximum dry bulb temperature, and the last 24 hours of rainfall. Reduction in drought occurs only when rainfall exceeds 0.20 inch (called net rainfall). The KBDI scale and description of moisture conditions is as follows:

KBDI = 0-200	Typical of spring dormant season following winter precipitation. Soil moisture and large class fuel moistures are high and do not contribute to fire intensity.
KBDI = 200-400	Typical of late spring, early growing season. Lower litter and duff layers are drying and beginning to contribute to fire intensity.
KBDI = 400-600	Typical of late summer, early fall. Lower litter and duff layers contribute to fire intensity and actively burn.
KBDI = 600-800	Often associated with more severe drought with increased wildfire occurrence. Intense, deep burning fires with significant downwind spotting can be expected. Live fuels can also be expected to burn actively at these levels.

The Keetch-Byram Drought Index map does not show a reporting weather station that includes Muscatine County. However, reporting weather stations in surrounding areas of Minnesota, Wisconsin, Illinois, and Missouri all show a KBDI of less than 200, or minimal risk of wildfire hazard.

According to the National Interagency Fire center, there have been 1,817 wildfires spanning 33,112 acres from 2002 to the end of 2012 in Iowa. This number is likely much greater when considering grass fires. There were 2,821 wildland fires in in Iowa from 2012 to end of 2018. Total acres burned in these fires was 77, 597. Muscatine County Joint Communications (MUSCOM) reported 659 grass fires in the county between 2006 and December 31, 2019, many of which began as controlled burns. Members of the Planning Committee commented that grassfires are a common occurrence in the county in the spring when people attempt to burn off the dried vegetation from the previous season. The data bears this out: the majority of the recorded fires occurred in the months of March and April and are listed as grass/field fires.

Probability. There is some variation in how data was reported for historical occurrence, and there may be some overlap in the reporting areas. Using the MUSCOM report of grassfire incidents, there was an average of 50.7 grass fires per year in the county over the total 13-year reporting period. This gives a probability of a 100% chance that there will be grass fires in Muscatine County in any given year.

Magnitude and Severity. While wildfires have proven to be most destructive in the western states, they have become an increasingly frequent and damaging phenomenon nationwide. People choosing to live in wild-land settings are more vulnerable to wildfires, and the value of exposed property is increasing at a faster rate than population. Iowa is less vulnerable to wild-land fire because of the extremely large percentage of land that is developed. Grass fires are often more easily contained and extinguished before there is damage to people or developed property. Fires often burn large portions of field crops in the fall when the crops are dry and the harvesting equipment overheats or throws sparks. This can be quite costly to the farmer in terms of lost production.

Most grass fires are contained to highway right-of-way and rail right-of-way ditches and are less than a few acres in size. High winds can turn a small flame into a multi-acre grassfire within a matter of minutes. The extent is dependent upon conditions such as land use/land cover, moisture, and wind. No grass or wildland fires have been reported in the National Climatic Data Center Storm Event Database.

Warning Time. As mentioned above, most grassfires occur without warning and travel at a rate dependent on fuel type and wind speed at the time of ignition. The situation depends on conditions at the time such as moisture, wind, and land cover. However, methods for forecasting the probability of occurrence of conditions most suitable for wildfires to occur has increased with the use of the national wildland significant fire potential outlook issued by the National Interagency Fire Center and the NOAA Storm Prediction Center.

Duration. The majority of Iowa wildfires occur in short duration in areas of brush and forestlands.

Muscatine County Multi-Jurisdictional Hazard Priority Ranking: #10, Medium Priority

Sources	
Iowa Homeland Security and Emergency Management Division	*Iowa Hazard Mitigation Plan, 2010 and 2013*
Muscatine County	Muscatine County Multi-Jurisdictional Hazard Mitigation Plan 2015
National Interagency Fire Center	http://www.nifc.gov/fireInfo/fireInfo_statistics.html
Local Sources:	Muscatine County Emergency Management (MUSCOM) City of Muscatine Fire Department Conesville Fire District

Hail

Hail one component of a supercell thunderstorm in which ball or irregularly shaped lumps of ice greater than 1 inch in diameter fall with rain. Hail is produced in many strong thunderstorms by strong rising currents of air carrying water droplets to a height where freezing occurs. The ice particles grow in size until they are too heavy to be supported by the cloud updraft and fall to earth. Hail can be smaller than a pea or as large as a softball and can be very destructive to plants and crops. Pets and livestock are particularly vulnerable to hail.

The National Climatic Data Center reports 72 hail events occurring in Muscatine County between 4/23/1965 and 4/22/2019 with hail size of at least one inch. More than one hail event may be recorded during one thunderstorm occurrence, but as separate reports from differing times and locations. The largest size hail reported for Muscatine County during this period is 2.75 inches in diameter occurring on May 11, 1975. Other significant events include:

Event Date	Hail Diameter	Location	Damage
May 9, 1995	1.75	Beginning location 6 miles west of the City of Muscatine	$20,000-30,000 in property damage
June 6, 1999	1.75	North of the City of Muscatine	Damaged close to 350 acres of corn, knocked out windows in a home, downed trees, and destroyed a storage trailer.
May 18, 2000	1.75	In the City of Muscatine	Damaged cars - $250,000 in property damage.
May 14, 2003	1.00	East of Atalissa	$100,000 in property damage
July 20, 2003	1.00	Near Muscatine	Left both property and crop damage.
April 13, 2006	2.00	In Muscatine	$47,000 in property damage
April 4, 2010	1.25	In Muscatine	$50,000 in property damage.
April 17, 2013	.88	In Conesville.	No amount listed for hail damage.
May 30, 2013	1.00	In Sweetland Center	No amount listed for hail damage.
July 22, 2013	1.00	In Muscatine	No amount listed for hail damage.
November 17, 2013	1.75	In Muscatine	No amount listed for hail damage.
September 17, 2015	1.50	In Muscatine	No amount listed for hail damage.
March 15, 2016	2.50 0.88	In Grandview In Muscatine	No amount listed for hail damage.
February 7, 2017	0.75	ENE of Fairport	No amount listed for hail damage.
February 28, 2017	1.00	SW of West Liberty	No amount listed for hail damage.
May 17, 2017	0.88	In Muscatine	No amount listed for hail damage.
June 17, 2017	1.25	West of Muscatine	No amount listed for hail damage.
July 20, 2017	1.00	Muscatine County	No amount listed for hail damage.
April 22, 2019	1.00	Muscatine County	No amount listed for hail damage.

Hail Size (inches)	Number of Events 1950 to 2019
1.00	35
1.25	6
1.50	4
1.75	23
2.00	4
2.25	0
2.50	1
2.75	1

The Tornado and Storm Research Organization (TORRO) of the United Kingdom has developed a scale of hailstorm intensity. The scale extends from H0 to H10 with its increments of intensity and damage potential related to hail size (distribution and maximum). Hail texture, numbers, fall speed, speed of storm translation, and strength of the accompanying wind are other factors that affect the damage effects. The scale as follows includes hail diameter size in both metric (mm) and inches measurements.

TORRO Hail Size Damage

Size code	Diameter		Description	Damage Impacts
	mm	inches		
H0	5-9	0.2-0.4	Pea size	No damage
H1	5-15	0.2-0.8	Marble size	Makes holes in leaves
H2	10-20	0.2-1.2	Penny size	Strips leaves from plants
H3	20-30	0.4-1.8	Nickel size	Breaks glass panels and can scrape paint
H4	20-30	0.6-2.4	Golf ball size	Breaks windows and scrapes paint
H5	30-50	0.8-3.0	Tennis ball size	Breaks some roof tiles, dents cars, strips bark
H6	40-60	1.2-3.9	Baseball size	Breaks many roof tiles, damages roofs
H7	50-75	1.8-4.9	Grapefruit size	Shatter roofs, serious damage to cars
H8	60-90	2.4-5.0	Softball size	Cracks concrete roofs, splits trees, injury to people
H9	75-100	3.2-5.0	Softball size	Marks concrete walls, kills people, fells trees
H10	>100	4.0-7.0	Melon size	Destroys wooden houses, damages brick homes, kills people

Extremely large hail can happen anywhere. In 2018, eight states in the U.S. had hail of 4” or greater and million dollar losses.

Probability. For 2016-2018, the top five states for hail loss claims were Texas, Colorado, Nebraska, Missouri, and Kansas. Iowa is ranked eighth in the nation for hail related losses.

May had the highest monthly average for hail loss claims with 203,296. June was next with 178,881. April (164,232), March (153,716), and July (96,947) round out the top five.

There were 6,045 major hailstorms in 2017, according to statistics culled from NOAA's Severe Storms database. During the past five years, claims related to wind and hail damage on a national basis accounted for almost 40 percent of all insured losses, averaging approximately $15 billion annually, and is growing each year.

Research based on historical data and input from experts at the National Weather Service indicates that any given point in Iowa can expect on average two to three hailstorms in a year. Data for just Muscatine County appears to support this average in the county as well.

Magnitude and Severity. The Illinois State Water Survey Contract Report 2009-12 states that "hail damages are a function of two conditions, hail characteristics and the characteristics of the target (property and crops). Hail characteristics that vary and produce varying damages include the size and number of hailstones that fall per unit area, and the strength of winds during a hail fall. The damage also varies according to the target. Some delicate-leaf crops such as tea and tobacco suffer damage from small hailstones, whereas other crops such as corn are not damaged unless hailstones are 3/4 inch or larger. The extent of crop-hail damages also varies during the growing season of a given crop. A specific type of hailstorm may not cause much damage early in the crop's growing season but the same storm in mid-crop season can be very destructive. Property damages vary considerably due to different surfaces and angles of exposure. Some types of wood used on structures are easily damaged as are aluminum and vinyl siding."

Injuries and four deaths have been attributed to hail in Iowa since 1980. Being exposed to hail larger than a nickel in size can be very dangerous and life threatening.

Of the five insurance policy types providing hail loss coverage, Personal Property-Homeowners was the most affected with 1,657,663 claims or 57 percent of the three-year total. Personal Auto followed it with 898,500 claims and Personal Property – Farm with 149,215 claims.

Hail Loss Claims for Iowa 2016 - 2018			
2016	2017	2018	Total
10,845	68,153	24,974	103,972
Percent of US Hail Claim Total - Iowa - 4%			

Note: Percentages have been rounded to the nearest whole number.

Hailstorms cause nearly $1 billion annually in property and crop damage in the United States. The peak hail activity coincides with the Midwest's peak agricultural season. Financial effects resulting from damage to property is in the millions of dollars every year, much of which is covered by crop and hazard insurance.

The National Climatic Data Center Storm Event Database lists property damage from hail to be $608,500 and crop damage to be $32,000. Only a small fraction of events in the database have a damage cost associated with the event. Actual damage related costs due to hail are most likely much higher in Muscatine County.

The land area affected by individual hail events is not much smaller than that of the parent thunderstorm, an average of 15 miles in diameter around the center of the storm. Hail only rarely results in loss of life directly, although injuries can occur.

Warning Time. Forecasting hailstorms as with their parent thunderstorms, and forecasting the conditions suitable for developing storms with the potential to create hail is becoming quite accurate due to the advancement in Doppler Radar and other technologies operated by the National Weather Service and many television weather departments. Warnings in the 20 to 30-minute range are usually available prior to the occurrence of the storm.

Duration. The occurrence of hailstorms is short-term in nature and usually limited to less than 6 hours per event.

Muscatine County Multi-Jurisdictional Hazard Priority Ranking: #12, Medium Priority

Sources	
Iowa Homeland Security and Emergency Management Division (HSEMD)	*Iowa Hazard Mitigation Plan, 2010 and 2013*
NOAA National Centers for Environmental Information	*https://www.ncdc.noaa.gov/stormevents/*
Illinois State Water Survey Contract Report 2009-12. **Hailstorms Across the Nation - An Atlas about Hail and Its Damages;** Stanley A. Changnon Illinois State Water Survey, David Changnon Northern Illinois University, Steven D. Hilberg Midwestern Regional Climate Center	*https://www.isws.illinois.edu/pubdoc/CR/ISWSCR2009-12.pdf*
National Climatic Data Center	*http://www.ncdc.noaa.gov/oa/climate/severeweather/extremes.html*
WeatherCheck	*https://weathercheck.co/about/*
National Insurance Crime Bureau, 2016-2018 United States Hail Loss Claims Report, 2019 Thomas Manasek, Strategic Analyst	*https://www.nicb.org/media/1547/download*
TORRO Hailstorm Intensity Scale Storm Track Severe Weather Tables	*http://www.torro.org.uk/TORRO/severeweather/hailscale.php* *http://www.stormtrack.org/library/edu/tables.htm*

Hazardous Materials Incident

This hazard profile continues to address fixed hazardous materials incidents and the transportation of hazardous materials. A hazardous materials incident is an accidental release of chemical substances or mixtures that present a danger to public health or safety during production or handling at a fixed facility or because of transportation. 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 ever-increasing types and quantities. As many as 500,000 products pose physical or health hazards and can be defined as "hazardous chemicals." Each year, over 1,000 new synthetic chemicals are introduced. These and other existing chemicals may be transported across the country via semi-truck and train. Hazardous substances are categorized as toxic, corrosive, flammable, irritant, or explosive. Hazardous materials incidents generally affect a localized area. The use of planning and zoning can minimize the area of impact.

According to the Iowa Department of Natural Resources Chemical Spills Report Database, 338 chemical spills were reported in Muscatine County between 1995 and December 31, 2018. Of those spills, 193 were during production or handing at a fixed facility while 100 were spills because of transportation. Costs associated with spill clean-ups were reported.

Year	Incidents	Transport	Fixed Facility	Pipeline	Railroad	Fire	Other
1995	17	3	10	-	4	-	-
1996	12	3	9	-	-	-	-
1997	13	3	9	-	1	-	-
1998	15	1	14	-	-	-	-
1999	0	-	-	-	-	-	-
2000	15	1	13	-	1	-	-
2001	13	3	7	-	-	-	3
2002	10	6	3	-	-	-	1
2003	7	2	4	-	-	-	1
2004	11	4	6	-	-	-	1
2005	9	3	5	-	-	-	1
2006	9	6	2	-	-	-	1
2007	15	3	7	1	-	1	3
2008	15	2	9	-	1	-	3
2009	30	19	9	-	-	-	2
2010	22	5	13	1	-	1	2
2011	8	2	4	-	-	-	2
2012	19	3	15	-	-	-	1
2013	18	7	8	-	-	-	3
2014	13	3	9	-	-	-	1
2015	18	5	10	-	1	-	2
2016	21	5	13	-	1	-	2
2017	15	3	11	-	-	-	1
2018	13	8	3	-	-	-	2
Total	**338**	**100**	**193**	**2**	**9**	**2**	**32**
% of Total	**100%**	**30%**	**57%**	**1%**	**3%**	**1%**	**9%**
Annualized	**14.08**	**4.17**	**8.04**	**0.08**	**0.38**	**0.08**	**1.33**

Month	Incidents	Annualized	% of Total
January	36	1.50	10.65%
February	20	0.83	5.92%
March	26	1.08	7.69%
April	42	1.75	12.43%
May	38	1.58	11.24%
June	44	1.83	13.02%
July	21	0.88	6.21%
August	22	0.92	6.51%
September	29	1.21	8.58%
October	29	1.21	8.58%
November	16	0.67	4.73%
December	15	0.63	4.44%
Total	338	14.08	100.00%

Hazardous Spills 2000-2018	
Location	**Incidents**
Atalissa	7
Conesville	5
Durant	2
Fruitland	4
Letts	7
Muscatine	170
Nichols	5
Stockton	1
West Liberty	12
Wilton	32

Source: Iowa DNR, Hazardous Spills Database

Examples of reported chemical spills include:

Chemical Spills at Fixed Facilities:

December 6, 1996: A plastics mixture of 33,000 lbs. was unintentionally released on site. Butadiene was released from the mix and escaped from the vents in the sewage system.

January 31, 2007: A pipeline carrying sodium hydroxide leaked between 1,000 to 3,300 lbs. of sodium hydroxide per day for 60 days until leak was found. The potential amount of chemical released totaled 198,000 lbs. The facility was located adjacent to Mississippi River, and it is unknown if the river was affected.

Chemical Spills as a Result of Transportation:

November 20, 1995: A railroad engine and two rail cars derailed on line. A fuel tank on the engine was damaged. An estimated 700 gallons of petroleum was spilled.

March 31, 1999: A supply truck and pick-up truck were in an accident on Highway 61. The supply truck was carrying 2,500 gallons of fuel. The semi turned over on its top near a ditch. (No final spill amount was reported.)

The Muscatine County Emergency Management Plan identified 17 facilities that have Extremely Hazardous Substances (EHS) on premise and are located on Map 3-2 on page 53. The majority of all reported chemical spills occur at locations with City of Muscatine addresses. The remaining reports are spread to other community locations throughout the county. For towns that may have addresses in another county, only the incidents that were located in Muscatine County were counted. Transportation-related hazardous material incidents can occur anywhere in the county, including the two railroad lines in the county. Although there are no interstate highways within the boundaries of the county, there are other roadways where transportation incidents may occur. Fertilizer and pesticides are common chemicals used in the agricultural industry, and because Muscatine County is agricultural in nature, those chemicals are transported countywide.

Probability. According to the 2010 *Iowa Hazard Mitigation Plan*, the SHMT analysis evaluated the probability that a high impact occurrence of a fixed hazardous materials incident has a 10-20% probability to occur in any given year. A high impact occurrence is defined as an environmental emergency by the Environmental Protection Agency. An environmental emergency is a sudden threat to the public health or the wellbeing of the environment, arising from the release or potential release of oil, radioactive materials, or hazardous chemicals into the air, land, or water.

Using the information provided by the Iowa DNR chemical spills report database, an average of 14 chemical spills in any given year can be expected. Of the chemical spills reported to the Iowa DNR from 1995 to December 31, 2018, 57% were located at fixed facilities, while 30% were reported as chemical spills because of transportation. The fixed-facility probabilities for Muscatine County are in keeping with the State of Iowa estimated probability. The transportation-related hazardous material incident probability for Muscatine County is lower than the state estimate. One reason for this could be that there are no interstate highways located within Muscatine County. Analysis of the data shows that the percentage of transportation-related hazardous materials incidents is increasing. Large quantities of hazardous materials are transported daily on Iowa streets, highways, interstates, and railways. The U.S. DOT estimates

that 7% of all trucks are carrying hazardous material; however, hazardous material crashes are under-represented in the overall crash picture. Roadways are a common site for the release of hazardous materials. Railways are another source for hazardous materials releases. The Department of Transportation (DOT) regulates routes and speed limits used by carriers and monitor the types of hazardous materials crossing state lines. Despite increasing safeguards, more and more potentially hazardous materials are being used in commercial, agricultural, and domestic activities and are being transported on Iowa roads and railways.

Magnitude and Severity. A hazardous materials accident can occur almost anywhere, so any area is considered vulnerable to an accident. Pets, livestock, and vegetation in close proximity to facilities producing, storing, or transporting hazardous substances are at higher risk. Populations near transportation corridors or downstream, downwind, and downhill of a released substance are also vulnerable. Depending on the characteristics of the substance released, a larger area may be in danger from explosion, absorption, injections, ingestion, or inhalation. Occupants of areas previously contaminated by a persistent material may also be harmed either directly or through consumption of contaminated food and water. Fixed facilities are required to have an off-site consequence plan that addresses the population of the surrounding area. Responding personnel are required to be trained to HAZMAT Operation Level to respond to the scene. Those personnel that come into direct contact with substances released are required to have HAZMAT Technician level training. The Muscatine Fire Department provides hazardous material response services for the county. It has an agreement to service all portions of Muscatine County.

Most of the hazardous materials incidents are localized and are quickly contained or stabilized by highly trained fire departments and hazardous materials teams. Depending on the characteristics of the hazardous materials 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. Effects that are more widespread occur when the product contaminates the municipal water supply or water system such as a river, lake, or aquifer.

The release of some toxic gases may cause immediate death, disablement, or sickness if absorbed through the skin, injected, ingested, or inhaled. Some chemicals may cause painful and damaging burns to skin if they come in direct contact with the body.

Warning Time. When managed properly under current regulations, hazardous materials pose little risk. However, when handled improperly or in the event of an accident, hazardous materials can pose a significant risk to the population. Hazardous materials incidents usually occur very rapidly with little or no warning. Even if reported immediately, people in the area of release have very little time to be warned and evacuated. During some events, sheltering in place is the best alternative to evacuation because the material has already affected the area and there is no time to evacuate safely. Public address systems, television, radio, and the NOAA Weather Alert Radios are used to disseminate emergency messages about hazardous materials incidents.

Duration. Response to a hazardous materials release is generally limited to the immediate effects of a release of dangerous materials and their threat to life and property. However, due to the laws surrounding hazardous materials and the duty to the public to inform and protect citizens from the effects of hazardous materials in their vicinity, response is expanded for environmental emergencies.

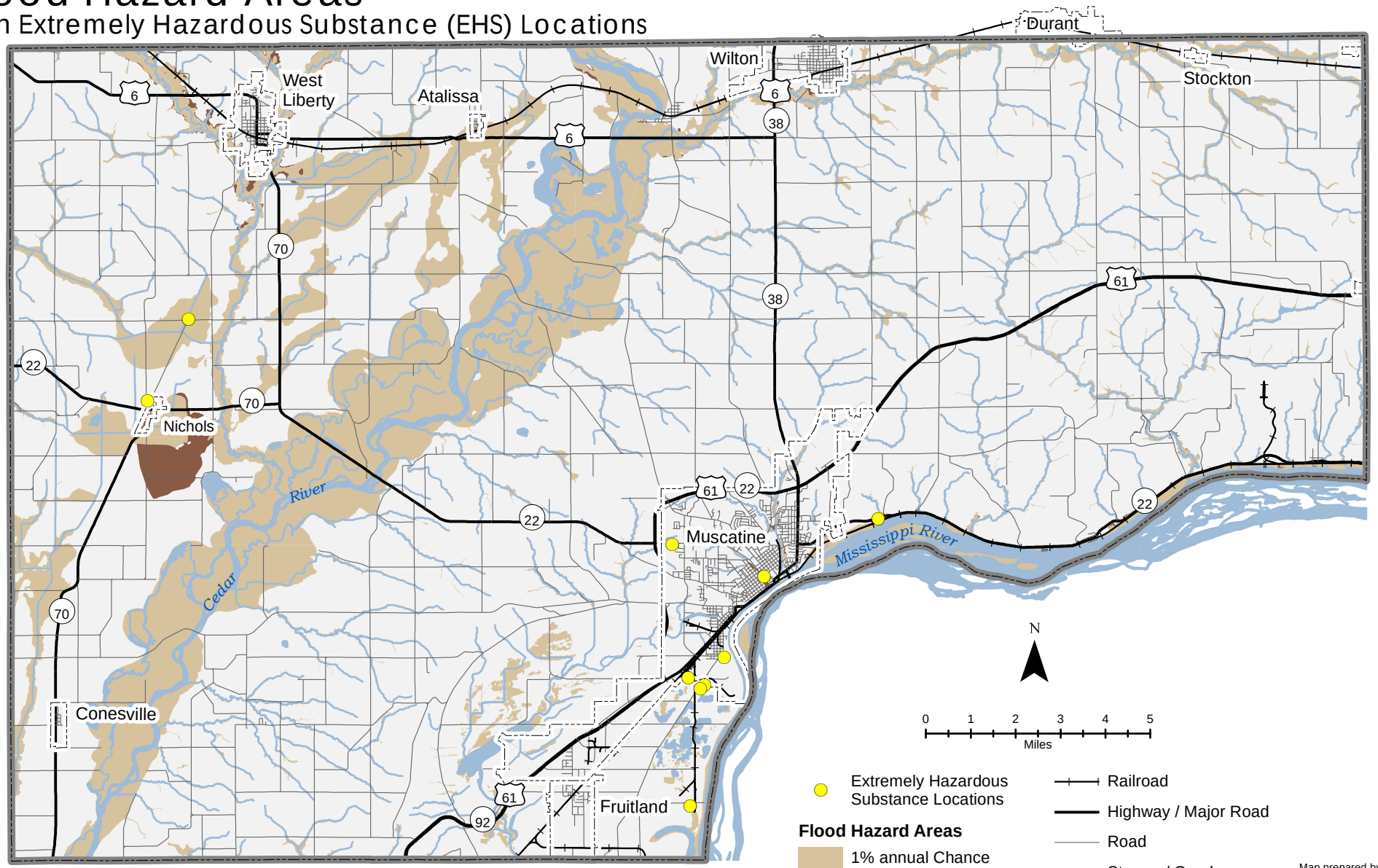
Muscatine County Multi-Jurisdictional Hazard Priority Ranking: #8, Medium Priority

Sources	
Iowa Homeland Security Emergency Management Division (HSEMD)	*Iowa Hazard Mitigation Plan, 2010 & 2013*
Muscatine County Emergency Management Agency	*Muscatine County Hazard Mitigation Plan 2003*
Muscatine County	*Muscatine County Multi-Jurisdictional Hazard Mitigation Plan 2010*
Iowa Dept. of Natural Resources (DNR) Emergency Response & Security Unit Spill Data	http://www.iowadnr.gov/spills/data.html
U.S. Department of Transportation Federal Highway Administration Office of Operations	http://www.ops.fhwa.dot.gov/publications/fhwahop08058/20.htm

Map 3.2

Flood Hazard Areas

with Extremely Hazardous Substance (EHS) Locations



Disclaimer: This map is for reference only. Data provided are Derived from multiple sources with varying levels of accuracy. Bi-State Regional Commission disclaims all responsibility for the accuracy or completeness of the data shown hereon.

Roads - Iowa DOT (2019)
Corporate Limits, Flood Hazard Areas - MAGIC (2019)
EHS Locations - Muscatine Fire Dept. (2015)
County Boundary - IA DNR
Water Features - USGS

Map prepared by:
Bi-State Regional Commission
October 2019

Landslides

Landslides occur when susceptible rock, earth, or debris moves downslope under the force of gravity and water. They may impose a direct threat to life and property. Landslides can range from very large to very small and can move at slow to very high speeds. Landslides can be activated by alternate freezing and thawing, ground saturation on steep slopes, steepening of the slopes by erosion or human modification, and removal of stabilizing vegetation.

The Iowa Department of Transportation reconnaissance trips to over fifty active and repaired landslides in Iowa suggest that, in general, landslides in Iowa are relatively shallow (i.e. failure surfaces less than 6 feet (2 m) deep) and are either translational or shallow rotational. A translational slide involves planar failure surfaces with movement in which the vector is primarily down slope with no upward component. The movement may be essentially parallel to the original slope surface. A rotational slide includes a large downward component near the top of the slide and an upward component at the bottom of the slide. These slides are deeper than translational slides. Rock falls can also occur in the sandstone and limestone outcrops in the Wild Cat Den State Park area.

Muscatine County is in an area of Iowa covered with loess of variable thickness. The loess ranges from a few feet deep along the crests of the ridges in the county to greater than 40 feet thick on the bluffs at Muscatine. The average depth on the uplands is 12 to 15 feet. This loess overlies glacial till. Local relief varies from 30 m (l00 ft.) to 9 m (30 ft.) and the hillslopes are intermediate in slope angle between the Des Moines lobe in the center of the state and the loess hills of western Iowa. The loess in Muscatine County is often described as plastic loess. Plastic loess has the tendency to be transformed from a solid state to putty-like and ultimately fluid-like with the addition of water. The term is taken from pottery making. In geotechnical engineering terms, increasing the moisture content of a plastic soil reduces the soil's shear resistance to sliding. Paleosols (buried soil profiles) occur in this region and could cause localized slope instability.

On a statewide basis, the soil most frequently associated with slope failures is undifferentiated fill with 28% of the failures. Glacial till and loess account for 24% and 21 %, respectively, of the landslides. Alluvium is the soil associated with 13% of the slides, and shale is the material in 7% of the slides.

Most of the landslides in the northeastern and eastern part of Iowa occurred on backslopes (cuts); however, most of the landslides in southeastern part of Iowa are in foreslopes (embankments). Statewide, 37% of slides are on fore slopes, 32% on back slopes, 26% along streams and riverbanks, and 5% on natural slopes.

Seventy-eight percent of the landslides identified by county engineers that occurred in Iowa from 1993-2001 happened in the spring with the remaining 22% happening in the summer. Fifty percent of the failures were associated with water where 28% of the slope failures occurred after heavy rainfall, and 22% were associated with high ground water table conditions. Twenty-one percent of the slope failures occurred due to design issues. In addition, maintenance or construction activities accounted for 1.4% of the stability problems while loading at the crest of slope and other causes account for 5% and 10%, respectively. Statewide, 25% of the slides occurred in slopes between 1'-10' high, 41% occurred in slopes 11'- 20' high, 21% occurred in

slopes 21'-30' high, and 13% occurred in slopes greater than 30' high. Slope was 3:1 on 96% of slopes prior to slope failure. See Map 3-3 on page **Error! Bookmark not defined.**.

Muscatine County has steep terrain adjacent to the Mississippi River that is susceptible to landslides. There is one area in the county where a significant landslide has occurred on more than one occasion. In 1982, the Iowa Department of Transportation (IDOT) condemned a portion of private property in conjunction with a plan to alter Highway 22 in Muscatine County. The condemnation was to prevent massive landslides that the IDOT feared would cover the highway. The amount of land taken was increased because, after construction began, unexpected difficulties were encountered in stabilizing the roadway. With the historic rains of 1993, the area had substantial movement of rock and soil onto Highway 22, and by September 1993, a new road project was being discussed, and a second condemnation proceeding began. Owners of the property appealed the condemnation and claimed to be entitled to an award for the loss of lateral support of their land adjacent to the IDOT project. A written statement from the owners' attorney was introduced into evidence stating "...research uncovered the fact that an extension of the fault that runs through New Madrid, Missouri extends through the edge off the…property." Experts testified to the presence of a fault causing landslides on the property in question.

A 1979 residence located at 1995 Sweetland Road in Muscatine is situated near the edge of a steep ravine. There have been landslide issues on the property since the home was constructed, particularly during extended periods of heavy rainfall. In 2010, as a result of increasing landslide activity, the owners retained foundation repair and stabilization specialists to diagnose issues and prescribe stabilization of the foundation. Nineteen concrete piers were installed under the foundation with extension of three of the piers an additional 40' two years later. In spring 2019, the homeowners noted additional settling. The home sustained new severe foundation cracks, major cracks in drywall, nonfunctional doors, slanted walls and floors, and loss of foundational support. Numerous cracks and depressions in the soil throughout the entire property were also noted. By June 2019, the homeowners reported that their home had sustained major damage. Staff from the Muscatine County Building and Zoning Office inspected the property on June 24, 2019. Due to the apparent lack of structural integrity as a result of shifting soils, the structure was deemed a Dangerous Building, and Muscatine County ordered that the owners of the property vacate. Since June, additional landslide activity has occurred, and county staff estimate the structure to be damaged beyond repair.

Probability: Per an IDOT survey of county engineers on the number of landslides that occurred in their county from 1993 to 2001, it was determined that southeast and western Iowa were high-risk areas for landslides. These high-risk areas contain deep to moderately deep loess. Most of the counties in the eastern part of Iowa had a significant number of landslides from 1993 to 2001, ranging from six to more than 15, except Scott County with 1-5 landslides. In Muscatine County, areas of greater than 15% slope may be at a high risk of landslides if disturbed or they become saturated or top loaded. While the 2010 *Iowa Hazard Mitigation Plan* does not mention Muscatine County, the 2007 *Iowa Hazard Mitigation Plan* has two areas of note for Muscatine County. The area between Montpelier and Fairport is indicated as having high susceptibility as also noted in the historical occurrence above. The 2007 plan also shows an area in southwest Muscatine County that has a moderate risk of landslides. Land with a steeper slope has a greater probability of slope failure and a landslide. The 2013 *Iowa Hazard Mitigation Plan* SHMT evaluated the probability of a significant landslide event in Iowa and indicated it was between 10% and 19% in any given year.

Magnitude/Severity: General landslides may pose a greater risk to property than to life. Sudden landslides may pose a threat to life, if warning signs of slope failure in structures overlooking steep slopes is undetected or ignored. According to the United State Geological Survey (U.S.G.S.), landslides threaten lives and property in every state in the nation, resulting in an estimated 25 to 50 deaths and damage exceeding $2 billion annually. Landslides are also a significant component of many major natural disasters and are responsible for greater losses than is generally recognized. Landslide damage is often reported because of a triggering event—floods, earthquakes, or volcanic eruptions—even though the losses from land sliding may exceed all other losses from the overall disaster.

Landslides have a significant adverse effect on buildings and infrastructure and threaten transportation corridors, fuel and energy conduits, and communications linkages. Road building and construction often exacerbate the landslide problem in hilly areas by altering the landscape, slopes, and drainages and by changing and channeling runoff, thereby increasing the potential for landslides. Landslides along roads can disrupt the use of that road until repairs are made to stabilize the slope and remove debris. Utilities such as pipelines, phone or fiber optic cables, power poles, etc. are often vulnerable to the downward movement of soil or rock. This may cause disruptions to water or sewer service, electricity, phone service, or internet access.

Landslides and others forms of ground failure also have adverse environmental consequences, such as dramatically increased soil erosion, siltation of streams and reservoirs, blockage of stream drainages, and loss of valuable watershed, grazing, and timber lands. Breakage of sewer mains could release hazardous materials. Breakage of gas pipelines could result in fire and disruption of supply. Landslides impose many direct and indirect costs on society. Direct costs include the actual damage sustained by buildings and property, ranging from the expense of cleanup and repair to replacement. Indirect costs are harder to measure and include business disruption, loss of tax revenues, reduced property values, loss of productivity, losses in tourism, and losses from litigation. The indirect costs often exceed the direct costs.

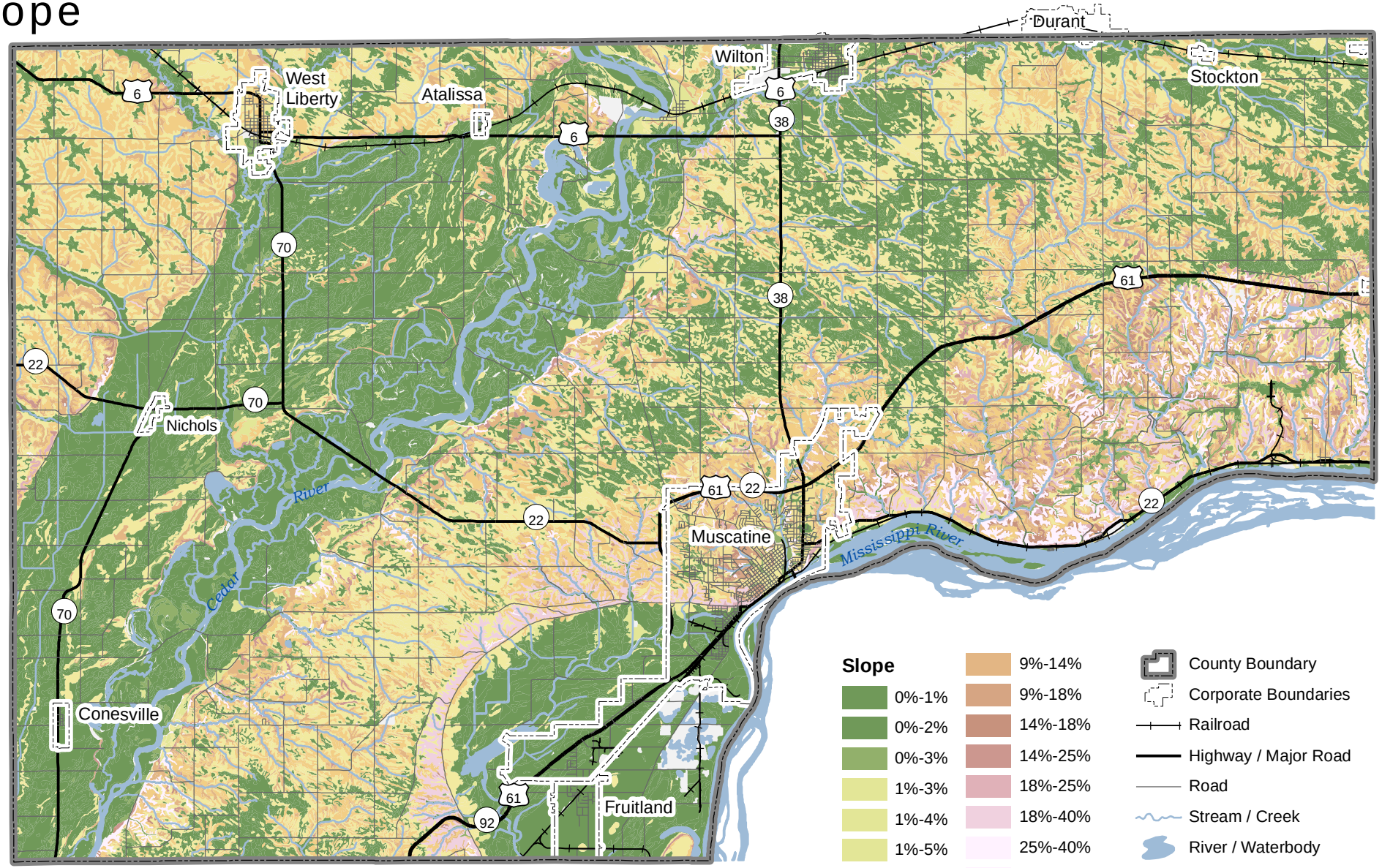
Warning Time: Landslide formation can be very slow or can occur very quickly. Landslides are often triggered by other natural hazards. Landslides and heavy rain or flooding and ground saturation can occur together. Landslides can be detected if areas at high risk are monitored for early signs of a slide such as cracks or a scarp at the top of the slope; a bulge at the bottom of the slope; diagonal cracks along the slope; ponded water indicating localized seepage; cattails or willows indicating localized seepage; and tilted tree trunks. Along roadways, pavement settlement, deformed guardrails, or erosion at the outlet of a drain structure can indicate instability below a roadway on fore slopes and back slopes. Instability above a roadway on fore slopes can be indicated by debris on the roadway and blocked drainage ditches.

Duration: The response tied to landslides is related to securing the immediate threat to life and property including immediate reroute of traffic from the affected infrastructure and search and rescue in the case of structural collapse. Return to use of facilities and roads could take hours to many days depending on the severity of the landslide and the actions needed to secure the slope.

Muscatine County Multi-Jurisdictional Hazard Priority Ranking: #13, Low Priority

Sources	
FEMA	*"A Cornerstone of National Mitigation Strategy."* July, 1997
Iowa DOT and Iowa State University of Science and Technology – Dept. of Civil & Construction Engineering	Regional Approach to Landslide Interpretation and Repair (2001); Iowa DOT Project TR 430
Iowa DNR Geological Survey Bureau	http://www.igsb.uiowa.edu/service/hazards.htm
U. S. Geological Survey Landslides Hazards Program	http://landslides.usgs.gov/
U.S. Geological Survey Circular 1244 Online Version 1.0	National Landslide Hazards Mitigation Strategy -- A Framework for Loss Reduction - **http://pubs.usgs.gov/circ/c1244/**
Panel on Land Subsidence, Committee on Ground Failure Hazards Mitigation Research, Division of Natural Hazard Mitigation, National Research Council Commission on Engineering and Technical Systems (CETS)	Mitigating Losses from Land Subsidence in the United States (1991)
Iowa Homeland Security and Emergency Management Division (HSEMD)	*Iowa Hazard Mitigation Plan, 2007, 2010 and 2013*
Iowa Judicial Branch	*Appeal No. 205/99-0204 filed December 20, 2000 in the Supreme Court of Iowa*
J. A Udden	*Geology of Muscatine County, 1914*
FORREX - *British Colombia's Watershed Technical Bulletin*	Streamlines Vol.2, No. 2 Article 2, *What is Soil Plasticity? How does it allow you to prevent slope failure? By Hardy Bartle*

Map 3.3
Slope



Slope

- 0%-1%
- 0%-2%
- 0%-3%
- 1%-3%
- 1%-4%
- 1%-5%
- 2%-5%
- 2%-9%
- 5%-9%
- 5%-14%
- 9%-14%
- 9%-18%
- 14%-18%
- 14%-25%
- 18%-25%
- 18%-40%
- 25%-40%
- 25%-45%
- 25%-50%
- No Slope Data

- County Boundary
- Corporate Boundaries
- Railroad
- Highway / Major Road
- Road
- Stream / Creek
- River / Waterbody

N

0 1 2 3 4 5
Miles

Roads - Iowa DOT (2019)
Corporate Limits, Flood Hazard Areas - MAGIC (2019)
County Boundary - IA DNR
Water Features - USGS
Slope - U.S. Dept. of Agriculture, Natural Resources Conservation Service, Soil Data Mart. Slope determined by soil type property from map unit description.

Disclaimer: This map is for reference only. Data provided are Derived from multiple sources with varying levels of accuracy. Bi-State Regional Commission disclaims all responsibility for the accuracy or completeness of the data shown hereon.

Map prepared by:
Bi-State Regional Commission
October 2019

Levee Failure

A levee failure is a loss of structural integrity of a wall, dike, berm, or elevated soil by erosion, piping, saturation, or under seepage causing water to inundate normally dry areas. Levees constructed of compacted clay with a high plasticity tend to crack during cycles of long dry spells. During heavy rainfalls that follow the dry spells, water fills the cracks and fissures. In addition to increasing the hydrostatic forces, the water is slowly absorbed by the clay. This results in a simultaneous increase of the slide (driving) forces and a decrease of the resisting (shear strength) forces.

Furthermore, the cyclic shrink/swell behavior of the cracked clay zone results in a progressive reduction of the sheer strength of the clay, perhaps approaching its residual strength. It also results in deepening of the cracked clay zone, which may eventually reach a depth of 9 ft. (2.74 m) or more, especially for clays with a plasticity index greater than 40. The result may be a sloughing failure following a heavy rainfall. It is believed that fast removal of the runoff water from the interconnected network of cracks could alleviate this surface instability problem.

Due to security concerns, the actual levees are not included on a map in the plan. Map 3-4 on page 65 shows areas protected by certified levees. Levees identified in Muscatine County as of 5/30/2013 are:

- Federal urban levee at City of Muscatine for Mad Creek and the Mississippi River (Level of Protection 100-500-year flood). This levee system has been certified, and two areas of floodplain have been reclassified as “X- Protected by Levee.”
- Federal rural agricultural levees listed for the City of Muscatine but in Louisa County (Agricultural population level of protection 100-500 year flood)
- Levee between Nichols and West Liberty Muscatine Island Levee District (Agricultural and Residential/Urban)
- Eichelberger Levee (Agricultural)
- Holcomb Levee (Agricultural)
- King Levee (Agricultural)
- The levee from Levee District No. 17 located on the west bank of the Cedar River. The levee was overtopped in 2008 causing structural damage with as many as 15 holes as deep as 12 feet. The levee was repaired by the levee district; however, the levee is not certified.
- The Muscatine Island Levee District and the Muscatine-Louisa County Drainage District No. 13, together with the upper half mile of the Louisa Drainage District No. 15, for a joint drainage and flood control system of the 26,478 acres of bottomland. The area is located immediately downstream of the City of Muscatine in Muscatine and Louisa Counties. The levee was certified, and the majority of the land behind the levee has been reclassified as “X – Protected by Levee.”

- There is also a levee along Hockey Slough from its mouth at Wapsinonoc Creek to about 4,500 feet upstream of the City of Nichols. This levee provides some protection against floods of less than 10-year frequency.

The flood of 1993 was so great that the limits of many levees were tested and sometimes exceeded. Of the 275 U.S. Army Corps of Engineers (USACE) levees affected by the flood, 85% held, but 31 were overtopped, eight were eroded and ruptured, and three were breached. The performance of nonfederal dams was much worse: only 43% withstood the trauma, and 800 of 1,400 failed. In Muscatine County, assistance was requested for the Eichelberger Levee because of heavy rains and flooding. However, since it is a private levee, it was not eligible for assistance under U.S. Army Corps of Engineers (USACE) programs. On June 22, 2007, the levee between Nichols and West Liberty topped during a rain event according to National Climatic Data Center. In June 2008, Levee District No. 17, which had not been maintained, was overtopped by record level floodwaters on the Cedar River. This is mostly farmland.

In 2013, the City of Muscatine and the Corps of Engineers completed an Urban Levee System Evaluation of Flooding Scenarios for three hypothetical levee breach locations in Muscatine County. The Corps used two-dimensional hydraulic modeling products to identify threats to human life and safety characterized by flood wave progression and rapid increases in water depths. Critical facilities were identified on the inundation maps as well as time to one foot and two-foot inundation levels at each facility. They chose three locations and, using data they collected with the Muscatine Area Geographic Information Consortium (MAGIC), put together flood projections based on breaks in three locations. The first scenario projects a break at Musser Park, just south of Riverside Park. While the whole Muscatine Island area floods in under three days, the majority of initial flooding is north of Grandview Avenue. The community of Fruitland is also partially inundated within 72 hours in this scenario. The second scenario projects a break just south of K.A. Steel Chemical Company. In two days, much of the Muscatine Island is underwater with levels as high as 15 or 18 feet. Fruitland is partially inundated within 32 hours in this scenario. The third scenario projects a break west of Coleman Island. Within a day, floodwaters have taken Monsanto, Agrilance, and even the National Guard post on Highway 61. Fruitland is wholly inundated in this scenario.

Link to the study *https://muscatineiowa.gov/745/Levee-Breach-Study*

The Corps of Engineers presentation is located here: *https://muscatineiowa.gov/DocumentCenter/View/9411/Muscatine-Urban-Levee-modeling-presentation-May-2013-with-USACE-Logo?bidId=*

Probability. The rate of failure of a levee or floodwall is difficult to predict, and sudden failure is a possibility. Proper design and construction can limit the probability of a levee failure. Development in the watershed can raise flood levels and make a levee designed and constructed under previous characteristics inadequate for current runoff conditions. The 2013 *Iowa Hazard Mitigation Plan* estimated the probability of a dam/levee failure event associated with heavy flooding in Iowa is between 10-20% in any given year.

Magnitude and Severity. People, property, and utilities in the floodplain are most at risk. Levees and floodwalls give a false sense of security. People feel that levees will protect them and their property against any future flooding. While this is usually true, the hazard is only temporarily contained.

Floodwaters breaching a levee are usually contained in the historic floodplain. Interestingly enough, levee failure in one area may prevent flooding in another area. A levee breach or overtopping occurring along one segment may drop the level of water along other segments of the stream. For initial overtopping, the overriding concern is choosing the least hazardous location for initial inundation of the interior. The least hazardous location could be a golf course, an oxbow lake, a ponding area, undeveloped area such as agricultural land, or a downstream reach.

Sudden failure in an urban setting could cause a catastrophe as was demonstrated in Cedar Rapids in 2008. In an urban setting, the severity and duration may cause health related concerns to the public, while the main impact of a levee failure in agricultural areas is economic. Water bursting through a narrow levee breach is moving much faster than the floodwaters in the main channel. The breaking out of this front of water and its fast flow can cause more destruction to structures behind the levee than floodwaters in the main channel would have caused. A failed levee continues to cause damage long after it breaks.

Residents behind levees often have a false sense of security. If the actual risk is not communicated to the residents by the jurisdiction, there may be effects to the reputation of the community if the levee fails. Effects would be similar to those experienced during a river or flash flood.

With updated floodplain mapping, FEMA requires certification of levees in order for property protected by the levee to be eligible for flood insurance at the rate of flood-level protection. Without certification, those properties would only be eligible for flood insurance at the actuarial rate for the elevation of the structure compared to the 100-year or 1 percent flood level.

Warning Time. The amount of warning time depends on the type of levee failure. Local flood warning systems can help in determining the maximum water surface and the timing of a flood situation. Hours or days of warning may be available for high water that may overtop levees, but this does not provide complete security from a rupture in the levee itself. A sudden failure of a portion of the levee may send floodwaters gushing from this break within seconds. Normally, occupants of the floodplain can be warned about potential levee breaches or breaks when high water encroaches upon the levee.

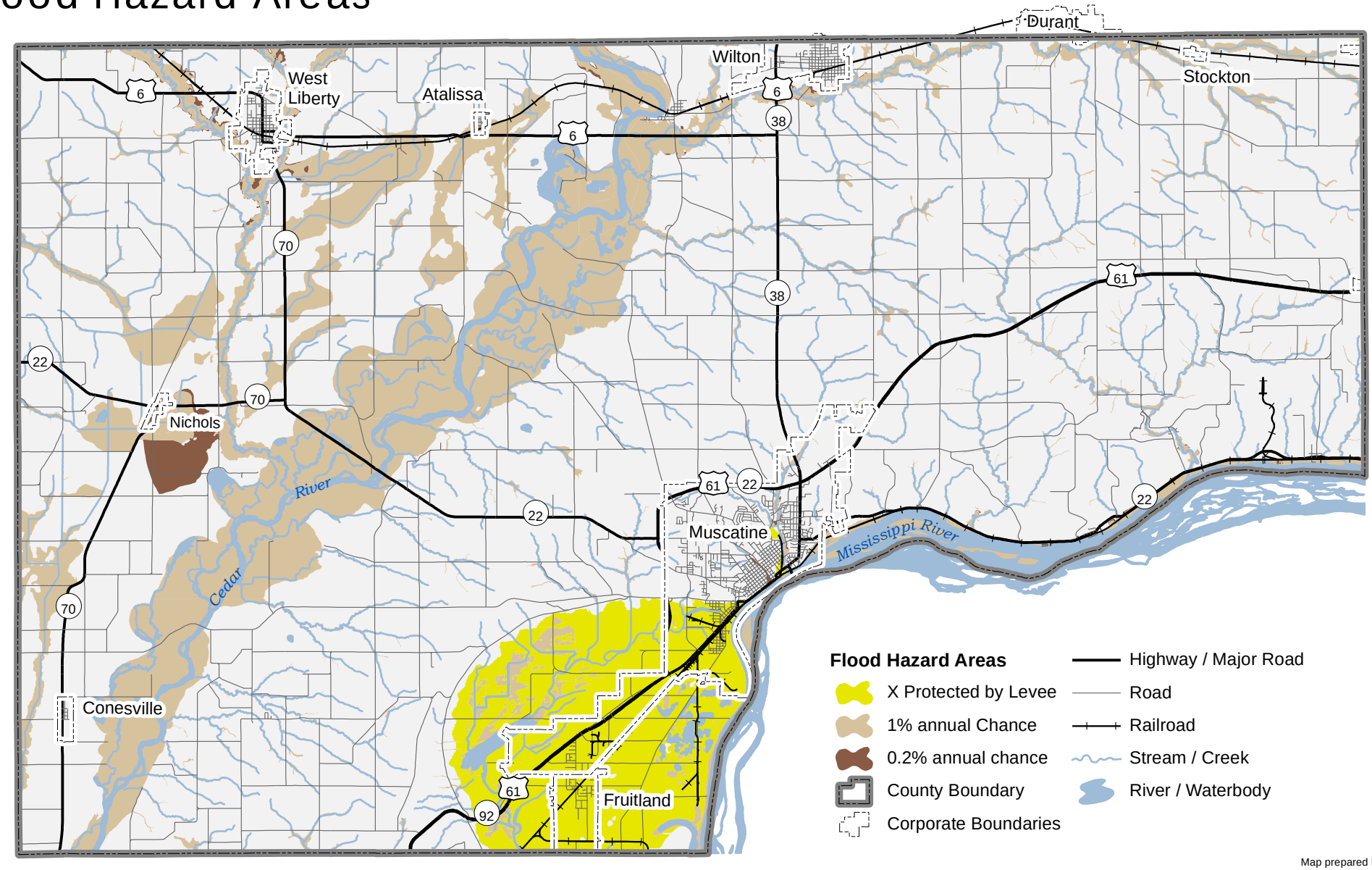
Duration. The effects of a levee failure and its association with river flooding are extensive and require substantial response efforts. The breach allows large volumes of water to enter formerly dry areas, forming temporary lakes. Such lakes do not go away immediately, because the lake is blocked from returning to the main channel by levee segments that were not destroyed. Consequently, the water level drops along the main river days before it drops behind breached levees. Often, pumps behind the levees are needed to remove floodwaters that breach the levees. This alleviates some of the effects associated with levee failures.

Muscatine County Multi-Jurisdictional Hazard Priority Ranking: #6, High Priority

Sources	
Iowa Homeland Security Emergency Management Division (HSEMD)	Iowa Hazard Mitigation Plan, 2010 and 2013
Muscatine County	Muscatine County Multi-Jurisdictional Hazard Mitigation Plan 2010
City of Muscatine/Corps of Engineers 2013 Levee Breach Study	*https://muscatineiowa.gov/745/Levee-Breach-Study*
U.S. Army Corps of Engineers (USACE) National Levee Database	http://nld.usace.army.mil/egis/f?p=471:1:
Iowa Department of Natural Resources	http://www.iowadnr.com
Local sources: Bi-State Regional Commission	Long-Range Flood Recovery Plan for the Bi-State Region: 1994
FEMA Flood Insurance Study	Muscatine County Unincorporated, 1986

Map 3.4

Flood Hazard Areas



Disclaimer: This map is for reference only. Data provided are Derived from multiple sources with varying levels of accuracy. Bi-State Regional Commission disclaims all responsibility for the accuracy or completeness of the data shown hereon.

Roads - Iowa DOT (2019)
Corporate Limits, Flood Hazard Areas - MAGIC (2019)
County Boundary - IA DNR
Water Features - USGS

0 1 2 3 4 5
Miles

N

Map prepared by:
Bi-State Regional Commission
October 2019

River Flooding

River flooding is a rising or overflowing of a tributary or body of water that covers adjacent land not usually covered by water when the volume of water in a stream exceeds the capacity of the channel. Floods are the most common and widespread of all natural disasters, except fire. Most communities in the United States can experience some kind of flooding after spring rains, heavy thunderstorms, winter snow thaws, waterway obstructions, or levee or dam failures. Often a combination of these elements causes damaging floods. Floodwaters can be extremely dangerous.

Floodwaters can be extremely dangerous. The force of six inches of swiftly moving water can knock people off their feet, and two feet of water can float a car. Floods can be slow or fast rising, but generally develop over a period of days. Flooding is a natural and expected phenomenon that occurs annually, usually restricted to specific streams, rivers, or watershed areas.

Since the *Muscatine County Multi-Jurisdictional Hazard Mitigation Plan* was adopted in April 2010, the entire county has adopted new flood insurance rate maps, which had previously been preliminary at plan adoption. The Muscatine Island Levee was accredited with portions of the 1% annual chance Special Flood Hazard Area and was moved to "Area Protected by Levee" in new FIRMs in 2014. Details of the new maps can been seen in Map 3-4 on page 65.

The National Flood Insurance Program (NFIP) Repetitive Loss Properties (RLP) report identifies properties vulnerable to multiple flood losses. The *Iowa State Floodplain Manager* report shows 19 unmitigated repetitive loss properties within Muscatine County as of October 2019. Most of the repetitive loss properties were single-family structures. Repetitive loss properties are any National Flood Insurance Program (NFIP) insured buildings for which two or more claims of more than $1,000 each were paid by the NFIP within any 10-year period. The 2013 *Iowa Hazard Mitigation Plan* showed that as of November 2012, unmitigated repetitive loss properties within Muscatine County had received in total over $1.3 billion in NFIP payments. Map 3-5 on page 72 shows approximate locations of the repetitive loss properties in Muscatine County as well as the Flood Insurance Rate Map 1% chance of flooding occurring in any given year. Appendix 3-2 contains more detailed FIRMS for the planning area. The 2013 *Iowa Hazard Mitigation Plan* also states that an average of $345,000.00 in flood damages occur annually in Muscatine County.

Flood categories in feet at the National Weather Service gage point within Muscatine County:

Flood Stages	Mississippi River at Muscatine	Cedar River at Conesville
Major Flood Stage (ft)	20	16.5
Moderate Flood Stage (ft)	18	15
Flood Stage (ft)	16	13
Action Stage (ft)	15	12

The National Climatic Data Center reports 44 flood events between January 1, 2000 and October 31, 2019 (7,244 days) for Muscatine County. Fifteen events are listed as flash flood or urban/small stream flooding and are addressed in the "Flash Flood" hazard profile. The listed

events document flooding on the major rivers in Muscatine County: the Mississippi River and its tributary the Cedar River. The highest crest on record for the Mississippi River occurred in 1993. The Mississippi River and tributaries remained above flood stage for as long as five months in some places. Damage from the 1993 flooding in Muscatine County was estimated at 643 residential structures damaged or destroyed at a cost of $6,580,191. An additional $647,300 was spent in the county for infrastructure damage and flood control.

October 1, 2016: Record to near record heavy rainfall in north central and northeast Iowa from September 21 to 23 of 4 to over 10 plus inches caused major river flooding on many forecast points on the Iowa tributaries of the Wapsipinicon, Cedar, lower Iowa, and Maquoketa rivers from late September through early October. Then, major river flooding occurred downstream on the Mississippi River from the Iowa River and Mississippi River convergence and south. Heavy rainfall of four to over ten inches fell over significant areas from September 21 to 23 in extreme north central and northeast Iowa. The resulting rainfall moved downstream causing the Cedar River to rise above major flood stage levels. The Cedar River at Conesville rose above its major flood stage level of 16.5 feet on September 28, 2016 at approximately 5 a.m. CST. It crested around 18.2 feet at approximately 9 a.m. CST on September 29, 2016. It fell below major flood stage on October 1 around 11 p.m. CST.

October 15, 2018: A prolonged and exceptionally wet fall combined with successive flash flood events in eastern Iowa and northwest Illinois to bring widespread minor to moderate river flooding to nearly all rivers in this area. In addition, major flooding occurred on rivers, including the Mississippi, Iowa, Wapsipinicon, English, North Skunk, Maquoketa, and Rock Rivers. This major flood event stretched through much of mid-October. Major flooding on the Mississippi River at the Muscatine, Iowa gage began at midnight, October 12, when it exceeded 18 feet. It crested at 20.8 feet, 4:45 p.m., October 13, before falling below 20 feet, which is major flood stage, at 6 a.m., October 15.

2008 Flood: Major to record flooding occurred along the Cedar River in Muscatine County during the month of June 2008 due to prolific persistent heavy rain from late May into early June. This was part of a statewide disaster declaration. The Cedar River reached its record height on June 15, 2008 as part of the flood event. Many roads in eastern Iowa sustained severe damage from the flooding. The flooding of the Cedar River also forced closure of many roads including I-80 between interchanges #265 and #267. This location is between Iowa City, IA and Davenport, IA. The detour route was designated as U.S. 61 to U.S. 20 to I-35. This detour added 115 miles to the normal route. The levee protecting levee district 17 on the Cedar River in Muscatine County breached. The cost to repair the levee was estimated to be $200,000. Final costs have not been confirmed with the levee district. In addition, several houses were destroyed. Through both FEMA Hazard Mitigation Grant Program funds and HUD Community Development Block Grant funds, 12 houses were bought out and removed from the floodplain. An additional 14 structures were demolished with disaster funds. According to Muscatine County, 40 structures were affected by the 2008 flood. The State of Iowa also created a state-funded recovery called Jumpstart Housing Assistance Program, which disbursed a total of $381,549.18 to assist 16 homeowners repair their homes within Muscatine County. Damage estimates for eastern Iowa alone are approximately $1 billion.

2019 Flood:

- **March 31, 2019:** Significant flooding occurred across eastern Iowa and northwest Illinois during spring 2019. Moderate to major flooding was observed on the Mississippi River due to snowmelt, frozen ground, ice jams, saturated soils, and rainfall that started in mid-March. It then continued through the end of the month and on into April and May. An initial crest occurred during the third and fourth weeks of March. Heavy rain and snowmelt across the region caused the Mississippi River to rise above its major flood stage of 20.0 feet on March 22, and remain above major flood stage through the end of the month. An initial crest of 20.71 feet occurred early in the morning of the 25th, and again late in the day on the 25th through the early morning hours of the 26th.

- **April 30, 2019:** The Mississippi River remained high through the month of April due to a combination of snowmelt and several rounds of heavy rain. Rain in the second half of the month caused the Mississippi River to rise back above major flood stage during the last week of April. The major flooding would continue into May. Heavy rain across the area caused the Mississippi River at Illinois City Lock and Dam 16 to rise above its major flood stage of 18.0 feet late in the evening of the 25th, and it remained above its major flood stage into the month of May. The river continued to rise through the end of the month with no crest during this period.

- **May 1, 2019**: The Mississippi River at Illinois City Lock and Dam 16 began the month above its major flood stage of 18 feet. The river would rise to a crest of 24.33 feet on May 3. This crest is the third highest crest for the Mississippi River at Illinois City Lock and Dam 16. The river fell below major flood stage the evening of the 12th.

  The Mississippi River at Muscatine (MUSI4) began the month above its major flood stage of 20 feet. The river would rise to a crest of 24.33 feet on May 3. This crest is the fourth highest crest for the Mississippi River at Muscatine. The river fell below major flood stage the afternoon of the 11th.

- **May 31, 2019:** Extensive flooding occurred late May and into June across eastern Iowa, northwest Illinois, and northeast Missouri. The last half of May was very wet with 5-8 inches of rain falling over the region. This combined with saturated soils, brought many rivers above Moderate to Major flood levels. Many climate sites only saw 3 days of no precipitation from May 16 to May 31. The Wapsipinicon, Iowa, Skunk, Des Moines, Rock, and Green Rivers all recorded a preliminary Top 10 crest on record. The main stem Mississippi also crested again in late May/early June, with sites from LeClaire LD on downstream recording a Top 10 crest. Several significant flood events also occurred in March 14-early May 2019 due to snowmelt, heavy rain, and saturated soil. The Mississippi River at Illinois City Lock and Dam 16 rose above its major flood stage of 18 feet during the afternoon of May 27 and continued into June. The river crested in June, with the stage rising to 21.45 feet at the end of May 31.

- **June 1-June 13, 2019**: The Mississippi River remained high during the month of May, and heavy rains that fell in the later part of the month resulted in the river rising back above major flood stage in late May south of Clinton, Iowa. The river remained above major flood level up to the middle of the month. The Mississippi River at Illinois City began the month

of June above its major flood stage of 18 feet and crested at 1 a.m. on June 2 at 22.81 feet. This is preliminarily the fifth highest crest on record. It fell back below major flood stage around 7 a.m. on June 13. The Mississippi River at Muscatine began June above its major flood stage of 20 feet and crested around 4 a.m. on June 2 at 24.52 feet. This is preliminarily the third highest crest on record. The river fell back below major flood stage on June 12 around 5 p.m.

Historic crests at National Weather Service gage points as of October 2019 are as follows:

Mississippi River at Muscatine:
Historic Crests
(1) 25.61 ft. on 07/09/1993
(2) 24.81 ft. on 04/29/1965
(3) 24.52 ft. on 06/02/2019 (P)
(4) 24.42 ft. on 06/17/2008
(5) 24.33 ft. on 05/03/2019 (P)
(6) 23.75 ft. on 07/05/2014
(7) 23.50 ft. on 04/25/2001
(8) 21.95 ft. on 04/10/2019 (P)
(9) 21.87 ft. on 04/23/2011
(10) 21.86 ft. on 04/22/2013

Cedar River near Conesville:
Historic Crests
(1) 23.40 ft. on 06/15/2008
(2) 18.24 ft. on 09/29/2016
(3) 17.88 ft. on 07/02/2014 (P)
(4) 17.11 ft. on 04/06/1993
(5) 17.00 ft. on 05/29/2004
(6) 16.90 ft. on 06/03/2013
(7) 16.87 ft. on 06/18/1990
(8) 16.85 ft. on 04/12/1965
(9) 16.80 ft. on 07/28/1999
(10) 16.74 ft. on 07/07/1993

Probability. The 2013 *Iowa Hazard Mitigation Plan* has evaluated the probability that a flooding event will occur in Iowa is classified as highly likely in any given year. Given that the list of events for Muscatine County includes more than one event in some years, it might be estimated that at least minor flooding could occur nearly every year somewhere in the county.

Magnitude/Severity. The vulnerability from river flooding is quite delineated. Much work in the area of flood hazard mapping has allowed many communities to restrict development in hazardous areas.

The Federal Emergency Management Agency has delineated the special flood hazard areas in most areas. These Flood Insurance Rate Maps (FIRMs) show properties affected by the floods that have at least a 1% chance of occurring in any given year. Generally, these areas are in the floodplain or adjacent areas. Map 3-5 on page 72 shows general locations of the repetitive loss properties as associated with the Special Flood Hazard Areas with a 1% chance of flooding annually in the preliminary Digital FIRM for Muscatine County.

Flooding effects include potential loss of life. River flooding does not have as high of a risk as flash flooding because of the slower onset of the river flood. Personal property can be extensively damaged and destroyed by swift moving water. Facilities and infrastructure can be scoured around, degrading its structural integrity. Damage to crops on the floodplain can be extensive. The planting of crops on low-lying areas may not happen, if spring floods extend past the planting season. This occurred in many areas in 2019. Various insurance programs paid $2.82 million in crop losses to Muscatine County farmers in 2019.

Damage and disruption of communications, transportation, electric service, and community services are likely in severe cases. Water treatment and wastewater treatment facilities are often

located in or near the floodplain are at high risk of flooding, and will eventually be taken offline. The National Climatic Data Center Storm Event Database reported floods causing $11,625,000 in property damage. The last reported damage dollar amounts were reported in 2016. Therefore, this number does not include any reports from floods after that date, including the 2019 flood.

Warning Time. Gages along streams and rain gages throughout the state provide for an early flood warning system. River flooding usually develops over the course of several hours or even days, depending on the basin characteristics and the position of the particular reach of the stream. The National Weather Service provides flood forecasts for Iowa. Flood warnings are issued over emergency radio and TV messages as well as the NOAA Weather Radio. People in the paths of river floods may have time to take appropriate actions to limit harm to themselves and their property.

Duration. The responses to the effect of river flooding in Iowa are extensive and require many days to adequately respond to the needs of the county, cities, school districts, and citizens. In 2019, the Mississippi River rose above flood stage at Muscatine in March and remained above flood stage through June.

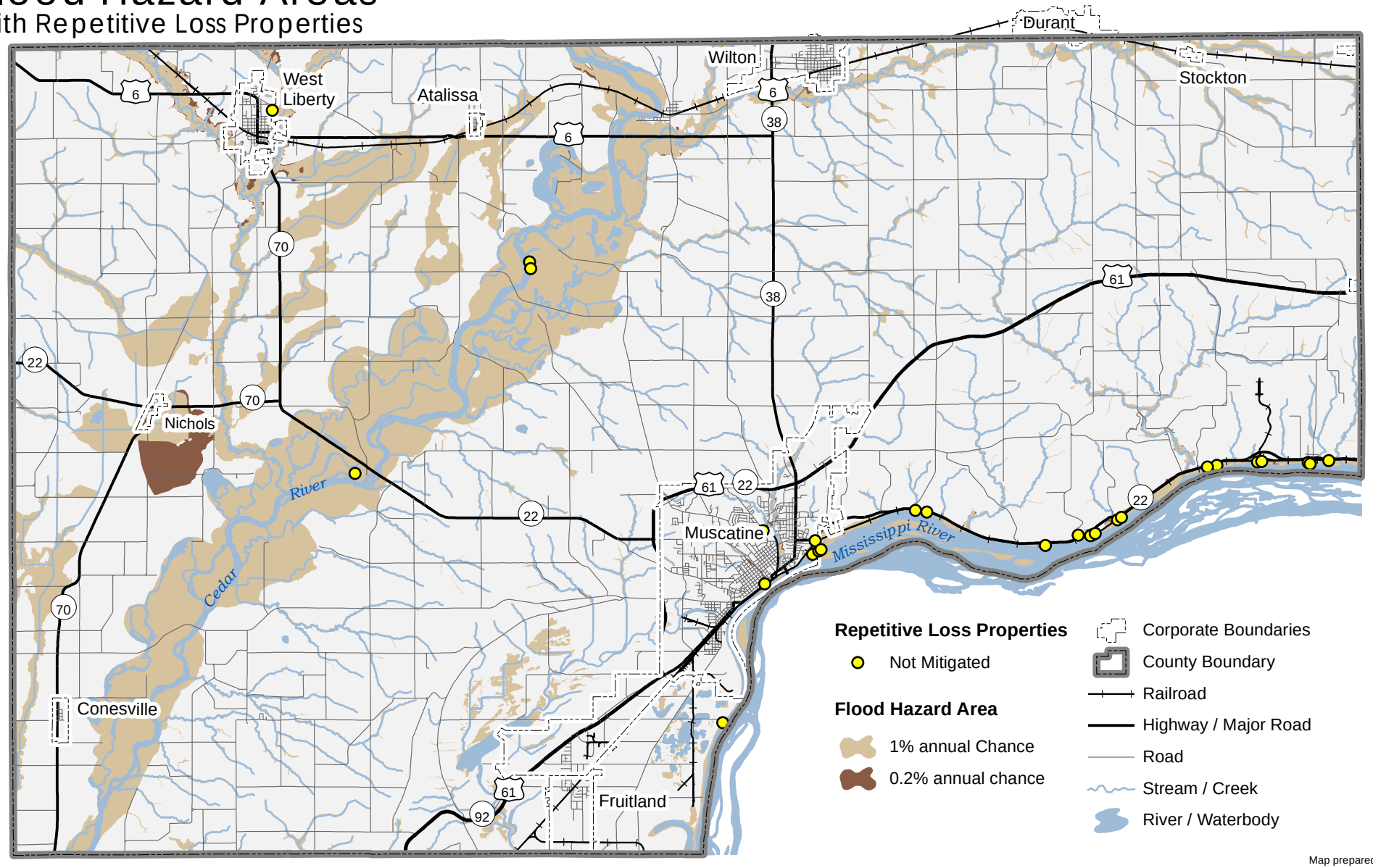
Muscatine County Multi-Jurisdictional Hazard Priority Ranking: #4, High Priority

Sources	
Iowa Homeland Security and Emergency Management Division (HSEMD)	*Iowa Hazard Mitigation Plan, 2010 and 2013*
National Climatic Data Center	*https://www.ncdc.noaa.gov/stormevents/*
Iowa State Iowa DNR	*Iowa State Floodplain Manager Report*
FEMA	*Flood Insurance Study, 1986*
Bi-State Regional Commission	Long-Range Flood Recovery Plan for the Bi-State Region: 1994

Map 3.5

Flood Hazard Areas

with Repetitive Loss Properties



Disclaimer: This map is for reference only. Data provided are Derived from multiple sources with varying levels of accuracy. Bi-State Regional Commission disclaims all responsibility for the accuracy or completeness of the data shown hereon.

Roads - Iowa DOT (2019)
Corporate Limits, Flood Hazard Areas - MAGIC (2019)
County Boundary - IA DNR
Water Features - USGS
Repetitive Loss Properties - IA DNR

0 1 2 3 4 5
Miles

N

Map prepared by:
Bi-State Regional Commission
October 2019

Severe Winter Storms

Severe winter storms are weather conditions that affect day-to-day activities. These can include blizzard conditions, heavy snow, blowing snow, freezing rain, heavy sleet, and extreme cold. Winter storms may occur at any time between October and April. The various types of extreme winter weather cause considerable damage. Heavy snows can cause immobilized transportation systems, downed trees and power lines, collapsed buildings, and loss of livestock and wildlife.

Blizzards are winter storms that last at least three hours with sustained wind speeds of 35 mph or more, reduced visibility of ¼-mile or less, and whiteout conditions. Heavy snow of more than six inches in a 12-hour period or freezing rain greater than ¼-inch accumulation may cause hazardous conditions in the community. Blizzards can slow or stop the flow of vital supplies, and cause disruptions of emergency and medical services. Loose dry snow begins to drift when the wind speed reaches 9 to 10 mph under freezing conditions. The potential for some drifting is substantially higher in open country than in urban areas where buildings, trees, and other features obstruct the wind.

Iowa is prone to at least one thunder snowstorm each winter. Snowfall muffles thunder, resulting in an echo of only two to three miles, which means that people outside the range might not realize that a snowstorm is a thunder snowstorm. Thundersnow often coincides with very heavy snow, usually falling at 1 to 3 inches per hour. A "thunder snowstorm's" strong tropical storm force level winds can also cause property damage, extremely low wind chills, and frostbite. A thunder snowstorm carries the same lightning dangers as a regular thunderstorm.

Ice storms can result in fallen trees, broken tree limbs, downed power line and utility poles, fallen communication towers, and impassable transportation routes. Severe ice storms have caused total electric power losses over large areas of Iowa and rendered assistance unavailable to those in need due to impassable roads. Frigid temperatures and wind chills are dangerous to people, particularly the elderly and the very young. Dangers include frostbite or hypothermia. Water pipes, livestock, fish and wildlife, and pets are also at risk from extreme cold and severe winter weather.

There have been 127 winter weather events recorded in Muscatine County between January 1,1993 and February 12, 2019 (NCDC). Events included were heavy snowfalls, extreme cold temperatures, blizzard conditions, freezing rain or glazing, blowing snow, frost, and sleet. Following are significant events that have occurred in Muscatine County from February 2007 to February 2019.

> **February 24, 2007:** A widespread and crippling ice/snow storm affected eastern Iowa, northwest and western Illinois, and extreme northeast Missouri. 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. 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. Several trees also fell 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. Muscatine County was part of the declared disaster area and included in the Presidential Disaster Declaration (FEMA -1688-DR; March 14, 2007).

January 13-16, 2009: Heavy snow fell January 13-14 (6-8 inches), and then extreme cold temperatures set in on January 14-16. Actual air temperatures were ¯10° to ¯20°F (wind chills ¯30° to ¯50°F). Cedar Rapids set a record low of ¯29°F.

January 31-February 2, 2011: A tremendous blizzard affected the region, with snowfall totals ranging from 10-20 inches and snow drifts as high as 7 feet. Many roads and interstates were closed. Blizzard conditions were widespread, and visibility was near zero with 55-65 mph wind gusts (Davenport recorded one of the strongest wind gusts of 56 mph). At the height of the blizzard, snowfall rates were as high as 1-3 inches per hour. Muscatine County received 15.0 inches of snowfall.

February 1, 2015: A prolonged snow event from the mid-afternoon on January 31 to late February 1 created widespread snow across the region. The heaviest snowfall of 9-15" fell along the Interstate 80 corridor. Gusty northwest winds developed behind the system resulting in considerable blowing and drifting snow. Several areas experienced prolonged power outages and downed tree limbs due to heavy snow.

February 25 -26, 2015: A fast moving storm system occurred from the mid-morning on February 25 to the early morning on February 26. An area of low pressure moved across the Plains and into Missouri spreading widespread snow across the region. Widespread snowfall totals between 3 and 6 inches were common. The heaviest snowfall of 6-7.5" fell generally along and southwest of a line from Cedar Rapids, to Muscatine, to Macomb, IL. Northerly winds of 10-20 mph resulted in some snowdrifts of 1-2' in parts of southeast Iowa. A storm spotter reported 6” snow in Muscatine, and 3-6" of snow was reported elsewhere in the county.

November 20-21, 2015: A potent low-pressure system moved across Missouri and southern Illinois November 20 and 21, bringing the season's first snowfall to much of the area. Widespread snowfall totals of 6-12" were found across northern Iowa and the Wisconsin-Illinois border. Isolated higher amounts of 14-16" were reported. Strong northerly winds developed as the system moved off to the northeast, which created patchy blowing and drifting snow. A storm spotter reported 6.2" of snow in Muscatine.

December 28-29, 2015: A potent low-pressure system tracked from eastern Oklahoma and Missouri into northern Illinois and the Great Lakes region, from December 28 to the early morning hours of the 29th. An unseasonably warm and moist air mass interacted with the system to produce heavy mixed precipitation across eastern Iowa. Thundersnow was reported in some areas, as well as heavy snow, sleet accumulations up to 2-4 inches, and a glaze ice amounts over a quarter inch. The ice and strong winds gusting to 50 mph resulted in widespread downed trees and powerlines, and power outages. The hardest hit areas, with glaze ice amounts of 1/4-1/2 inches, were located in southeastern Iowa. The highest amounts of combined snow and sleet, in the 5-7" range, occurred west and north of a line from Brighton, IA in Washington County, to Cedar Rapids, Anamosa, and Dubuque, Iowa. Trained spotters reported 1.5-3" of sleet across Muscatine County.

December 4, 2016: A storm system moved from the eastern Dakotas and Nebraska across Minnesota and Iowa on December 4. This brought mainly light to moderate snow across the region through the day with periods of heavy snow. The heaviest snow fell across Cedar, Clinton, Muscatine, and Scott Counties where 6-8" with 9-10" was reported in the metro

Quad Cities. Elsewhere across eastern Iowa, snowfall totals ranged from 3-5 inches. Trained spotter reports ranged from 5” two miles east southeast of Muscatine to 8" three miles east northeast of Muscatine.

December 29, 2017: A winter storm moved across the region during on December 29, brought snow along, and north of a line from Fairfield to Burlington Iowa. The heaviest snow fell in the counties along the Interstate 80 corridor where 4-7" of snow was reported. One-four inches of snow was reported to the south and north of that line with the lightest amounts along the U.S. Highway 20 corridor and along a line from Fairfield to Burlington. Snowfall reports ranged from an estimate of 6" one mile east northeast of Muscatine to 6.5" southwest of Muscatine.

January 1-2, 2019: A strong area of low pressure tracked across the lower Mississippi River Valley, bringing heavy snow from central Missouri and southern Illinois up to northwest Illinois January 11-12. The heaviest snow amounts fell from Missouri into Ohio, where amounts over a foot were common. Further north, snowfall totals ranged from 1-3" along the Highway 20 corridor, to 4" near the I-80 corridor, to 8-12" along and south of Highway 34. Trained spotters reports ranged from 6.5" three miles north northeast of Muscatine to 7.8" in Muscatine.

January 18-19, 2019: A significant winter storm system brought accumulating snow and hazardous travel conditions to the region Friday afternoon (January 18) through much of the day Saturday (January 19). Total snowfall accumulations of 3-6" fell across the area, with the higher amounts of 7-9" in the Freeport, IL area. In addition, strong winds resulted in some blowing and drifting snow and hazardous travel conditions. A trained spotter reported 4.8" in Muscatine. Wind gusts of 20 to 30 mph caused blowing and drifting snow.

January 22-23, 2019: A significant winter storm system brought hazardous travel conditions to the region the afternoon and evening of Tuesday, January 22, through the morning of Wednesday, January 23. Freezing drizzle and rain fell for much of the morning and afternoon on Tuesday causing slick roads. Precipitation quickly changed to snow mainly north of a line from Keosauqua to Burlington. Snowfall totals of 2-6" were common over much of eastern Iowa and northwest Illinois. Rainfall totals over three quarters of an inch were seen over west central and north central Illinois. Snowfall reports ranged from 5.5" two miles north of Muscatine to 7.2" from a trained spotter in Muscatine.

February 11-12, 2019: A winter storm moved from the southern Plains into the Great Lakes Monday, February 11 into Tuesday, February 12, bringing snow, freezing rain, and some sleet to the area. Significant snow accumulations of 6-9" fell across portions of northeast Iowa and far northwest Illinois. Ice accumulations from freezing rain ranged from a light glaze to around two tenths of an inch, especially in parts of northwest Illinois. This storm was preceded by two other icing events, on February 5 and 7. The storm on the 12th combined with preexisting ice and strong west winds between 40-50 mph caused widespread tree limb, power pole, and power line damage across eastern Iowa and northwest Illinois. A trained spotter reported 3.5"of snow in Muscatine, Iowa along with 0.25 ice accumulation. Significant blowing and drifting snow was widespread over the area with white out conditions at times lingering through the day of February 12. Power outages from down power lines, power poles, and tree branch damage were widespread.

Probability: Most Iowa counties can usually expect two or three winter storms per season with an extreme storm every 3 to 5 years on average. A snowfall of six inches or more from one storm only occurs in 49% of Iowa winters, while a large winter storm event of 10 inches or more will occur about once every 3 years. A simple average of recorded Muscatine County events yields about 5 days of winter storm incidents per year.

Magnitude/Severity: Hazardous driving conditions due to snow and ice on highways and bridges lead to many traffic accidents. About 70% of winter-related deaths occur in automobiles, and about 25% are people caught out in a storm. Those at risk are primarily either engaged in outdoor activity (shoveling snow, digging out vehicles, or assisting stranded motorists), or are elderly or very young. The 2010 *Iowa Hazard Mitigation Plan* reports that an average annual loss estimate of $86,771.80 from severe winter storms in Muscatine County. The 2013 *Iowa Hazard Mitigation Plan* does not list an amount for Muscatine County. The National Climatic Data Center Storm Event Database reported $497,000 in winter storm related property damage.

Warning Time: The National Weather Service (NWS) has developed effective weather advisories that are promptly and widely distributed via radio, TV, internet, and weather alert radios. Winter storm information is made available to public officials and the public up to days in advance.

Duration: Winter storms may affect a large area, although local variations in storm intensity and quantity of snow or ice may occur. The duration of the storm will be determined by the local response to snow removal and any associated losses and dangers of electrical outages.

Muscatine County Multi-Jurisdictional Hazard Priority Ranking: #7, Medium Priority

Sources	
State of Iowa, IHSEMD	*Iowa Hazard Mitigation Plan, 2010*
National Weather Service, Quad Cities	*http://www.crh.noaa.gov/dvn/*
National Climatic Data Center	*http://www.ncdc.noaa.gov/stormevents/*
FEMA	*http://www.ready.gov/winter-weather*
American Red Cross	*http://www.redcross.org/prepare/disaster/winter-storm*

Sinkholes and Land Subsidence

Land subsidence is a gradual settling or sudden sinking of the Earth's surface because of subsurface movement of earth materials that may impose a direct threat to life and property. Land subsidence can range from broad, regional lowering of the land surface to localized collapse such as a sinkhole. More than 80 percent of the identified land subsidence in the U.S. is induced by human activity on subsurface water. Examples include aquifer-system compaction from excessive groundwater withdrawal and drainage and subsequent oxidation of organic soils. Other human-related effects include underground mining of coal or rock, petroleum withdraw, natural compaction, and broken water or sewer mains in a localized area. Sudden and sometimes catastrophic subsidence is associated by localized collapse of subsurface cavities forming sinkholes. This type of subsidence is commonly triggered by ground water level declines from pumping. Sink holes are also formed due to the dissolution of the susceptible subsurface rocks such as limestone, dolomite, anhydrite, salt, or gypsum by constant water action resulting in collapse of the ground surface. This dissolution process can take many years in the areas of limestone or dolomite and can happen in hours or days in areas of anhydrite, salt, and gypsum.

Collapse of surface material into underground voids during the creation of a sinkhole is the most dramatic form of subsidence. Damage can consist of damaged or destroyed buildings or other structures, potential contamination of groundwater, and removal of land from productive use. Losses can also include business and personal losses that accrue during periods of repair. The sudden and unpredictable nature of sinkholes can result in the loss of human life.

Probability: Per the *Iowa Hazard Mitigation Plan 2013*, "Historic inventories estimate 2,596 sinkholes in the Upper Iowa River Watershed. However, there is no central collection point for this information." The Iowa Department of Natural Resources has no known records of land subsidence or sinkholes in Muscatine County. Depressions or sinks are identified on the *City of Muscatine, Iowa Comprehensive Plan (2002)* map of Development Constraints, although they are not mentioned in the 2013 plan. Within the corporate limits, several depressions or sinks are mapped in the northwest corner. Others are mapped to the north outside corporate limits. According to the Iowa DNR/IGS, these areas, which are mostly in sandy or alluvial areas, are not likely sinkholes. Karst areas located within Muscatine County are shown on Map 3-6. According to the Iowa DNR, a few small coal mines near Wyoming Hill in Montpelier Township operated before 1900. These mines are not in the IDNR database, but are discussed in the Muscatine County report and the Annual Report articles that deal with coal mining. Based on the minimal location information that these sources provide, it seems likely that the mines were adits/drifts located near the bluffs above the river (e.g. Wyoming Hill) and could contribute to instability of those slopes. In Muscatine County, the current risk of general land subsidence or formation of sinkholes is very low.

Magnitude/Severity: General land subsidence may pose a greater risk to property than to life. Sudden sinkhole formation may pose a threat to life. Significant damage to property, facilities, and infrastructure could occur if an actual sinkhole formed resulting in loss of land surface, undermined foundations, and destruction of structures.

Warning Time: Regional lowering occurs gradually over time, while the collapse of abandoned mines can occur suddenly.

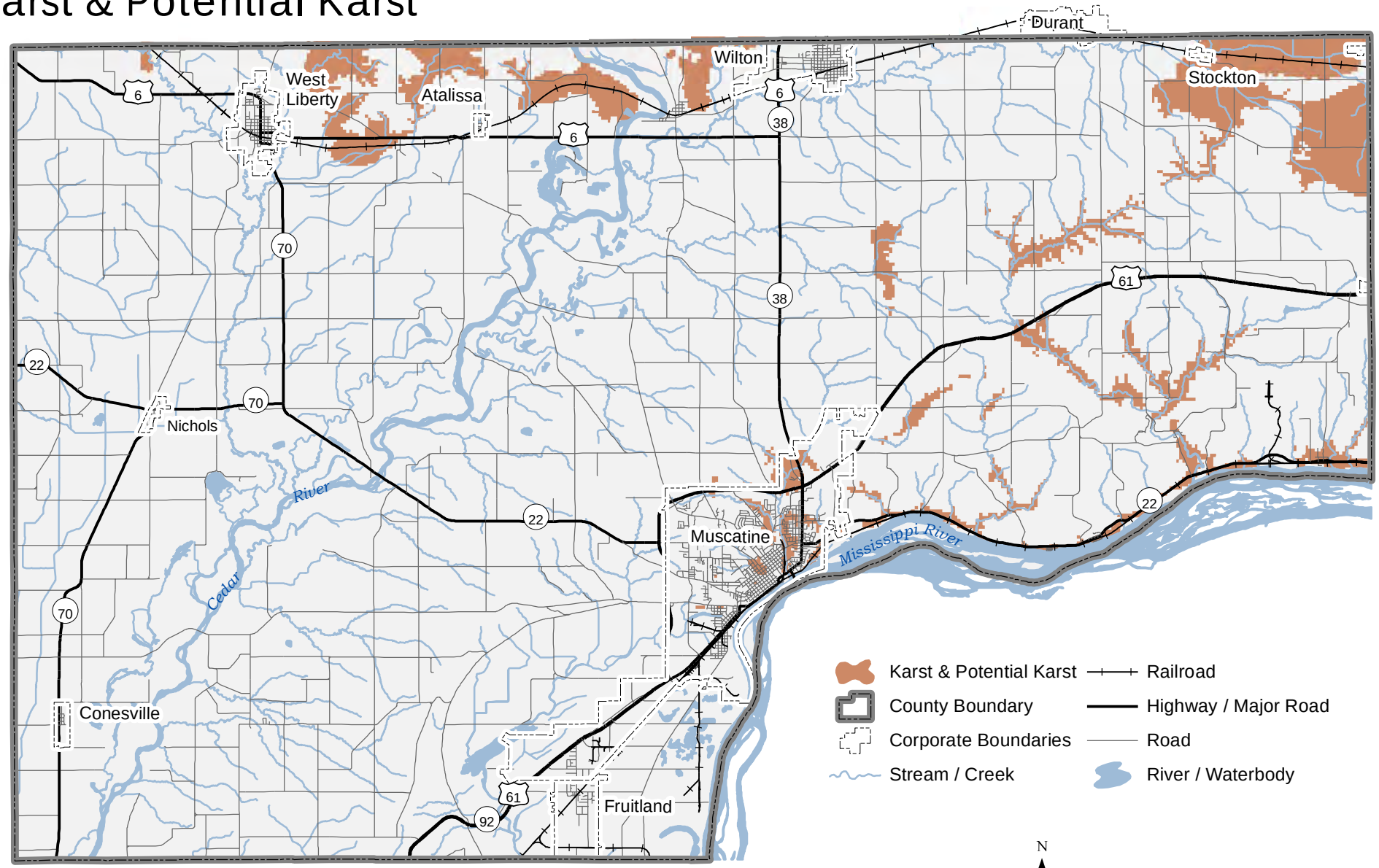
Duration: The response tied to sinkholes is related to securing the immediate threat to life and property including immediate reroute of traffic from the affected infrastructure and search and rescue in the case of structural collapse.

Muscatine County Multi-Jurisdictional Hazard Priority Ranking: #15, Low Priority

Sources	
FEMA	*"A Cornerstone of National Mitigation Strategy." July, 1997*
City of Muscatine	*Muscatine Comprehensive Plan 2002*
Iowa DNR Geological Survey Bureau Hazards and Interactive Karst & Sinkholes map	http://www.igsb.uiowa.edu/service/hazards.htm https://www.iowadnr.gov/environmental-protection/land-quality/animal-feeding-operations/mapping/karst-sinkholes
U. S. Geological survey	USGS Fact Sheet -165-00 Land Subsidence in the Unites States.
Panel on Land Subsidence, Committee on Ground Failure Hazards Mitigation Research, Division of Natural Hazard Mitigation, National Research Council Commission on Engineering and Technical Systems (CETS)	Mitigating Losses from Land Subsidence in the United States (1991)

Map 3.6

Karst & Potential Karst



Disclaimer: This map is for reference only. Data provided are Derived from multiple sources with varying levels of accuracy. Bi-State Regional Commission disclaims all responsibility for the accuracy or completeness of the data shown hereon.

Roads - Iowa DOT (2019)
Corporate Limits - MAGIC (2019)
County Boundary - IA DNR
Water Features - USGS
Karst - IA DNR (2017)

Map prepared by:
Bi-State Regional Commission
October 2019

Thunderstorms and Lightning

Thunderstorms are common in Iowa and can occur singly, in clusters, or in lines. A thunderstorm is a rain shower during which you hear thunder. Since thunder comes from lightning, all thunderstorms have lightning. Thunderstorms are usually created by surface heating, convection is upward atmospheric motion that transports whatever is in the air along with it—especially any moisture available in the air. A thunderstorm is the result of convection.

Most thunderstorms produce only thunder, lightning, and rain. A thunderstorm is classified as "severe" when it contains one or more of the following: hail one inch or greater, winds gusting in excess of 50 knots (57.5 mph), or a tornado. Thunderstorms are most likely in the spring and summer months and during the afternoon and evening hours, but they can occur year-round and at all hours.

Thunderstorms have caused other hazards such as damaging straight-line winds, hail, flash flooding, river flooding, and tornadoes. The associated hazards related to thunderstorms are discussed further as separate hazards in this plan. Because thunderstorms may occur as single-cells, in multi-cell clusters, or in squall lines, several thunderstorms may affect the same area in the course of a few hours. This can lead to additional hazards such as land subsidence and landslides when soils on slopes become saturated. Land subsidence and landslides are also discussed as separate hazards for Muscatine County.

The National Weather Service classifies Supercell Thunderstorms as storms that are long-lived (greater than 1 hour) and highly organized that feed off an updraft (a rising current of air) that is tilted and rotating. This rotating updraft – as large as 10 miles in diameter and up to 50,000 feet tall – can be present as much as 20 to 60 minutes before a tornado forms. Scientists call this rotation a mesocyclone when Doppler radar detects it. The tornado is a very small extension of this larger rotation. Most large and violent tornadoes come from supercell thunderstorms.

A Mesoscale Convective System (MCS) is a collection of thunderstorms that act as a system. An MCS can spread across an entire state and last more than 12 hours. On radar, one of these storms might appear as a solid line, a broken line, or a cluster of cells.

Between 1980 and June 30, 2019, there were 160 thunderstorm/windstorm events within Muscatine County, according to the National Climatic Data Center. The data for thunderstorms also includes other high wind events. Since windstorms are a separate hazard profile for Muscatine County, high wind events exceeding 63 knots will be discussed in that profile. Because most of those windstorms were also associated with thunderstorms, they were not removed from the total number of thunderstorm events. It is common to have multiple entries in the database per day; however, that is being interpreted as separate storm, multiple storm events that can occur in quick succession.

Lightning is an electrical discharge that results from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt." This flash of light usually occurs within the clouds, in the air, or between the clouds and the ground. A bolt of lightning reaches temperatures approaching 50,000 degrees Fahrenheit in a split second. This rapid heating, expansion, and cooling of air near the lightning bolt creates thunder.

The National Climatic Data Center storm events database lists lightning separately from thunderstorm/windstorm. There have been four events recorded. The recorded event dates span from the months of March through August. Though not in the National Climatic Data Center, on May 4, 2015, two males were struck by lightning while on horseback rounding up cattle near the 2500 block of 150 Street in rural Muscatine. One was treated and released while the other died from the lightning strike.

Probability. Globally, some 2000 on-going thunderstorms cause about 100 lightning strikes to earth each second. USA insurance company information shows one homeowner's damage claim for every 57 lightning strikes. Data about commercial, government, and industrial lightning-caused losses is not available. Annually, in the U.S.,lightning causes more than 26,000 fires with damage to property (NLSI estimates) in excess of $5-6 billion.

Lightning strikes the ground approximately 25 million times each year in the U.S. According to the NWS, the chance of an individual in the U.S. being struck during a given year is one in 1.2 million. Assuming an average life span of 80 years, a person's odds over their lifetime becomes one in 15,300.

The SHMT analysis evaluated the probability that thunderstorms and lightning affect Iowa as highly likely in any given year. In Muscatine County, that translates to about four thunderstorms annually. With Iowa's location in the interior of the U.S., there is a very high probability that a few thunderstorms will become severe and cause damage. Because of the humid continental climate that Iowa experiences, ingredients of severe thunderstorms are usually available (moisture to forms clouds and rain, relatively warm and unstable air that can rise rapidly, and weather fronts and convective systems that lift air masses).

Magnitude and Severity. Severe thunderstorms can be quite expansive with areas of localized severe conditions. Most severe thunderstorm cells are 5 to 25 miles wide with a larger area of heavy rain and strong winds around the main cell. Most non-severe thunderstorms have a lifespan of 20 to 30 minutes, while severe thunderstorms last longer than 30 minutes.

Like tornadoes, thunderstorms and lightning can cause death, serious injury, and substantial property damage. The power of lightning's electrical charge and intense heat can electrocute people and livestock on contact, split trees, ignite fires, and cause electrical and communications failures. Thunderstorms can also bring large hail that can damage homes and businesses, break glass, destroy vehicles, and cause bodily injury to people, pets, and livestock.

High winds can damage trees, homes (especially mobile homes), and businesses, and can blow vehicles off the road. Straight-line winds are responsible for most thunderstorm damage. One or more severe thunderstorms occurring over a short period (especially on saturated ground) can lead to flooding and cause extensive power and communication outages as well as agricultural damage. The 2010 *Iowa Hazard Mitigation Plan* estimates that losses from lightning and thunderstorms totals approximately $168,941 annually in Muscatine County. The National Climatic Data Center Storm Event Database lists $2,817,000 in property damage and $167,050 in crop damage from thunderstorm, lightning, and wind events.

Anyone in the path of a severe thunderstorm is at risk, with those in unprotected areas, mobile homes, or automobiles during a storm at a more pronounced risk. Sudden strong winds often accompany a severe thunderstorm and may blow down trees across roads and power lines.

Lightning presents the greatest immediate danger to people and livestock during a thunderstorm. Cloud-to-ground lightning can kill or injure people by direct or indirect means. The lightning current can branch off to a person from a tree, fence, pole, or other tall object. The current also may travel through power or telephone lines or plumbing pipes to a person who is in contact with an electric appliance, telephone, or plumbing fixture. About 10% of those struck by lightning are killed. From 2009-2018, the U.S. averaged 27 lightening fatalities per year

Similarly, objects can be directly struck resulting in an explosion, burn, or total destruction. Alternatively, the damage may be indirect when the current passes through or near it. Sometimes, current may enter a building, transfer through wires or plumbing, and damage everything in its path. In urban areas, it may strike a pole or tree, and the current then travels to several nearby houses and other structures and enter them through wiring or plumbing.

Hail can be very dangerous to people, pets, and livestock if shelter is not available. Flash floods and tornadoes can develop during thunderstorms as well. People who are in automobiles or along low-lying areas when flash flooding occurs can become trapped or swept away. Because of the way they are constructed, mobile homes, and recreational vehicles such as campers, recreational trailers, motorhomes, houseboats, sailboats, and yachts are vulnerable to the effects of severe thunderstorms. For more details on the vulnerabilities from the flooding and tornado hazards, see those specific hazard profiles.

Warning Time. Some thunderstorms can be seen approaching, while others hit without much warning. The National Weather Service issues severe thunderstorm watches and warnings as well as statements about severe weather and localized storms. These messages are broadcast over NOAA Weather Alert Radios and are TV and radio stations. Advances in weather prediction and surveillance have increased the accuracy of storm location and direction. Weather forecasting and severe weather warnings issued by the National Weather Service usually provide residents and visitors with adequate time to prepare. Isolated problems arise when warnings are ignored.

Duration. The immediate response related to severe thunderstorms and lightning events are more aptly associated with the cascading effects of multiple events occurring over a short time period in the case of flash and river flooding, and particularly severe thunderstorm events in the case of tornadoes. Response to thunderstorm events is relatively minor in scope.

Muscatine County Multi-Jurisdictional Hazard Priority Ranking: #5, High Priority

Sources	
Iowa Homeland Security Emergency Management Division	Iowa Hazard Mitigation Plan 2010 and 2013
National Climatic Data Center	*http://www.ncdc.noaa.gov/oa/climate/severeweathe/extremes.html*
NOAA - The National Severe Storm Laboratory	*https://www.nssl.noaa.gov/*
National Lightning Safety Institute	*http://lightningsafety.com/nlsi_lhm/lpts.html*
Muscatine County	Muscatine County Multi-Jurisdictional Hazard Mitigation Plan 2010
Other	Individual Accounts and news coverage of recent events
KWQC	*http://kwqc.com/2015/05/05/one-dead-after-lightning-strike-in-muscatine-county/*

Tornado

Tornadoes form during thunderstorms when warm, humid air collides with colder air to form a swirling vortex that extends down from the clouds and sometimes reaches the ground where it can cause extensive damage. Tornadoes can have rotating wind speeds that exceed 300 mph and travel across the ground at average speeds of 25 to 30 mph. A tornado can be a few yards to about a mile wide where it touches the ground, but an average tornado is a few hundred yards wide. It can move over land for distances ranging from short hops to many miles, causing great damage wherever it descends. The tornado is made visible by the dust sucked up and by condensation of water droplets in the center of the tornado.

More than one tornado vortex can descend from the same storm supercell. A multiple-vortex tornado is a tornado that contains several vortices (called subvortices or suction vortices) rotating around, inside of, and as part of the main vortex. The only times multiple vortices may be visible are when the tornado is first forming or when condensation and debris are balanced such that subvortices are apparent without being obscured. They can add over 100 mph to the ground-relative wind in a tornado circulation, and are responsible for most (if not all) cases where narrow arcs of extreme destruction lie right next to weak damage within tornado paths. On rare occasions, separate tornadoes can form close to one another as satellite tornadoes. A satellite tornado develops independently from the primary tornado, not inside it as with a subvortex. The tornadoes are separate and distinct as the satellite tornado orbits its much larger companion within the same mesocyclone. Their cause is unknown, but they seem to form most often near exceptionally large and intense main tornadoes.

The size and shape of a tornado does not give an indication of tornado strength. Wedge shaped and rope shaped tornadoes can both cause EF 4-5 damage.

In the U.S., Iowa is ranked third in the number of tornadoes per 10,000 square miles. Between 1985 and 2014, Iowa averaged approximately 47 tornadoes per year. In Iowa, most tornadoes occur in spring and summer months, but they can and have occurred in the fall and winter months. Tornadoes are most common in late afternoon to evening hours, but they can occur at any time of the day.

According to the National Climatic Data Center, there were 40 tornado reports for Muscatine County between January 1, 1950 and July 1, 2017. This number does not clearly represent individual tornado events, since there are duplicate reports for the same event or, in one case, multiple tornadoes on the same day. By analyzing the reports and including the most recent tornadoes, there appears to be 22 separate tornado events with an average interval of three years over the reporting period. Most of the reports are of F0 or F1 tornados. Notable events include:

May 23, 1966 and May 07, 1967: F2 tornadoes reported for both of these dates with $250,000 and $25,000 in property damage respectively.

May 09, 1995: Numerous small and brief tornadoes of F0 and F1 intensity touched down west of Muscatine and south of Wilton with most damage from hail. One of the tornadoes occurring on this date is reported as F3 traveling 10 miles between Stockton and New Liberty. Property damage from this one tornado reported at $650,000.

June 14, 2001: An F2 tornado touched down east/northeast of Montpelier near Highway 22 and the Muscatine/Scott County line.

August 21, 2002: An F1 tornado touched down north of Muscatine near Highway 38. Extensive damage to a machine shed was reported. Corn was flattened in spots and trees blown down starting at the Municipal Golf Course and along its path.

April 13, 2006: A tornado developed 4.2 miles west southwest of Muscatine and moved across the U.S. 61 bypass and Highways 92 and 61 across the south edge of Muscatine. The tornado moved into the Mississippi River and crossed over into Rock Island County, Illinois. Intermittent F0 damage to trees and outbuildings was noted while in Iowa.

June 01, 2007: A tornado entered into Muscatine County from Louisa County just south of Fruitland. It progressed through the center of Fruitland destroying the post office and city hall buildings, numerous homes, and overturning some railroad cars. The tornado weakened as it approached the southwest portions of Muscatine. In Muscatine, the western sections of the city had varying degrees of damage, mainly confined to roof damage. At a car dealership, some cars were displaced. The tornado eventually lifted on the northeast side of Muscatine near the junction of Highways 22 and 61. Debris from Muscatine and Fruitland fell in Lowden, IA. The super cell re-intensified as it entered the southeast part of Cedar County producing a brief tornado near Wilton. The F3 tornado is reported at 774 yards in major width and traveling 10 miles with property damage of $15 million.

April 25, 2008: The tornado touched down 5.2 miles northeast of Nichols and tracked to the northeast before lifting 2 miles west of Moscow. The EF2 tornado was on the ground for 6.5 miles, had maximum winds to 115 mph, and was 150 yards wide. Five farmsteads were hit by the tornado, but no injuries were reported. Property damage was reported at $200,000.

May 13, 2013: An EF1 tornado near Todd's Ferry Road and 260th Street occurred at 3:10 p.m. This tornado travelled 6.5 miles. There were no injuries.

June 24, 2013: An EF1 tornado was spotted along Highway 61 in Muscatine just before 3:30 p.m. The tornado hit Krieger's Collision Center causing one fatality. The storm also caused damage to a church, hotel, and several other businesses. Damage continued down New Era Road where several farmsteads were also damaged. Damage estimate was over $500,000.

October 6, 2016: An EF1 tornado touched down northwest of the intersection of N Mulberry Road and Bayfield Road at 9:07 p.m. The tornado travelled 9.52 miles and was 30 yards wide. There were no injuries reported.

March 6, 2017: An EF2 tornado touched down in Kent Stein Park at about 10:05 p.m. This tornado traveled 1.78 miles to the northeast to downtown Muscatine. This tornado caused three injuries, and $100,000 in damage was reported.

March 6, 2017: An EF2 tornado touched down near Wild Cat Den Road and Highway 22. This tornado travelled over 25 miles and was 1,000 yards wide. No injuries were reported. Damage reported was $2,000.

Probability. The SMHT analysis evaluated the probability that damaging tornadoes will occur in Iowa is highly likely in any given year. Using the number of events in Muscatine County over the recording period, it is likely that a tornado event will occur every three years.

Magnitude and Severity. The rating scale used to rate tornado intensity is called the Fujita Scale that estimates wind speeds based on the damage caused by the tornado. This scale has been recently revised as the Enhanced Fujita (EF) Tornado Scale, which includes additional enhanced descriptions of damage to multiple types of structures and vegetation with photographs, a PC-based expert system, and enhanced training materials. The Enhanced Fujita scale replaced the original as of February 1, 2007 in all tornado damage surveys done in the United States.

The Enhanced Fujita (EF) Scale

Fujita Scale			Operational EF Scale	
F Number	Fastest ¼ mile (mph)	3-Second Gust (mph)	EF Number	3-Second Gust (mph)
0	40-72	45-78	0	65-85
1	73-112	79-117	1	86-110
2	113-157	118-161	2	111-135
3	158-207	162-209	3	136-165
4	208-260	210-261	4	166-200
5	261-318	262-317	5	Over 200

Those most at risk from tornadoes include people living in mobile homes, campgrounds, and other dwellings without secure foundations or basements. People in automobiles and trucks are also very vulnerable to tornadoes. The elderly and those with physical or mental disabilities are most vulnerable for many reasons including mobility impairments that allow them to escape the path of destruction. People who may not understand the terminology of National Weather Service tornado watches and warnings due to language, mental, or educational barriers are also at high risk. Visitors to the county may be unfamiliar with tornadoes and procedures to follow when warnings are given. They be unfamiliar with their surroundings and not know where to go for safety. They may not know city or county location names given in the broadcast warnings.

Generally, the destructive path of a tornado is only a couple of hundred feet in width, but stronger tornadoes can leave a path of destruction up to a mile wide. Normally, a tornado will stay on the ground for no more than 20 minutes; however, one tornado can touch ground several times in different areas. Large hail, strong straight-line winds, heavy rains, flash flooding, and lightning are also associated with severe storms and may cause significant damage to a wider area. The 2013 *Iowa Hazard Mitigation Plan* estimates that losses from tornadoes in Muscatine County total approximately $289,000 annually. According to the National Climatic Data Center Storm Event Database, $18,809,000 in property damage and $5,000 in crop damage were estimated to have occurred within Muscatine County from 1950-2017.

Effects can range from broken tree branches, shingle damage to roofs, and some broken windows all the way to the complete destruction and disintegration of well-constructed structures, infrastructure, and trees. Tornadoes can affect many critical services, mainly electrical power. Buried services are not as vulnerable, but can be affected by their system components that are above ground.

Whole towns have been known to be "wiped off the map." Economic effects can result from direct damages to facilities or business disruption from the lack of critical services such as power, gas, or water. This is considered a countywide hazard. While a tornado is unlikely to affect the entirety of the county on any given occurrence, tornadoes are likely to strike anywhere within the county.

Warning Time. Tornadoes strike with an incredible velocity. Wind speed may exceed 300 miles per hour, and the storm can travel across the ground at more than 70 mph. The advancement in weather forecasting has allowed watches to be delivered to those in the path of these storms for up to hours in advance. The best lead-time for a specific severe storm and tornado 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 due to darkness, blowing dust, driving rain, and hail.

Duration. The response to a tornado event is tied to responding to the immediate threat to life and property immediately following the tornado event and in the shelter of affected families and individuals.

Muscatine County Multi-Jurisdictional Hazard Priority Ranking: #1, High Priority

Sources	
National Climatic Data Center Enhanced Fujita Scale	*http://www.ncdc.noaa.gov/oa/satellite/satelliteseye/educational/fujita.html*
National Climatic Data Center	*http://ncdc.noaa.gov/oa/climate/severeweather/extremes.html*
Iowa Homeland Security Emergency Management Division	*Iowa Hazard Mitigation Plan 2013*
Muscatine County	*Muscatine County Multi-Jurisdictional Hazard Mitigation Plan 2010*
Iowa Weather Blog	*http://iowawx.com/2013/06/25/muscatine-tornado-on-monday-was-an-ef1/*

Windstorms

Windstorms can be described as extreme winds associated with severe winter storms, severe thunderstorms, downbursts, and very strong pressure gradients. Windstorms, other than tornados, are experienced in all regions in the United States. It is difficult to separate the various wind components that cause damage from other natural events that often occur with or generate windstorms.

Damaging winds are often called "straight-line" winds to differentiate the damage they cause from tornado damage. Strong thunderstorm winds can come from a number of different processes. Most thunderstorm winds that cause damage at the ground are a result of outflow generated by a thunderstorm downdraft. Damaging winds are classified as those exceeding 50-60 mph.

Types of damaging winds that can affect Iowa:

Straight-line wind is a term used to define any thunderstorm wind that is not associated with rotation, and is used mainly to differentiate from tornadic winds.

A **downdraft** is a small-scale column of air that rapidly sinks toward the ground.

A **macroburst** is an outward burst of strong winds at or near the surface with horizontal dimensions larger than 4 km (2.5 mi) and occurs when a strong downdraft reaches the surface. To visualize this process, imagine the way water comes out of a faucet and hits the bottom of a sink. The column of water is the downdraft and the outward spray at the bottom of the sink is the macroburst. Macroburst winds may begin over a smaller area and then spread out over a wider area, sometimes producing damage similar to a tornado. Although usually associated with thunderstorms, macrobursts can occur with showers too weak to produce thunder.

A **downburst** is the general term used to broadly describe macrobursts and microbursts. Downburst is the general term for all localized strong wind events that are caused by a strong downdraft within a thunderstorm, while microburst simply refers to an especially small downburst that is less than 4 km across.

A **gust front** is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes the winds push up air above them, forming a shelf cloud or detached roll cloud.

A **derecho** is a widespread, long-lived windstorm that is associated with a band of rapidly moving showers or thunderstorms. A typical derecho consists of numerous microbursts, downbursts, and downburst clusters. By definition, if the wind damage swath extends more than 240 miles (about 400 kilometers) and includes wind gusts of at least 58 mph (93 km/h) or greater along most of its length, then the event may be classified as a derecho.

These events can produce straight-line winds in excess of 64 knots causing some power outages, property damage, impaired visibility, and crop damage.

In 2011, Iowa had two Presidentially Declared Disasters that included straight-line winds in the disaster description. The NCDC shows Iowa has experienced four instances where recorded

winds equaled or exceeded 100 knots since 2009. From 2000- 2013, Iowa experienced 78 instances of wind speeds at or exceeding 70 knots.

Historically, windstorms are associated with severe thunderstorms and blizzards. The National Weather Service has developed a windstorm warning system similar to other events such as tornado, winter storm, and thunderstorm. Watches are issued when conditions are favorable for windstorms to develop, and they come 12 to 24 hours in advance. Advisories are issued when existing or imminent high winds cover part or all of the forecast area and pose a threat to life and property.

Based on historical averages, Iowa would expect to have 15 to 20 wind events each year where wind speeds exceed 64 knots (73 mph). (Note: 1 knot = 1.15155 mph). Since 1987, Muscatine County has experienced 16 events where wind speeds exceeded 64 knots, according to the National Climatic Data Center storm events database.

June 29, 1998: Super-cell thunderstorms developed over Central Iowa and rapidly intensified into a long squall line that raced southeast over Eastern Iowa into Central Illinois. Numerous funnel clouds were sighted along the leading edge of the storm, and a few non-super-cell tornadoes were masked within a large area of damaging winds. Straight-line winds from 60 to over 120 mph produced the most serious damage with these storms and eight counties in Eastern Iowa, including Muscatine County, were declared disaster areas. Across Muscatine County, Kimberly Park, Wapsi Park, and the Oakridge Cemetery all lost several large trees. About 30 percent of large trees were destroyed at Weed Park in Muscatine. Of those remaining, 80 percent were damaged. Preliminary figures had 65 homes suffering $150,000 in damage, while seven businesses sustained $900,000 in losses. The roof at Muscatine High School received $75,000 worth of damage, and the rain damaged the gym floor. Several people were treated at Muscatine General Hospital for cuts and other minor weather-related injuries. In the Conesville and Nichols areas, some farms lost 90 percent or more of their corn crops. Wind speed reported at 78 knots (90 mph) is highest for Muscatine County for the reporting period starting from 1/1/1950.

July 8, 2001: Thunderstorms moved over eastern Iowa and redeveloped for a second time later the same day, producing heavy rain of 1 to 2 inches per hour. Numerous trees down and debris in the streets were reported in the City of Muscatine by emergency management. There were many reports of strong winds with gusts as high as 75 to 80 mph.

July 6, 2003: A strong thunderstorm travelled across Southern Cedar and Northern Muscatine counties during the early afternoon. A microburst about a mile in diameter occurred along the Cedar/Muscatine line between Wilton and Durant. Wind was reported at 65 knots (75 mph).

June 8, 2008: Wind gusts estimated to be 75 mph (65 knots) were observed about 3 miles south of Nichols. Thunderstorms produced widespread wind damage with winds between 60 and 90 mph with nickel-sized hail and very heavy rain.

June 14, 2008: A trained spotter reported a large 3-foot diameter tree blown down about two miles northwest of Muscatine. The thunderstorm system produced large hail and damaging winds across parts of eastern Iowa into northwest Illinois. Wind magnitude was reported at 70 knots (80 mph).

June 19, 2009: A cold front pushed through Iowa and Illinois during the afternoon and evening of June 19 bringing severe thunderstorms and flooding to much of the area. Winds in excess of 70 mph were reported with some of the storms as they passed through the areas toppling trees and causing structural damage. In addition to the high winds, torrential downpours were common with the storms with 1-3 inches of rain in one to two hours. Wind gusts estimated to be 85 mph blew down several 20-inch diameter tree limbs in Nichols. A fence was also blown away.

May 19, 2013: Winds of 53 knots were recorded by ASOS at the Muscatine Municipal Airport. A very unstable air mass on May 19, 2013 led to the development of severe thunderstorms that produced large hail and damaging winds. Temperatures were in the 80s with dew points around 70 with a mid-level speed maximum rotating around the base of a developing upper low in the Plains states. This increased the deep layer shear during the afternoon and evening hours. Some of the storms produced golf to baseball size hail and 70 to 80 mph winds.

May 30, 2013: A trained spotter four miles north northwest of Muscatine reported 65-knot winds. A cold front pushing into a very moist and unstable air mass triggered numerous severe thunderstorms. Deep layer shear was moderate to strong, and freezing levels were in the 11-12k foot level, which was ideal for large hail. The storms produced damaging winds, large hail, and several weak tornadoes. An EF1 tornado touched down in Andalusia, IL around 4:45 p.m. CDT and traveled due north. This weak tornado crossed the Mississippi River and moved through eastern sections of Buffalo, IA. Wind speeds were estimated to be 95 mph. Some large trees were snapped and uprooted along the path. Some of the trees fell onto houses. A trained spotter estimated winds of 65 to 75 mph.

June 24, 2013: A trained spotter two miles north northeast of Muscatine reported 65-knot winds. A disturbance moving northeastward from northern Missouri into eastern Iowa led to the development of a severe squall line with bowing segments that produced widespread wind damage across eastern Iowa north of a line from Jefferson to Louisa County. An EF-1 tornado touched down in the city of Muscatine with damage in the business district and one fatality. A trained spotter estimated a thunderstorm wind gust of 75 mph.

May 21, 2014: A trained spotter recorded 52-knot winds at Stockton, IA. Warm and muggy conditions were found across the region on May 20 as a cold front tracked east across Iowa. A strong line of showers and thunderstorms developed ahead of the front and affected areas mainly between Highway 20 and Highway 30 in Iowa as well as Carroll and Jo Daviess Counties in Illinois. Very large hail fell with the stronger storms with hail sizes as large as golf balls over Dubuque, Jackson, and Jones Counties in Iowa. Torrential rains were also common with these storms. Elsewhere, dry and warm conditions were found. High temperatures were in the mid to upper 80s. Wind gusts estimated to be 60 mph were observed about 2 miles west of Walcott, IA on May 21.

June 17, 2014: Winds of 50 knots were recorded at Stockton, IA by a trained spotter. Strengthening midlevel winds along with a strong low-level jet in place later in the evening and overnight on June 17 produced widespread damaging winds of 60 to 70 mph. Strong warm air advection triggered more severe thunderstorms during the late evening of June 17. A trained spotter reported several 5 to 6 inch diameter tree limbs down.

July 6, 2015: Winds of 65 knots were recorded at Fruitland, IA. A cold front passing late in the afternoon spawned scattered thunderstorms that produced a few severe storms and localized heavy rains that resulted in a couple of flash flooding events. Utility poles and several trees were down near Fruitland Road and Spitz Drive. The time of the event was estimated from radar. Damages of $2,000 was reported.

July 6, 2015: The Muscatine Municipal Airport recorded 59-knot winds. A cold front passing late in the afternoon spawned scattered thunderstorms that produced a few severe storms and localized heavy rains that resulted in a couple of flash flooding events.

February 19, 2016: A strong low-pressure system moving just north of Iowa brought a very strong cold front through Iowa and Illinois. Behind this cold front, sustained west winds of 35 to 40 mph gusted frequently to 60 to 63 mph over all of eastern Iowa and northern Illinois generally along and north of Interstate 80. AWOS observations from eastern Iowa airports along and north of Interstate 80 began reporting winds gusts of 50 to 60 mph around 11 a.m. and continued until around 3 p.m. The peak winds for all areas occurred around 1 p.m.

June 22, 2016: The Muscatine Municipal Airport recorded 57-knot winds. The afternoon of June 22 saw strong to severe thunderstorms form over eastern Iowa, and moved into northern Illinois. The storms became supercell thunderstorms as they moved into Illinois and produced tornadoes over portions of northern Illinois, along with wind damage and hail. Iowa DOT AWOS observations at Muscatine airport reported 66 mph.

July 13, 2016: Winds of 52 knots were recorded one mile west of Muscatine, IA. A cold front moved across the area spawning numerous severe thunderstorms with damaging winds during the afternoon hours. A trained spotter reported several branches were down varying in size from two to 18.5 inches in diameter along Peartree Lane. A trained spotter reported a single 16.5-inch diameter tree branch was down near the Wildcat Den State Park.

October 6, 2016: Winds of 64 knots were recorded at Fairport, IA. Low pressure brought strong thunderstorms over Iowa and Illinois the evening of October 6, 2016. Just ahead of the low's path, a warm front was positioned over Iowa and Illinois near Interstate 80. This allowed for winds supporting tornadoes to develop with the strongest storms. A cluster of strong to severe storms moved from near Ottumwa, Iowa, northeast through Scott County, with several areas of damaging winds and tornadoes along the path from Louisa and Muscatine Counties, through Scott County, and into portions of Rock Island County, Illinois before ending. A storm survey team found broken off hardwood tree branches between 1 and 3 inches in diameter and uprooted hardwood trees due to straight-line winds.

March 6, 2017: Winds of 59 knots were recorded at the Muscatine Municipal Airport and in other locations in Muscatine County. A line of severe storms tracked east over eastern Iowa, northwest Illinois, and northeast Missouri during the evening of March 6. Widespread winds over 70 mph, small hail, and several tornadoes were reported. Damage from these storms included downed trees, power poles, destroyed outbuildings, and roof damage to several homes. Some damage was reported to a local residence's carport. A tree was damaged and power lines were down. A tree fell on a roof, near the vicinity of Schiller and Taylor Streets in Muscatine.

June 17, 2017: Winds of 56 knots were reported one mile west of Muscatine, IA, and 78 knot winds were reported two miles north northeast of Ardon. Supercell thunderstorms developed in Iowa, near Muscatine County the afternoon of June 17. They produced large hail, heavy rain, and very high winds that caused damage to trees and some structures. As the storms moved into Illinois, they increased in number, and produced a few more areas of damage. A small tree was blown over west of Muscatine. In the area of Ardon, the National Weather Service storm survey concluded that straight-line winds caused widespread damage to trees, along with a roof blown off a structure that then hit a house. Damage to roofing of several structures was noted.

July 10, 2017: Winds of 61 knots were reported at Conesville, IA. A stalled boundary produced a couple of rounds of severe storms with very heavy rain producing flash flooding, several reports of damaging winds of 60 to 70 mph, and isolated, large hail in the afternoon and lasting into the overnight hours. Wind damage was estimated at $3,000.00.

July 21, 2017: Winds of 50 knots were reported one mile west of Muscatine. Another round of convective storms fired along a stalled boundary and lasted overnight resulting in a major heavy rain and flooding event from three to over 8 inches of rain falling. Some storms become severe with damaging winds over 60 mph and isolated large hail. A trained spotter reported a few 2 to 4 inch diameter branches were down within the city of Muscatine. In addition, two 5 to 8 inch diameter tree limbs were down from soft wood trees.

July 13, 2018: Winds of 52 knots were reported one mile southeast of West Liberty, IA. A weak low-pressure system produced scattered thunderstorms in eastern Iowa and northwestern Illinois in the late afternoon into early evening hours. These storms produced damaging winds of 60 to over 70 mph A public report was received via social media of 5 to 6 inch in diameter tree limbs down. The time was estimated by radar.

August 28, 2018: Winds of 50 knots were reported at Muscatine Municipal Airport. A powerful line of thunderstorms developed ahead of a cold front that moved across eastern Iowa during the late afternoon and evening hours of August 28. The line of thunderstorms produced damaging winds mainly south of a line from Cedar Rapids to Clinton Iowa. This line of storms also produced a tornado that traveled across Scott and Clinton Counties. There were also swaths of more intense damaging winds in Clinton, Henry, Iowa, and Scott Counties. The heaviest rain fell south of Interstate 80, where 2 to 4 inch amounts were reported.

September 18, 2018: Nichols, IA had winds reports at 50 knots. A slow moving cool front and moist air produced scattered thunderstorms with isolated damaging winds of 60 mph or more. Law enforcement reported large trees down, blocking the road.

February 24, 2019: A strong storm system brought heavy rain and strong winds to all of eastern Iowa, northwest Illinois, and northeast Missouri. On the backside of this storm, high winds swept through the region, with wind gusts over 60 mph common over locations generally along and north of Interstate 80 in Iowa and Illinois. A wind gust to 55 mph was reported as part of a long duration high wind event.

June 30, 2019: A line of thunderstorms tracked southeast across northeast Iowa into eastern Iowa and northwest Illinois during the afternoon and evening of Sunday, June 30, 2019,

bringing widespread downed trees and power lines as 50-70 mph winds rolled through. Wind speed was recorded as 56 knots one-mile west of Muscatine.

Probability. Large-scale extreme wind phenomena are experienced over every region of the United States. Damage from severe thunderstorm winds account for half of all severe weather reports in the lower 48 states and is more common than damage from tornadoes. Historically, high wind events are associated with severe thunderstorms and blizzards. It is often difficult to separate windstorms and tornado damage when winds get above 64 knots (74 mph). Based on historical information, Muscatine County can expect to have 1-2 windstorms every one to two years. The SHMT determined the probability of storms with the potential to cause large-scale power outages to be 10-20% statewide in any given year.

Magnitude and Severity. The 2010 *Iowa Hazard Mitigation Plan* estimated that windstorms cause approximately $23,060 in losses in Muscatine County annually. There was not an update to this information in the 2013 plan. Since most thunderstorms produce some straight-line winds because of outflow generated by the thunderstorm downdraft, anyone living in thunderstorm-prone areas of the world is at risk for experiencing this hazard.

People living in mobile homes are especially at risk from injury and death. Even anchored mobile homes can be seriously damaged when winds gust over 80 mph. Winds from thunderstorms can cause EF-2 damage.

People in high profile vehicles such as semi and delivery trucks are very vulnerable to high winds. The elderly and those with physical, medical, sensory, or cognitive disabilities are most vulnerable for many reasons including mobility impairments that would hinder their ability to escape the path of destruction. People who may not understand the terminology of National Weather Service high wind watches and warnings due to language, cognitive, or educational barriers are also at high risk. Visitors to the county may be unfamiliar with the various types of high winds and procedures to follow when warnings are given. They may be unfamiliar with their surroundings and not know where to go for safety. Unlike tornadoes, straight-line winds may have a destructive path that is tens of miles wide and several hundred miles long. Large hail, heavy rains, flash flooding, and lightning are also associated with severe storms and may cause significant damage to a wider area. Effects can range from broken tree branches, shingle damage to roofs, and some broken windows all the way to the complete destruction of well-constructed structures, infrastructure, and trees. Crop damage is often associated with straight-line winds, laying down crops, breaking stalks, and twisting plants, reducing yield, and making it difficult to harvest.

Damaging straight-line winds can affect many critical services that rely on electrical power if the transmission system is damaged and power is disrupted. Disruption of critical services can also affect operations. Employees may be affected and unable to get to or attend work. Economic effects can result from direct damages to facilities or business disruption from the lack of critical services such as electrical power.

Warning Time. Wind speeds can reach up to 100 mph and can produce a damage path extending for hundreds of miles. These winds can uproot trees and structures and turn harmless objects into deadly missiles, all in a matter of seconds. The advancement in weather forecasting has allowed watches to be delivered to those in the path of these storms up to hours in advance. The best warning lead-time for a specific storm is about 30 minutes.

Duration. The response tied to windstorm events is one directly related to the immediate protection of vulnerable populations from the direct threat to life and property. Response time is limited to event duration and immediate impact.

Muscatine County Multi-Jurisdictional Hazard Priority Ranking: #2, High Priority

Sources	
Iowa Homeland Security Emergency Management Division (HSEMD)	*Iowa Hazard Mitigation Plan, 2010 and 2013*
National Climatic Data Center	*http://ncdc.noaa.gov/oa/climate/severeweather/extremes.html*
Muscatine County	*Muscatine County Multi-Jurisdictional Hazard Mitigation Plan 2010*

Assessing Vulnerability: Overview

This section analyzes the county's vulnerability to natural and man-made hazards in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities. The first part is a general profile of Muscatine County that describes the county's characteristics and its historic development.

Community Profile: Muscatine County, Iowa

Geography and Land Use

Muscatine County is located in east-central Iowa. The county is bounded by Cedar County to the north, Scott County on the northeast, the Mississippi River and Rock Island County, Illinois, on the east, Louisa County on the south, and Johnson County on the west. Muscatine is the largest city and the county seat. Other cities include West Liberty, Wilton, Nichols, Atalissa, Stockton, Fruitland, and Conesville.

The soils in Muscatine County are nearly level, gently sloping (0-5 percent) prairie-derived soils developed from alluvium along the Cedar River and Wapsinonoc Creek valleys. The Mississippi River Valley soils are gently sloping to steep (2-25 percent) forest-derived soils developed from loess or pre-Wisconsin till. Separating these two valley soils are gently to strongly sloping (1-14 percent) prairie to forest-derived soils developed from loess. Predominantly, these soils are moderately well- to well-drained soils and do not contribute to the flooding conditions.

The Cedar River travels across the western half of Muscatine County in a southwesterly direction where it joins the Iowa River just southwest of Muscatine County. The topography of Muscatine County is a predominantly broad expanse of relatively flat land along the Cedar and Mississippi Rivers. Between these two river floodplains lies a small hilly area. In the Muscatine Island area, the valley of the Mississippi River reaches a maximum width of 8.5 miles, although a width of 2 miles is more typical of the region. The Cedar River flows through a valley reaching up to two miles in width.

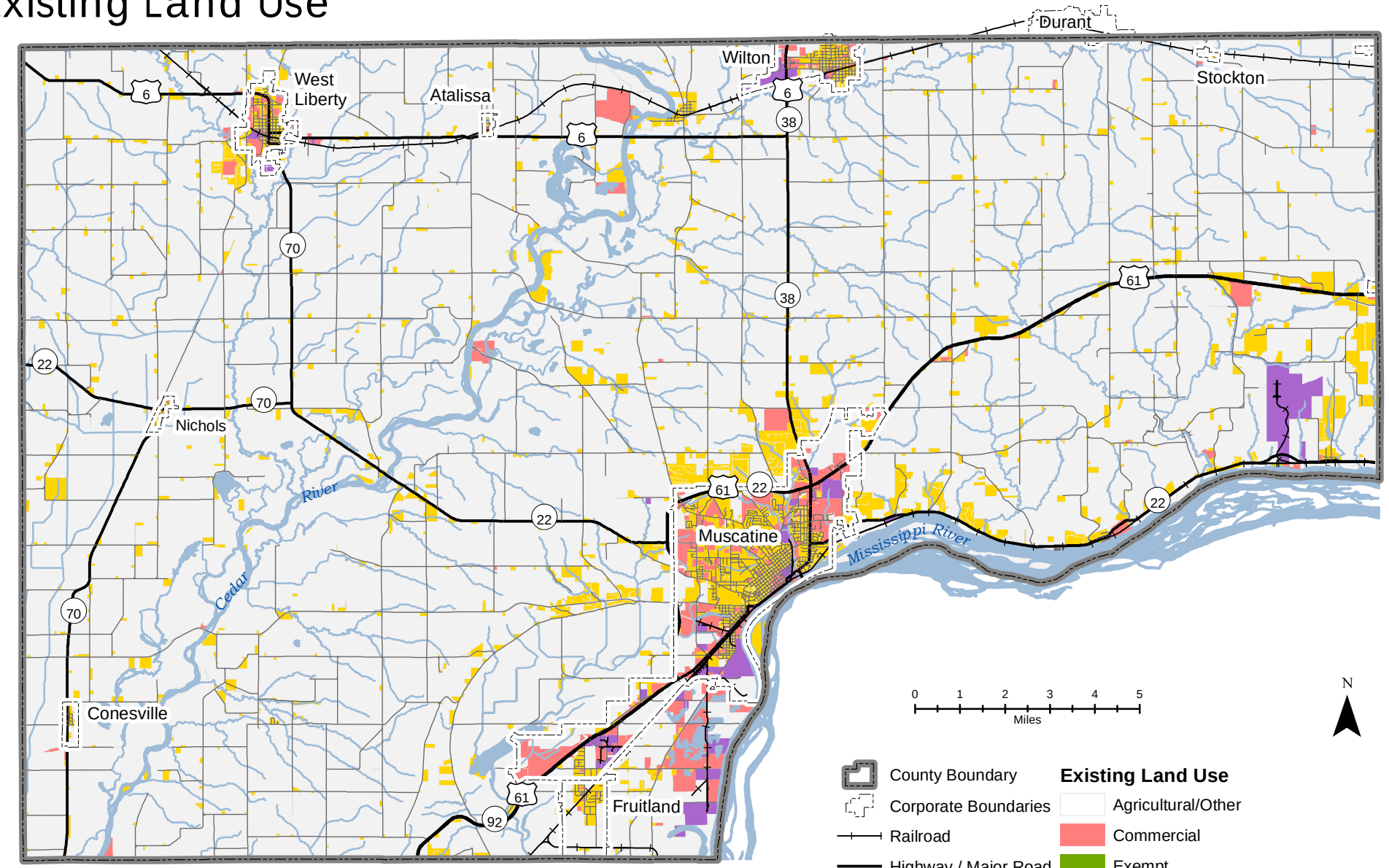
Muscatine County is predominantly agricultural with residential areas located in or near incorporated cities and along highways and county roads. Commercial and industrial areas are predominantly located within the City of Muscatine with additional industrial areas near West Liberty, Wilton, and along Highway 22 in southeastern Muscatine County. Recreational areas are located along the Cedar River and within incorporated areas. Map 3-7 on page 97 shows existing land uses in Muscatine County as described.

Climate and Weather

The climate of the Muscatine County area is sub humid midcontinental, with an average annual temperature of 51.6 degrees Fahrenheit. The average July temperature is 76.2 degrees Fahrenheit, and the January temperature is 23.7 degrees Fahrenheit. The typical precipitation in Muscatine County is 38.53 inches with an average of 25.2 inches of snowfall. [Source: National Climatic Data Center, 1981-2010 Summary of Monthly Normals; Muscatine, IA Station (USC00135837)]

Map 3.7

Existing Land Use



Disclaimer: This map is for reference only. Data provided are Derived from multiple sources with varying levels of accuracy. Bi-State Regional Commission disclaims all responsibility for the accuracy or completeness of the data shown hereon.

Existing Land Use - MAGIC
Roads - Iowa DOT (2019)
Corporate Limits - MAGIC (2019)
County Boundary - IA DNR
Water Features - USGS

Map prepared by:
Bi-State Regional Commission
October 2019

Government Structure

A five-member County Board elected by district to four-year terms governs Muscatine County. Elections are on a staggered basis. The county has both taxing and bonding authority. County government provides court and law enforcement services, the Department of Public Health, veteran's assistance, community mental health facilities and services, and a zoning office who handles all inspections, platting, and building permits.

Other participating jurisdictions include incorporated municipalities that range from very few to sizeable staffs. All the cities have a similar mayor-council form of government with the mayor as the chief elected official. The mayor is generally elected for a two-year term. Council members are elected for each of five wards and serve for four-year terms under a staggered system, with the exception of the City of Muscatine, which has council members in five wards and two at-large council members who represent the entire community. The cities of Muscatine, West Liberty, and Wilton appoint a city administrator or city manager to carry out the policies formulated by the council in addition to other duties. More information on government structure can be found under the individual jurisdiction profiles.

Local History

The name of Muscatine is of Indian origin, derived from the Mascoutin Indians, a war-like tribe, who had been driven westward across the Mississippi River and settled on a large sandy bottomland encircled by a slough just south of present day City of Muscatine. This area, now known as Muscatine Island, was once an actual island that became farmland when the Mississippi River changed its course. It is 30,000 acres of farmland known throughout the Midwest for its sweet corn, cantaloupes, watermelons, potatoes, and tomatoes, with the Muscatine Melon being perhaps the most recognized.

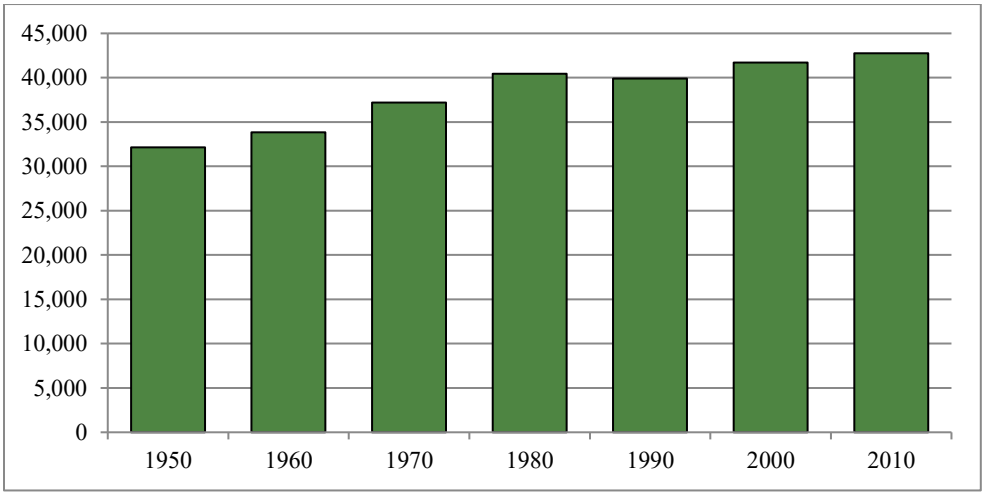
The City of Muscatine, seat of Muscatine County, first came into existence in the summer of 1833 when Colonel George Davenport of Rock Island, Illinois, sent three representatives into the territory to set up a trading post. That same year, James W. Casey and John Vanatta stopped at the outpost. Casey's "woodpile" stocked the steamboats providing access to the frontier opened June 1, 1833 by the Black Hawk Purchase and gave the settlement its first name, "Casey's Woodpile." In May 1836, a surveyor was engaged to survey a town, and when the first plat was made, the name Newburg was given to the town. This name was discarded and changed to Bloomington.

The town of Bloomington was originally incorporated in 1839, but the name led to confusion. Frequent miscarriages of letters by mail occurred because there were towns of the same name in Illinois, Kentucky, Missouri, and Indiana. On June 7, 1849, the town's name was changed from Bloomington to Muscatine. Muscatine became a stopping place on the Mississippi River as a lumbering center. In 1890, the manufacture of pearl buttons began to supplant other industries. Muscatine soon became the world's largest pearl button manufacturer, known as the Pearl Button Capital of the World, and employing approximately half the town in its factories. Muscatine's pearl button factory opened the door to other industries such as H.J. Heinz Co., Stanley Consulting, Inc., Grain Processing Corp., HON Industries, Carver Pump Company, Bandag Inc., Musco Sports Lighting, Monsanto Company, IPSCO, North Star Steel, Communication Data Services, and West Liberty Foods.

Population & Households

In 2015, Muscatine County's population was 42,913, which is the all-time highest population the county has experienced. Historically, the county grew steadily from 1950 to 1980 at an average of 8.0% a decade. The 1990s saw a small population decrease of 1.3% that rebounded successfully by 4.5% to 41,722 in 2000, which was the new highest population at the time. [Source: U.S. Census Bureau] Figure 3-1 shows the county's population by decade in more detail.

Figure 3-1
Historical Population of Muscatine County



Source: U.S. Census Bureau, 1950 - 2010 Censuses

The City of Muscatine is the largest municipality within Muscatine County that makes up approximately 55.7% of the county's population. The Cities of West Liberty and Wilton are the next largest. [Source: U.S. Census Bureau] Table 3-6 shows the comparison of all the municipalities within Muscatine County.

Table 3-6
Muscatine County Populations by Municipality

	2010	2015
Muscatine County	**42,745**	**42,913**
City of Atalissa	311	327
City of Conesville	432	524
City of Fruitland	977	1,281
City of Muscatine	22,886	23,888
City of Nichols	374	392
City of Stockton	197	209
City of West Liberty	3,736	3,737
City of Wilton	2,802	2,791
Unincorporated Area	11,030	

Source: U.S. Census Bureau, 2010 Census, American Community Survey 5-year estimates (2010-2015)

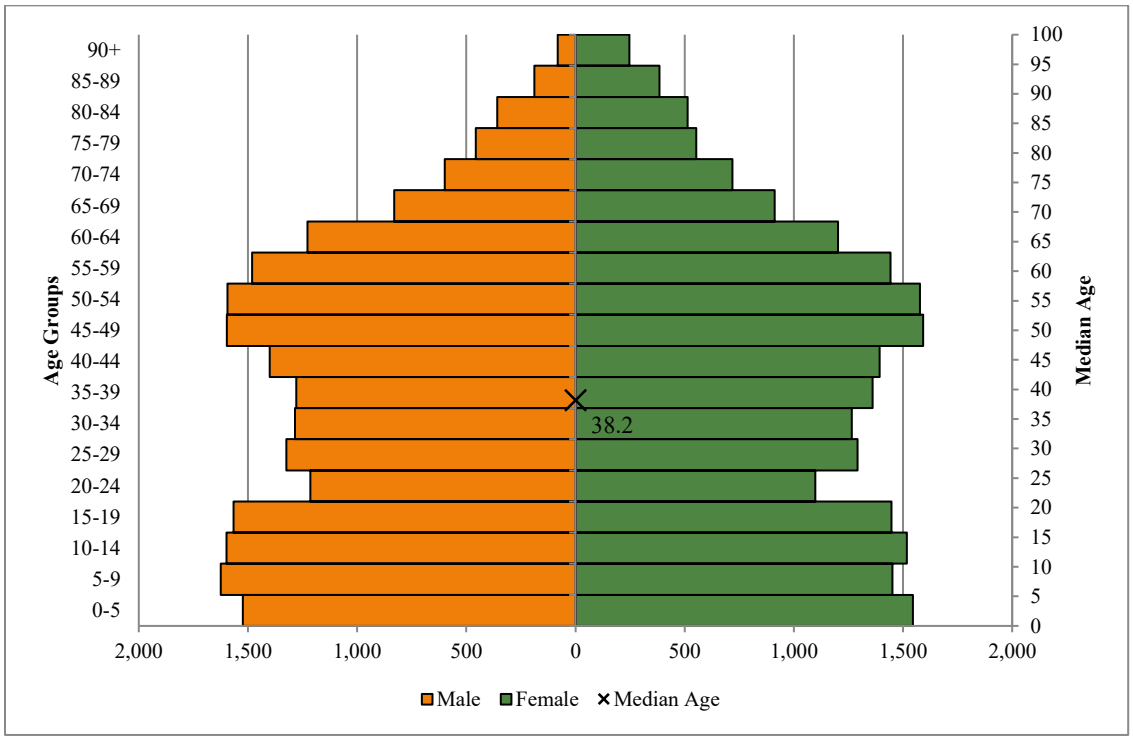
In 2017, there were 16,414 households in Muscatine County. Of those households, 69.1% are family households. Of those family households, 28.7% are living with their own children under 18, with 17.1% being single parent households. The average household size is 2.58, and the average family size is 3.10. [Source: U.S. Census Bureau, American Community Survey 5-year estimates (2013-2017)]

Age & Gender

The median age is a statistic that can be used to gauge the overall age of a population. The higher the median age the older a population, and conversely the lower the median age the younger the population. Muscatine County's median age in 2010 was 38.2, which is a 2.2-year increase since 2000.

Similar to the majority of U.S. places, Muscatine County has nearly equal amounts of males and females. As of the 2010 Census, Muscatine County was 49.7% male and 50.3% female. [Source: U.S. Census Bureau] Figure 3-2 shows Muscatine County's population by age distribution and median age.

Figure 3-2
Muscatine County Population by Age Distribution



Source: U.S. Census Bureau, 2010 Census

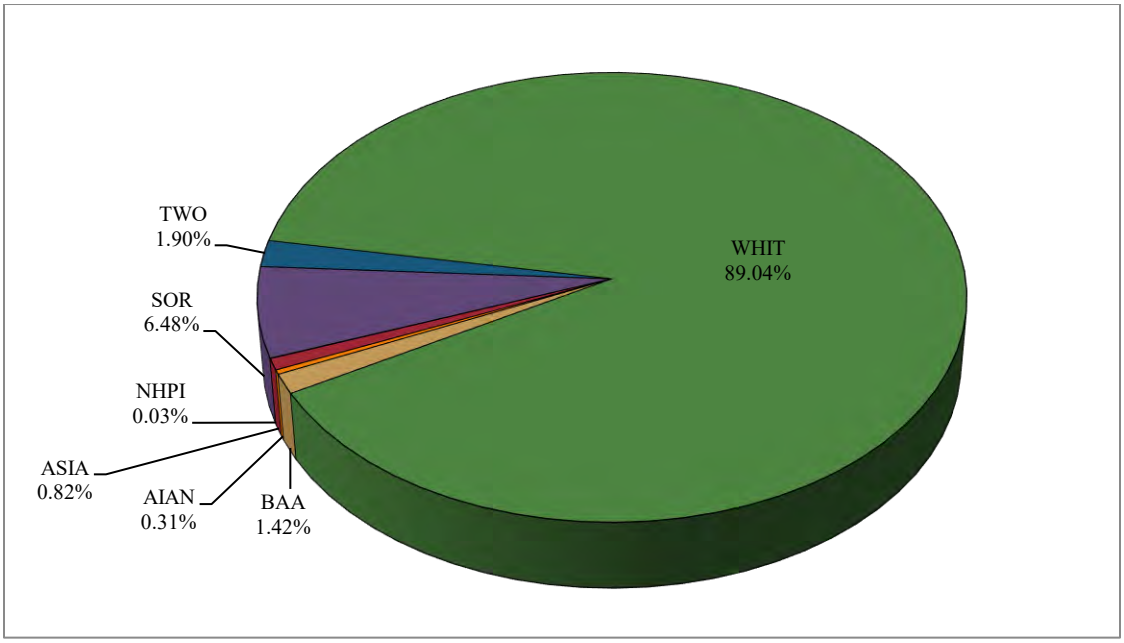
Race & Ethnicity

The Census Bureau tabulates race data into the following general categories that persons choose to self-identify with:

- White alone
- Black or African American alone
- American Indian or a Native alone
- Asian alone
- Native Hawaiian or other Pacific Islander alone
- Two or more races
- Some other race

Muscatine County's population as of the 2010 Census shows that 89.04% of the population is identified as white alone. The most common single racial minority are persons of Black or African American race (1.42%), followed by Asian race (0.82%). Figure 3-3 shows the race categories for Muscatine County in more detail. Hispanic or Latino ethnicity can be associated with any race. In 2010, 15.9% of Muscatine County's population identified themselves as Hispanic or Latino (of any race). [Source: U.S. Census Bureau]

Figure 3-3
Race by Category for Muscatine County



Source: U.S. Census Bureau, 2010 Census
Note: WHIT - White alone; BAA - Black or African American alone; AIAN - American Indian and Alaska Native alone; ASIA - Asian alone; NHPI - Native Hawaiian or Other Pacific Islander alone; SOR - Some Other Race alone; TWO - Two or more races

Ancestry

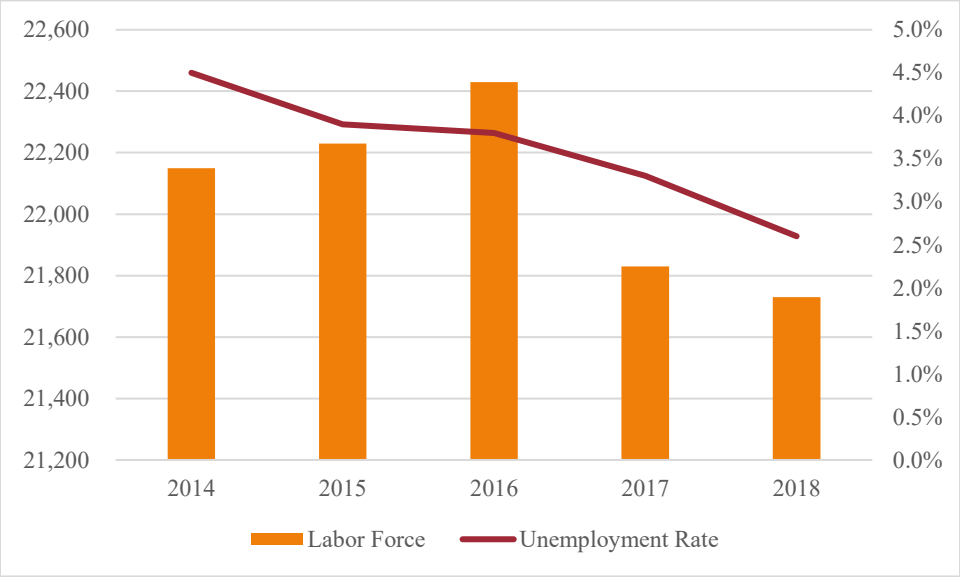
The U.S. Census Bureau records ancestry in the American Community Survey. Persons can choose from numerous ancestries and may pick more than one. A person's race or ethnic status has no bearing on the ancestries they may choose.

The most common identified ancestry in Muscatine County was German (29.2%), followed by Irish (10.1%), and English (7.8%). [Source: U.S. Census Bureau, American Community Survey 5-year estimates (2013-2017)]

Employment

From 2014 to 2016, Muscatine County's labor force rose by 1.26%, peaking in 2016 at 22,240. Labor force dropped in 2018 by 3.12% from 2016. Unemployment rates have steadily declined and were an average of 2.6% in 2018. [Source: Iowa Workforce Development] Figure 3-4 shows Muscatine County's labor force and unemployment trends over the past few years.

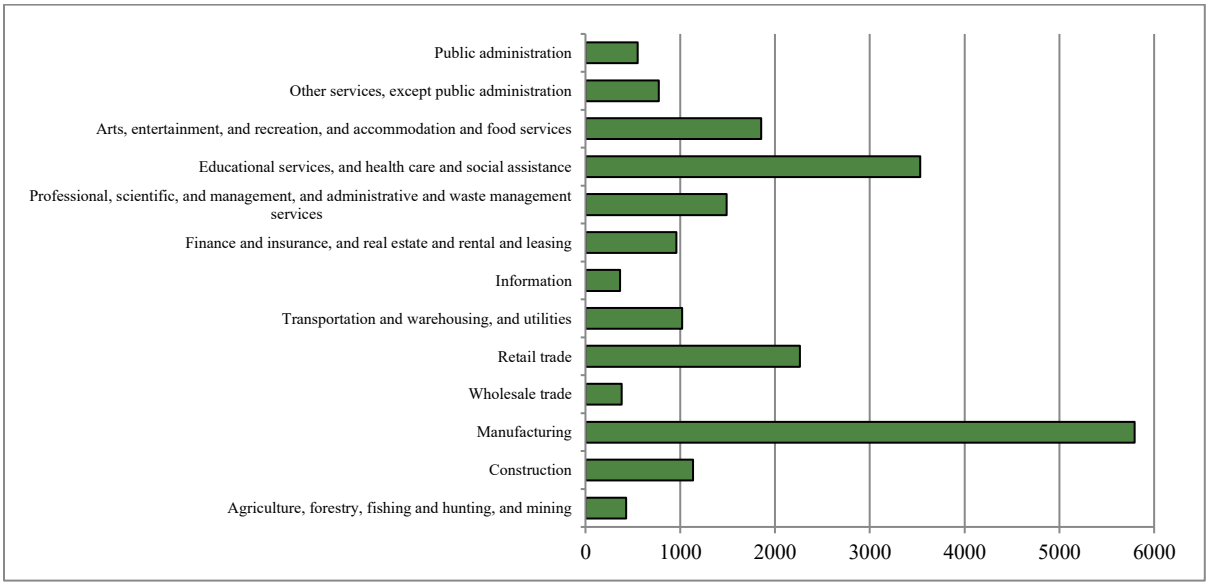
Figure 3-4
Muscatine County Labor Force



Source: Iowa Workforce Development

Muscatine County's workers are employed in a variety of industries. The most common industry reported was manufacturing, which employs more than a quarter of all workers (29.6%). The next most common industries are educational services, health care and social assistance (21.4%), and retail trade (8.7%). Figure 3-5 shows employment by industry in more detail. The largest employers in Muscatine County are listed in Table 3-7. These employers show a variety of industries including manufacturing, education, and government. [Source: U.S. Census Bureau, American Community Survey 5-year estimates (2013-17)]

Figure 3-5
Employment by Industry in Muscatine County for the Population 16 and over



Source: U.S. Census Bureau, American Community Survey 5-year estimates (2013-2017)

Table 3-7
Major Employers in Muscatine County

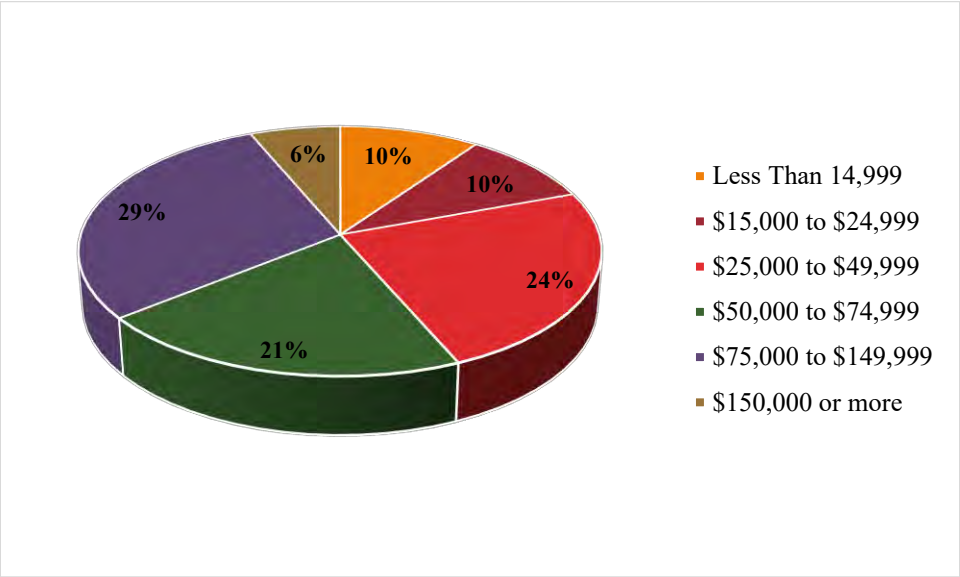
Employer	Employed	Industry
HNI Corporation	3,200	Office furniture manufacturer
Kent Corporation	1,011	Animal Feed producer
Muscatine Community School District	823	Education
Trinity Muscatine	483	Health Care
SSAB of Iowa	410	Place work and fabricated structural products
Musco Sports Lighting	400	Sports and event lighting
Monsanto Company / Bayer US – Crop Science	381	Herbicide and Pesticide producer
Walmart	350	Retail services
H.J. Heinz LP	305	Food processing
Muscatine Power and Water	300	Utility service company
The Stanley Group	279	Engineering and consulting services
City of Muscatine	224	Government
The Raymond Corporation	220	Electrical lift trucks
Muscatine County	184	Government
Bridgestone Commercial Service Solutions Groups	180	Pre cured tread rubber

Source: Muscatine Chamber of Commerce, Web Access Jan 9 2020.

Income

Median household income is a standard measure of prosperity in a community. Muscatine County's median household income is $56,398 (2017 dollars). Compared to the State of Iowa ($56,570), the county is just slightly below the state average. Figure 3-6 shows household income breakouts in more detail. [Source: U.S. Census Bureau, ACS 3-year estimates (2013-2017)]

Figure 3-6
Household Income in Muscatine County

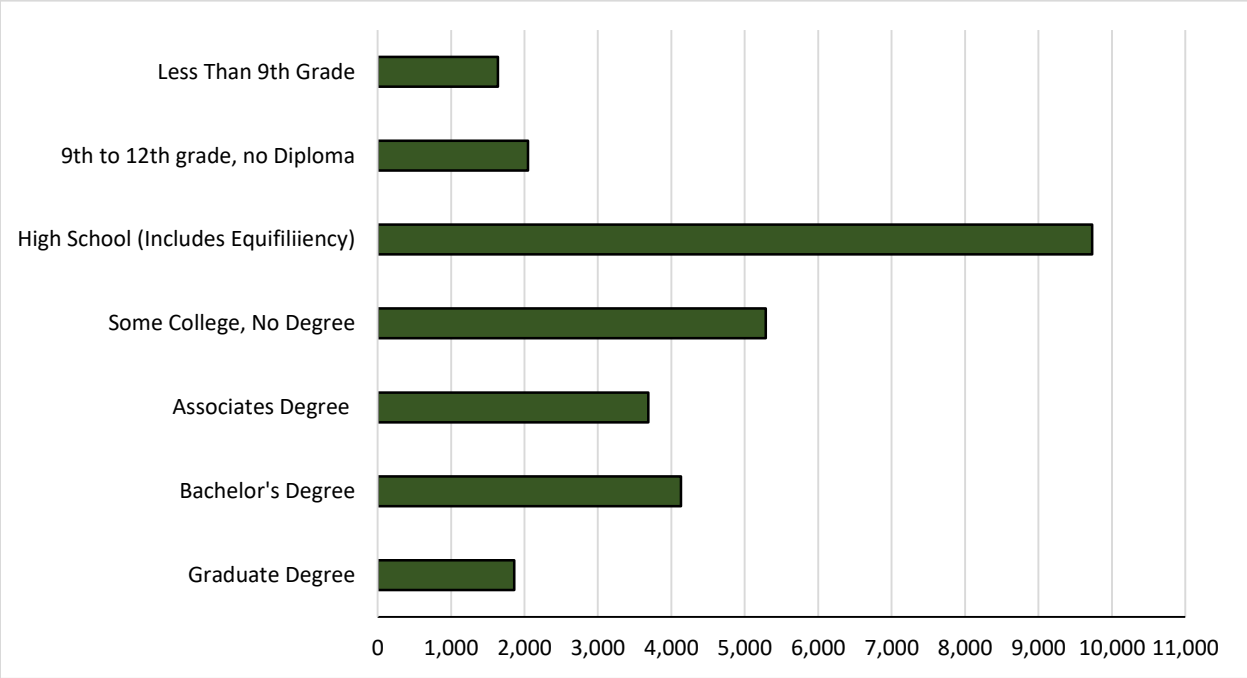


Source: U.S. Census Bureau, American Community Survey 3-year estimates (2013-2017)
(Shown in 2017 inflation-adjusted dollars)

Education

The United States is becoming a more highly educated society. The percentage of Iowan's age 25 and older with a bachelor's degree or higher increased by 3.2% from 2010 to 2017. As of 2017, 84.0% of Muscatine County's residents had a high school diploma or higher, and 21.1% had a bachelor's degree or higher. [Source: U.S. Census Bureau, American Community Survey 5-year estimates (2013-17)] See Figure 3-7 for more details.

Figure 3-7
Educational Attainment in Muscatine County for the Population 25 years and over



Source: U.S. Census Bureau, American Community Survey 5-year estimates (2013-2017)

As of 2017, 10,699 persons over the age of 3 were enrolled in school. With more than half of that population in Preschool through 8th grade (59%), and 17% of the population is enrolled in College or Graduate school. [Source: U.S. Census Bureau, ACS 5-year estimates (2013-2017)]

There are three public school districts in Muscatine County. Portions of the county also fall into outside school districts, Columbus-Junction Community School District, and Louisa-Muscatine Community School District. There is also one community college located in the county, Muscatine Community College. See Table 3-8 for public school district enrollments.

Table 3-8
Public School Districts in Muscatine County (2018-19 school year)

School District	Total Enrollment
Muscatine Community School District	5,090
West Liberty Community School District	1,333
Wilton Community School District	838

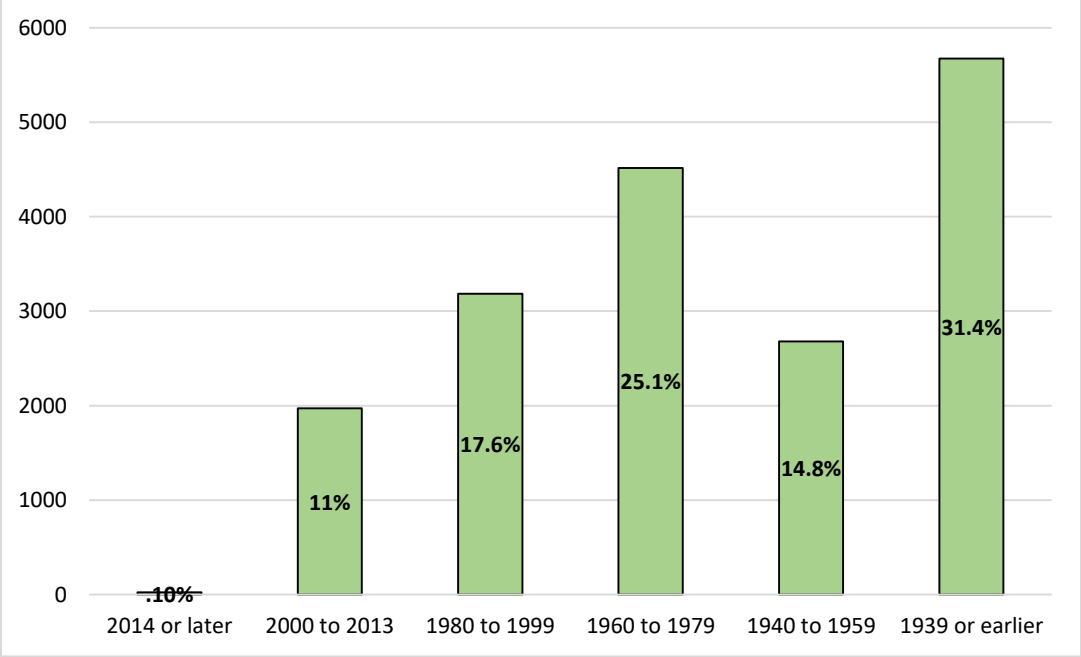
Source: Iowa Department of Education, Bureau of Information and Analysis

Housing

As defined by the U.S. Census Bureau, housing units are physical structures, such as a house, apartment, or mobile home that is occupied as living quarters. As of 2017, there were 18,051 housing units in Muscatine County with an average value of $165,500 (owner occupied). Approximately 91.6% of the total housing units are occupied (8.4% vacant). Three-quarters of the total housing units are owner occupied (25% renter occupied).

The housing stock in Muscatine County averages 50 years or older with more than a third of all housing units built before 1939 and the median year built 1962. [Source: U.S. Census Bureau, ACS 5-year estimates (2013-2017)] See Figure 3-8 for more details.

Figure 3-8
Housing in Muscatine County Year Structure was Built



Source: U.S. Census Bureau, American Community Survey 3-year estimates (2013-17)

Infrastructure

Muscatine County is traversed by four state highways: 22, 38, 70, and 92. In addition, there are U.S. Highways 6 and 61. One automobile bridge spans the Mississippi River within Muscatine County's limits: the Norbert F. Beckey Bridge (State Highway 92.) The Muscatine Municipal Airport and can accommodate large transport aircraft. The airport is considered by the Iowa Department of Transportation to be of regional significance. Railways within the county include the Iowa Chicago and Eastern and Iowa Interstate. Waterways within the county include the commercially navigable Mississippi River and the Cedar River (the Cedar River is a tributary of the Mississippi River). Lock and Dam 16 on the Mississippi River is located within the county borders and provides movement for barges carrying freight up and down the Mississippi River. Three active barge terminals are located within Muscatine County, two of which are served by rail and located within 20 minutes of Interstate 80. Source water for municipalities in the county comes from wells. The City of Muscatine operates 30 wells to provide its entire supply of water.

Water treatment facilities are operated by individual municipalities and are located in the following communities: Atalissa, Conesville, Fruitland, Muscatine, Nichols, West Liberty, and Wilton. Wastewater is also treated by individual municipalities with treatment facilities located in Muscatine, West Liberty, and Wilton.

Medical and Healthcare

Muscatine County is served by one hospital, Trinity Muscatine.

Communications

Newspapers	Radio Stations	Telephone Service	Public Safety
4 (Daily & Sunday)	3	AT&T	911 Service
3 (Weekly)		Quest	

Recreation and Tourism

The Muscatine County Conservation Board manages over ten sites and more than 13,000 acres of parks and public property throughout the county. These areas and facilities include an Environmental Learning Center; areas for camping, fishing, hunting, ice fishing, ice skating, cross country skiing, and canoeing; hiking and riding trails; a cemetery; playgrounds; and picnic areas. Areas managed by other agencies include five sites with more than 4,050 acres managed by the Iowa Department of Natural Resources and two sites owned by the Army Corps of Engineers totaling more than 20 acres including Big Sand Mound Nature Preserve, which contains 510 acres of habitat along the Mississippi River near the City of Muscatine known for its diverse ecosystem of unusual plants and animals, including 352 native plant species and 30 rare plants and animal inhabitants. The scenic Great River Road passes through Muscatine County along the Mississippi River. The Great River Road is a series of roads in ten states and two Canadian Provinces along the course of the Mississippi River.

Other attractions include Muscatine History & Industry Museum that displays a variety of memorabilia from the button factories, as well as the clam-shelling industry; Musser Public Library, home to the Oscar Grossheim collection of over 55,000 glass plate negatives; historic Musser Mansion, home to the Muscatine Art Center and the contemporary Stanley Gallery; the Fairport Fish Hatchery; and the Pine Creek Grist Mill, one of the finest examples of mid-nineteenth century mills left in the country and listed on the National Register of Historic Places.

The Muscatine County Fairgrounds are located in the City of West Liberty. The fairgrounds contain over 60 acres of tree-shaded concourse and campgrounds, a covered amphitheater, a half-mile dirt race track, and a community building used for many activities. The Muscatine County Fair is the oldest county fair in the State of Iowa.

In addition to regional attractions and facilities, Muscatine County's communities host a number of large events throughout the year that draw large numbers of people. These events include Eagles and Ivories Ragtime Weekend, Melon City Criterium bike race, Muscatine Boat Show, Wilton Smorgasbord, the Midwest Soccer Classic, Great River Days, Heritage Days, and several winter festivities.

Determining Community Assets

An outline and definition of assets was taken from the state and local hazard mitigation planning how-to guide *Understanding your Risks: Identifying Hazards and Estimating Losses*, FEMA document 386-2. The following types of facilities were considered, and general information about the presence of these types of facilities in the county-wide area is mentioned as available. However, a description of the facilities selected by participating jurisdictions is included within the individual multi-jurisdiction risk assessments later in this chapter. FEMA separates critical buildings and facilities into five categories based on their loss potential. All of the following elements are considered critical facilities.

Essential Facilities

Essential facilities provide for the health and welfare of the whole population and are especially important following hazard events. The potential consequences of losing them are so great that they should be carefully inventoried. Be sure to consider not only their structural integrity and content value, but also the effects on the interruption of their functions because the vulnerability is based on the service they provide rather than simply their physical aspects. Essential facilities include hospitals and other medical facilities, police and fire stations, emergency operation centers and evacuation shelters, and schools.

Hospitals and Medical Facilities	Police Stations	Fire Stations	Emergency Operation Centers	Evacuation Shelters	Schools and Colleges
Trinity Muscatine	Muscatine	Atalissa	Muscatine	Various Locations	Muscatine Community SD
	West Liberty	Conesville	Wilton		West Liberty Community SD
	Wilton	Fruitland			Wilton Community SD
		Montpelier			Muscatine CC
		Muscatine			
		Nichols			
		West Liberty			
		Wilton			

Transportation Systems

Transportation systems include airways (airports, heliports), highways (bridges, tunnels, roadbeds, overpasses, transfer centers), railways (trackage, tunnels, bridges, rail yards, depots), and waterways (canals, locks, seaports, ferries, harbors, dry docks, and piers).

Airways	Highways	Railways	Waterways
Muscatine Municipal Airport (KMUT)	U.S. Highways - 6, 61	Canadian Pacific (DME)	Cedar River
	State Highways - 22, 38, 70, 92	Iowa Interstate (IAIS)	Mississippi River (commercially navigable)
	Bridges - Norbert F. Beckey Bridge/ Highway 92 (Mississippi River)		Lock & Dam 16 (Mississippi River)

Lifeline Utility Systems

Lifeline utility systems include potable water, wastewater, oil, natural gas, electric power, and communication systems.

Potable Water*	Wastewater*	Natural Gas	Electric Power
Atalissa	Atalissa	Alliant Energy	Alliant Energy
Muscatine	Conesville	MidAmerican Energy	Eastern Iowa REC
West Liberty	Fruitland		MidAmerican Energy
	Montpelier		Muscatine Power and Water
	Muscatine		West Liberty
	Nichols		Wilton
	West Liberty		
	Wilton		

* Operated by individual jurisdictions

High Potential Loss Facilities

These are facilities that would have a high loss associated with them, such as nuclear power plants, dams, and military installations.

Hazardous Material Facilities

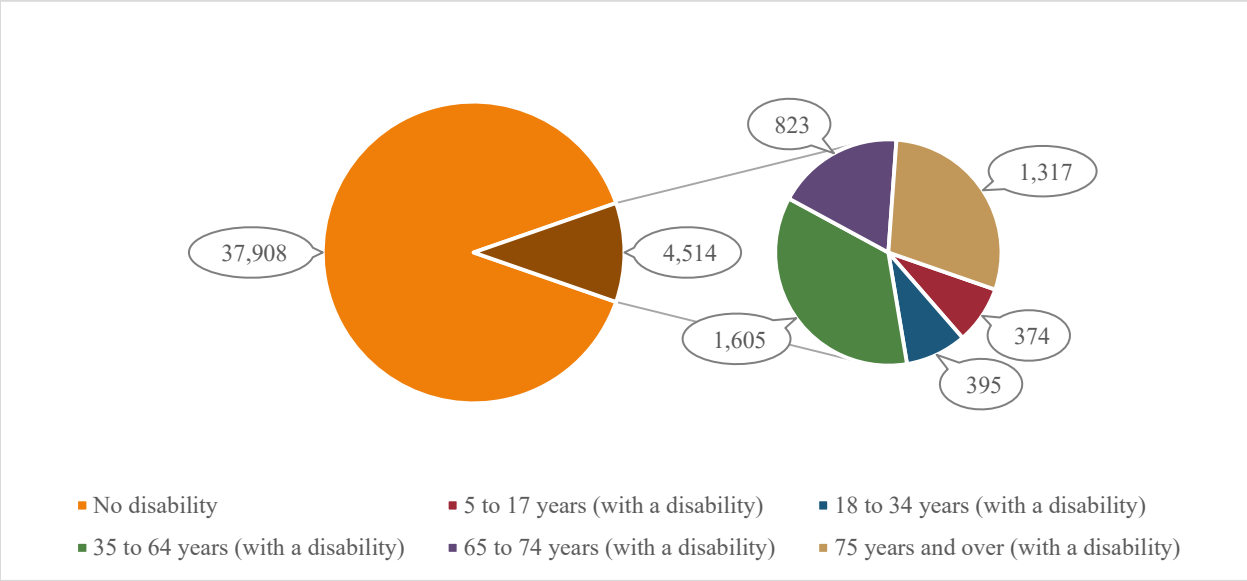
These are facilities housing industrial/hazardous materials, such as corrosives, explosives, flammable materials, radioactive materials, and toxins. There are 17 identified facilities within Muscatine County that house extremely hazardous substances. The most common hazardous materials found in the county are fertilizers and pesticides. See “Hazardous Material Incident” hazard profile for more information.

Vulnerable Populations

The risk assessment should include areas of greater population density, as well as populations that may have unique vulnerabilities or be less able to respond and recover during a disaster. Certain groups of people may not be able to comfortably or safely access the standard resources

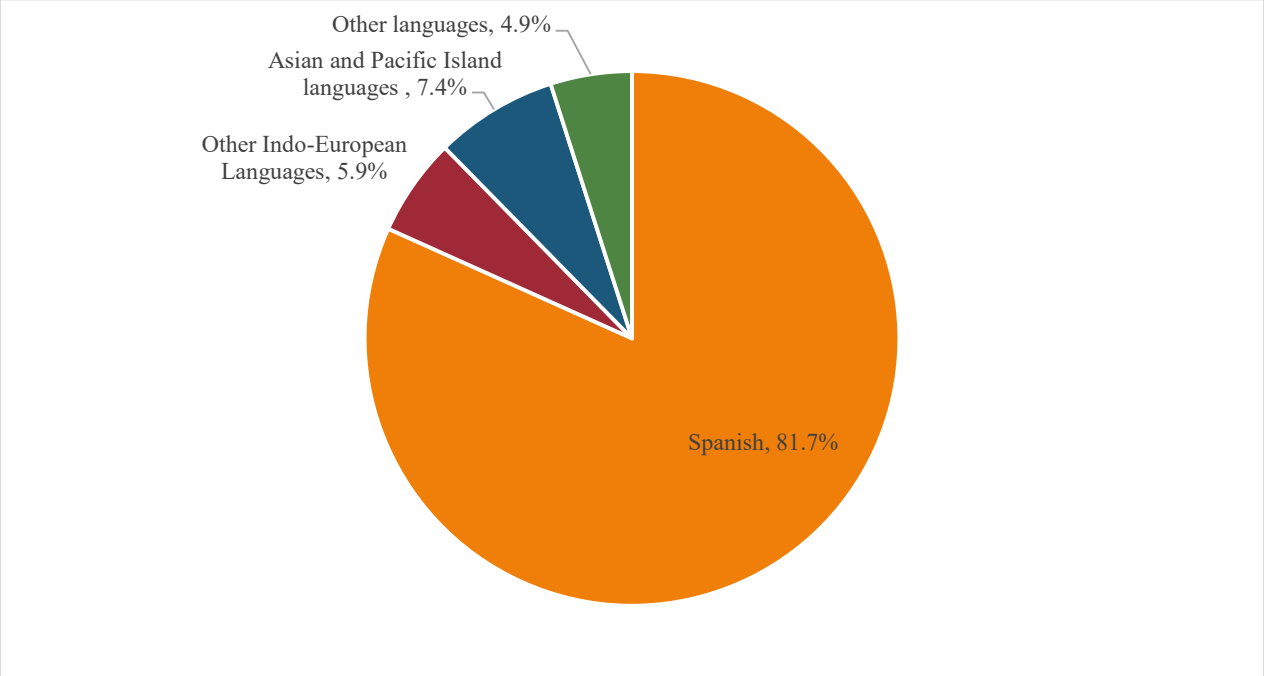
offered in emergencies. These populations could include small children, persons with disabilities, elderly persons, or non-English speaking residents that may require special response assistance or special medical care after a disaster. In Muscatine County, nearly a quarter of the population is under 5 or over 65 (6.4% and 15.4% respectively). Of the non-institutionalized population in Muscatine County, 10.6% of the population have a disability. Figure 3-9 shows disability in detail by age. Of the population in Muscatine County age 5 and over, 94.2% speak English only or speak English "very well." Of the population who speak a language other than English, 42.9% speak English less than "very well." Figure 3-10 shows language spoken in more detail.

Figure 3-9
Disability Status by Age of the Civilian Non-Institutionalized Population in Muscatine County



Source: U.S. Census Bureau, American Community Survey, 5-year estimates (2013-17)

Figure 3-10
Language Spoken for the Population 5 years and Over Who Speak English Less Than "Very Well" in Muscatine County



Source: U.S. Census Bureau, American Community Survey, 5-year estimates (2013-17)

Economy

Every community has specific economic features that are important and assist in the recovery of a community following a disaster. They can also add to the impact of a disaster if severely damaged or became inoperable. These can be major employers, primary economic sectors (i.e. manufacturing), and commercial centers.

Muscatine County
City Halls
County Facilities
Federal Buildings and Courthouse
Fire Stations
Police Stations
Public Works Facilities
U.S. Postal Facilities

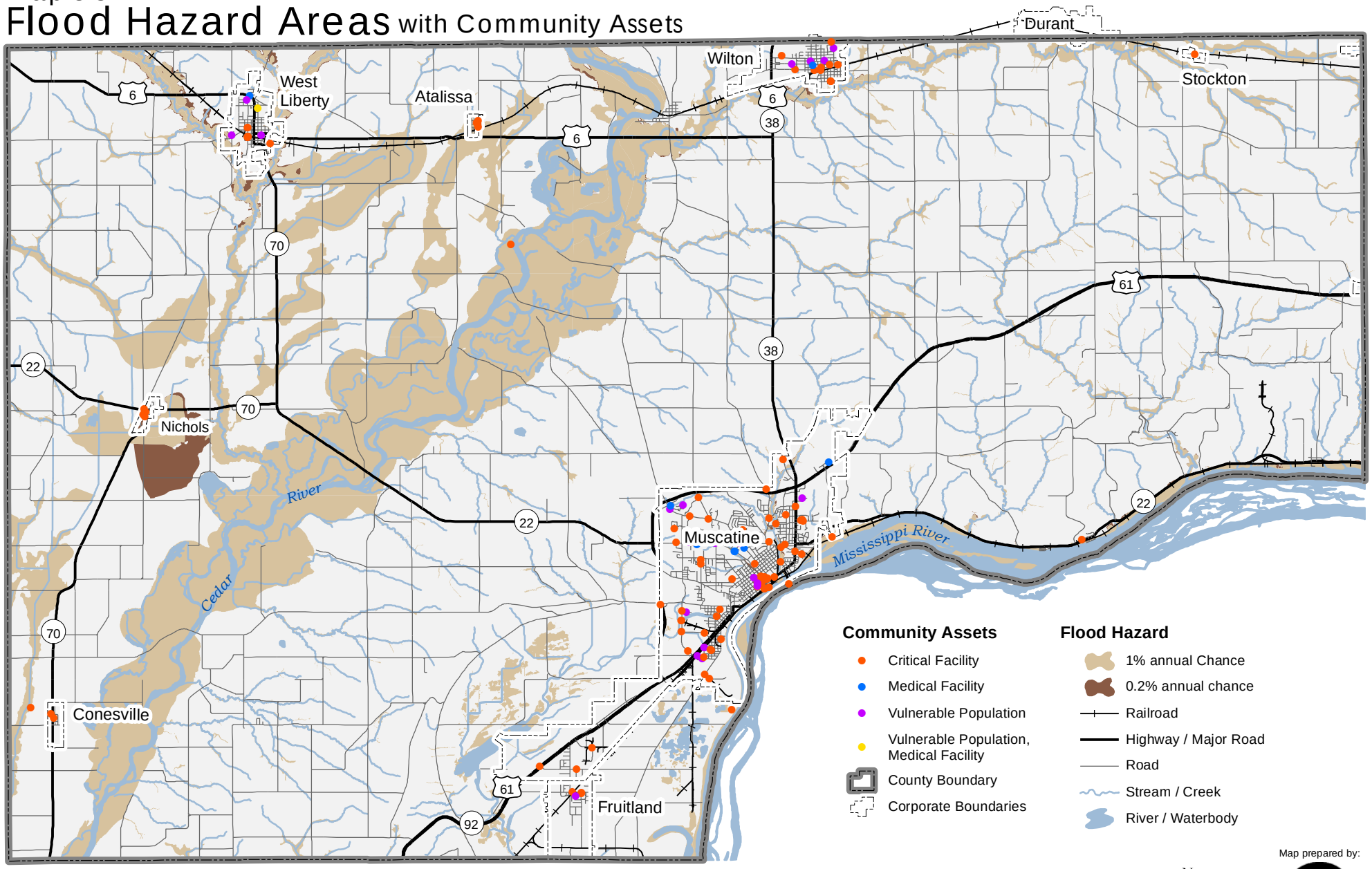
Other Significant Areas

Other areas that should be taken into consideration when planning are areas of historical, cultural, and natural resource significance; high density areas; and other facilities that that help ensure a full recovery of your community following a hazard event.

Historical, Cultural, and Natural Resources	High Density Areas	Other Facilities
Historical districts	Shopping districts	Grocery Stores
County and State Parks	High density residential developments	Hardware Stores
Agricultural areas	Commercial buildings	Gas Stations
	Sports facilities	
	Fairgrounds	

Map 3.8

Flood Hazard Areas with Community Assets



Community Assets provided by jurisdiction
Roads - Iowa DOT (2019)
Corporate Limits, Flood Hazard Areas - MAGIC (2019)
County Boundary - IA DNR
Water Features - USGS

Disclaimer: This map is for reference only. Data provided are Derived from multiple sources with varying levels of accuracy. Bi-State Regional Commission disclaims all responsibility for the accuracy or completeness of the data shown hereon.

Map prepared by:
Bi-State Regional Commission
January 2020

Critical Facilities

Participating jurisdictions were asked to inventory community assets that could be damaged by a hazard event using the samples listed above as a guide. They individually determined which ones they considered critical facilities. These assets and critical facilities are described in general terms for each participating jurisdiction in the "Multi-Jurisdiction Risk Assessment" section. While specific site addresses are not included in this document for security reasons, the selected critical facilities have been mapped for the planning area as a whole in relation to the special flood hazard areas as represented on Map 3-8 on page 113. A total of 155 facilities were identified from the lists provided by the individual jurisdictions and Muscatine County EMA. Of these, 9 or 5.9% were found to be located within the 1% floodplain as represented on the map. Since this has been an initial effort to identify critical facilities, the list may be further refined in future plan updates.

Assessing Vulnerability: Estimating Potential Losses

Estimating potential losses due to natural hazards is recommended in the hazard analysis and risk assessment portion of the local hazard mitigation plan, but is required only for flood hazards according to the funding that supports this plan process. The FEMA hazard mitigation planning guidance offers methodology for calculating potential losses due to hazards; however, this required a level of detail for individual structures not readily available for the county-wide planning area. The following analysis is based on best available data for a flood hazard.

The Muscatine County Assessor's Office provides county-wide assessment information for residential, commercial, industrial, agricultural land, agricultural dwellings, utilities, and exempt land classifications. Data was collected for all the values of land, residential improvements, commercial improvements, yard items, and agricultural improvements, and the total value of land/property for all of Muscatine County was estimated. With the use of GIS mapping, the parcel shape files were matched with the Muscatine County Preliminary Digital Floodplain Insurance Rate Map using the intersect function. This function pulls parcels within and adjacent to the floodplain. Properties with only a portion of the floodplain were classified as located in totality within the floodplain. This yielded an indication of the quantity of land classifications located in the 1% hazard floodplain. The value of the land/property within the floodplain was recalculated from the assessment data collected and compared with the total county-wide land/property value to give the following proportionate estimation of potential losses from flood hazard. This analysis was done prior to the adoption of the new FIRMs around the Muscatine Island Levee where areas were removed from the floodplain. The next plan update will include more detailed information on structure types and numbers if available.

Table 3-9
Estimated Potential Exposure from Flood Hazard

Land Classification	Land Total (in acres)	Assessed Value (in millions)	Land Within & Adjacent to 1% Floodplain (in acres)	Assessed Value in 1% Floodplain (in millions)	Percentage of Land Classification in 1% Floodplain
Residential	14,692	$1,632.44	4,156	$137.80	28%
Commercial	3,183	$327.59	1,144	$32.35	36%
Industrial	2,744	$246.86	703	$68.71	26%
Agricultural Land	199,401	$404.59	101,019	$183.03	51%
Agricultural Dwelling	40,623	$216.02	19,816	$90.98	49%
Utility	1,454	$4.45	738	$1.29	51%
Exempt	8,136	$229.46	6,073	$58.85	75%
	270,223	**$3,061.42**	**133,649**	**$573.01**	—

This methodology only provides for a worst-case estimate. Not every property and structure in the 1% hazard floodplain will be damaged or destroyed to the full amount of its value in any given flood event.

Development Trends and Future Land Use

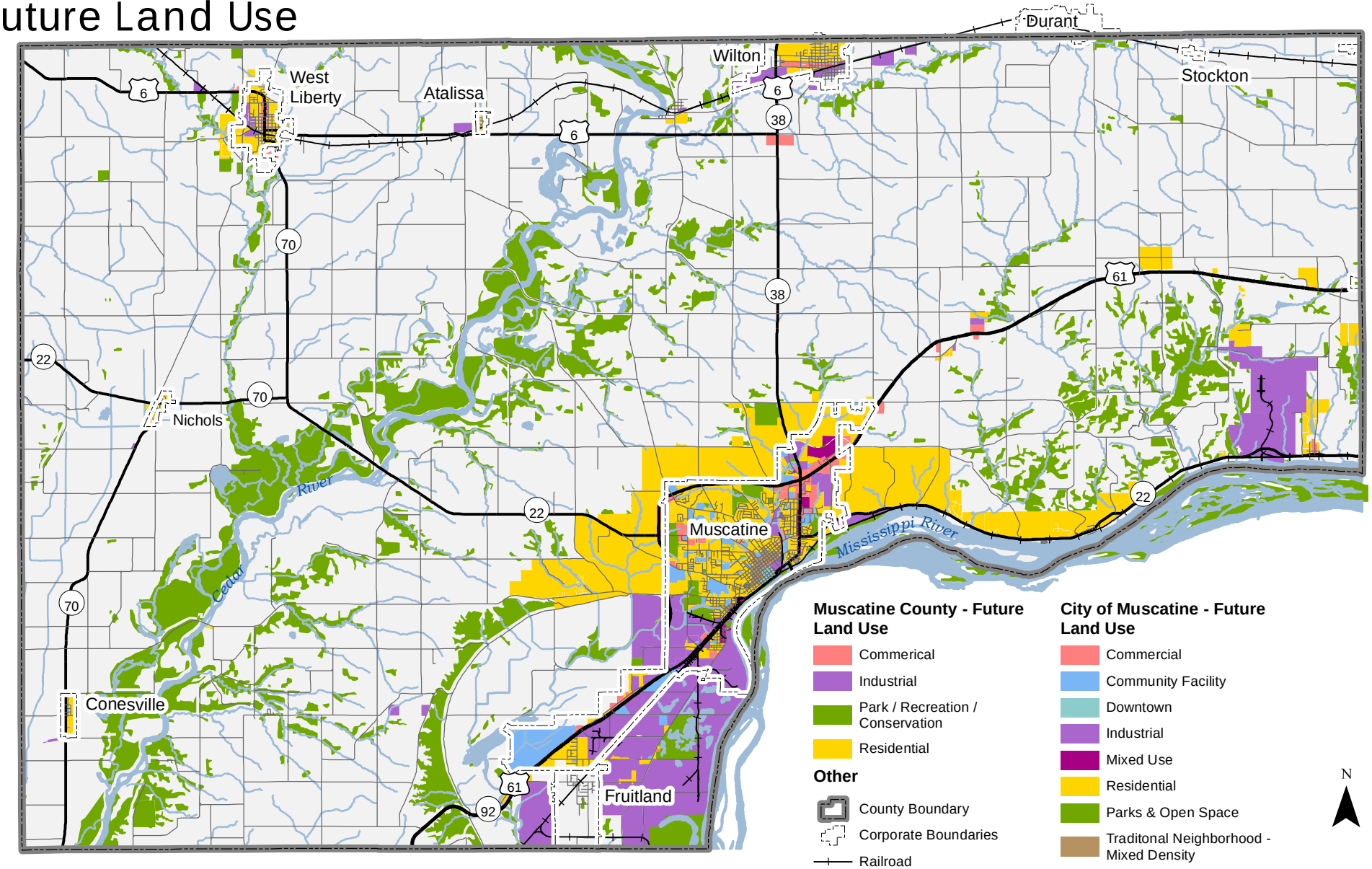
Currently, development in Muscatine County is concentrated around the cities of Atalissa, Conesville, Fruitland, Muscatine, Nichols, Stockton, West Liberty, and Wilton. Muscatine County has jurisdiction over land uses in the unincorporated area. These land uses are largely agricultural and open spaces with the exception of limited residential development in unincorporated areas such as north of the City of Muscatine and along highways. Map 3-8 shows future land use within Muscatine County.

As the future land use map shows, a significant increase in county land set aside for parks and conservation is expected. These areas correspond with important watershed and wildlife corridors, and particularly focus on the floodplains of the Cedar River Valley.

Industry is an integral part of the county's economy, accounting for approximately 30% of employment. As such, two industrial areas show where anticipated industrial growth may occur. One is located along the Mississippi River east of Fruitland between the City of Muscatine and the Louisa County border, while the second area is located west of the City of Muscatine close to the Scott County border with land adjacent to the Mississippi River.

Map 3.9

Future Land Use



Muscatine County - Future Land Use

- Commerical
- Industrial
- Park / Recreation / Conservation
- Residential

Other

- County Boundary
- Corporate Boundaries
- Railroad
- Highway / Major Road
- Road
- Stream / Creek
- River / Waterbody

City of Muscatine - Future Land Use

- Commercial
- Community Facility
- Downtown
- Industrial
- Mixed Use
- Residential
- Parks & Open Space
- Traditonal Neighborhood - Mixed Density

N

0 1 2 3 4 5
Miles

Roads - Iowa DOT (2019)
Corporate Limits - MAGIC (2019)
County Boundary - IA DNR
Water Features - USGS
City Future Land Use - City of Muscatine
County Future Land Use - Bi-State Regional Commission

Disclaimer: This map is for reference only. Data provided are Derived from multiple sources with varying levels of accuracy. Bi-State Regional Commission disclaims all responsibility for the accuracy or completeness of the data shown hereon.

Map prepared by:

Bi-State Regional Commission

October 2019

Development Trends by Jurisdiction

The following are detailed summaries of development plans by jurisdiction (of the participating jurisdictions). The communities of Atalissa and Nichols do not have comprehensive land use plans at this time.

City of Atalissa

No development has occurred within the city since the 2015 plan was adopted. Currently, the city does not have any development plans within the next 5 years.

City of Conesville

No development has occurred within the city since the 2015 plan was adopted. Currently, the city does not have any development plans within the next 5 years.

City of Fruitland

There has been no significant new development within the city since the 2010 hazard mitigation plan was adopted. The City of Fruitland's most current comprehensive plan dates from November 1999. The main development goal laid out in this plan was to retain the city's bedroom community image. Accordingly, residential land uses have almost doubled since 1999. The future land use goals in the plan also continue to confine industrial uses to the current zone adjacent to the railroad and commercial development to the city's main arterial, Muscatine Street.

City of Muscatine

Between 2010 and 2019, 361 dwelling units have been constructed in the City of Muscatine. Between 2010 and 2016, an average of 32 dwelling units per year were constructed. Since 2017, that average has increased to 45 dwelling units per year. Most of this growth has been for the construction of larger scale multi-family projects. Since 2017, 89% of added dwelling units are attributable to just three multi-family projects. Over the course of this decade, the development of new single-family homes has been limited to scattered subdivisions platted just prior to the recession of 2008. The glut of single family lots created just prior to recession has now largely been worked through. Construction on the first new single-family home subdivision since 2008 is currently underway, and construction of new homes within this 62-lot subdivision will begin in spring 2020, which will increase the annual number of new single family homes constructed within the City of Muscatine.

The city's current comprehensive plan was adopted September 19, 2013. This plan discusses existing land use as well as future land use plans. As of 2013, the parcels within the city's zoning districts contain land uses of the following categories (based on acreage): residential (48.5%), industrial (31.2%), agricultural (11.2%), special use (5.6%), and commercial (3.5%). Residential, commercial, and industrial are further defined by type.

Development has been entirely out of the floodplain. The city plans for new development to occur within infill areas and limit development on the urban fringe for only those locations that are suitable for urban development. In addition, The city annexed Ripley's manufactured home park along Highway 61 and County Road G14. There was the addition of a large business between Highway 92 and the railroad tracks by the airport.

City of Nichols

There has been no major development in the city since the hazard mitigation plan was adopted in 2010. Currently, the city does not have any development plans within the next 5 years.

City of West Liberty

No major development has occurred within the city since the hazard mitigation plan was adopted in 2010. West Liberty's most recent comprehensive plan was adopted in November 2016.

The City of West Liberty has outlined several broad development goals including encouraging business development, expanding industrial land uses, trail development, and providing a variety of housing. The proposed development is not within a floodplain.

City of Wilton

The City of Wilton's last comprehensive plan was completed in February 2003. As of 2003, agricultural and open lands made up the majority of the city's area at 42%. The second largest land use is industrial at 26%, followed by residential (20.5%), commercial (4.5%), institutional (5%), and recreational (2%). Most of the industrial development is located west of U.S. Highway 6, while residential uses are focused in the eastern portion of the city.

The city is currently working on plans to develop a 50-acre site for industrial use in the north-west section of town just west of U.S. Hwy 6. That has been annexed into the city since the 2010 hazard mitigation plan was adopted. Additional residential use is a long-term plan on the north side of town, outside of Muscatine County's boundaries.

Population Trends

Table 3-10 shows population, household, and housing unit change from 2000 to 2012, as well as projections for 2017 for Muscatine County. Both population and housing can be used to indicate the amount of development that has occurred in an area and help plan for future developments. Between 2000 and 2010 growth has mainly occurred in Fruitland (+18.4%), West Liberty (+12.5%), and the unincorporated area of the county (+5.8%). Comparatively, other areas of the county have seen population decline by -0.1% to -13.9%. Muscatine County overall continues to grow and is projected to gain 2.5% in population by 2017 (from 2010).

Table 3-10
Change in Population, Households, and Housing Units

Population	2000	2010	2015	2017	2019	2024	Percent Change 2000-2010	Percent Change 2000-2017
Muscatine County	41,722	42,745	42,913	42,923	43,324	43,679	2.5%	2.9%
City of Atalissa	361	311	327	308	315	318	-13.9%	-14.7%
City of Conesville	443	432	524	524	435	436	-2.5%	18.3%
City of Fruitland	825	977	1,281	1,248	941	930	18.4%	32.8%
City of Muscatine	22,920	22,886	23,888	23,852	23,713	23,795	-0.1%	4.1%
City of Nichols	403	374	392	403	393	401	-7.2%	0.0%
City of Stockton	198	197	209	196	228	241	-0.5%	-1.0%
City of West Liberty	3,321	3,736	3,737	3,746	3,798	3,830	12.5%	12.8%

Population	2000	2010	2015	2017	2019	2024	Percent Change 2000-2010	Percent Change 2000-2017
City of Wilton	2,830	2,802	2,791	2,815	2,955	3,025	-1.0%	-.5%
Unincorporated	10,421	11,030	9,764	9,831	10,546	10,703	5.8%	6.3%

Households	2000	2010	2012	2017	2019	2024	Percent Change 2000-2010	Percent Change 2000-2017
Muscatine County	15,847	16,412	16,589	16,820	16,558	16,668	3.6%	6.1%
City of Atalissa	122	111	111	112	112	113	-9.0%	-8.2%
City of Conesville	129	132	134	138	133	133	2.3%	7.0%
City of Fruitland	286	331	322	308	317	313	15.7%	7.7%
City of Muscatine	9,012	9,008	9,153	9,347	9,298	9,316	0.0%	3.7%
City of Nichols	148	142	147	154	148	151	-4.1%	4.1%
City of Stockton	70	73	71	69	84	89	4.3%	-1.4%
City of West Liberty	1,144	1,251	1,248	1,244	1,263	1,272	9.4%	8.7%
City of Wilton	1,101	1,155	1,187	1,230	1,216	1,243	4.9%	11.7%
Unincorporated	3,835	4,209	4,216	4,218	3,987	4,038	9.8%	10.0%

Housing Units	2000	2010	2015	2017	2019	2024	Percent Change 2000-2010	Percent Change 2000-2017
Muscatine County	16,786	17,910	17,955	18,244	18,330	18,574	6.7%	8.7%
City of Atalissa	131	122	124	117	124	125	-6.9%	-10.7%
City of Conesville	145	153	182	155	154	155	5.5%	6.9%
City of Fruitland	295	342	408	336	343	344	15.9%	13.9%
City of Muscatine	9,493	9,830	10,169	10,092	10,361	10,468	3.5%	6.3%
City of Nichols	151	150	155	159	157	161	-0.7%	5.3%
City of Stockton	73	76	78	75	88	93	4.1%	2.7%
City of West Liberty	1,186	1,316	1,326	1,341	1,339	1,355	11.0%	13.1%
City of Wilton	1,138	1,231	1,255	1,294	1,299	1,332	8.2%	13.7%
Unincorporated	4,174	4,690	4,673	4,675	4,465	4,541	12.4%	12.0%

Source: Esri, Community Analyst (2019)
Note: Data from 2000-2017 are Census data; data from 2019 and 20124 are Esri estimates

Jurisdictional Profiles

As described in the previous section on profiling hazards, each of the participating jurisdictions evaluated the hazards identified for the planning area.

The following individual jurisdiction risk assessments provide comparable data regarding population and land area. A geographic summary notes specific features that distinguish the jurisdiction from the planning area as a whole. The hazard priority provides a list of the top ranking hazards based on the hazard profile scoring and adjusted as needed based on local experience. The section also explains any differences in hazard ranking compared to the planning area. Finally, the "Critical Facilities" section summarizes structures identified as important to the

jurisdiction that may be vulnerable to hazards. The specific lists of critical facilities were mapped in relation to the 1% chance of annual flood hazard (also known as the 100-year floodplain) for the county-wide planning area as a whole and are shown in Map 3-6 on page 79. More detailed maps showing the special flood hazard areas for each jurisdiction can be found in Appendix 3-2.

Atalissa

Population (2010 Census): 311
0.73% of the total county's population
Ranks 8 of 8 jurisdictions in population

Land area: 0.14 sq. miles
0.03% of the total county's land area
Ranks 8 of 8 in land area

NFIP status: participating

Geography

Atalissa is located in the northwest part of Muscatine County; it is the smallest of the represented jurisdictions in both land and population. The existing land use in Atalissa includes residential; park, recreation, and conservation; and commercial. Transportation features along the southern border are U.S. Highway 6 and Iowa Interstate Railroad, which runs through the southern half of the town.

Government Structure

The City of Atalissa has a mayor-council form of local government. The mayor and five-member city council are elected to four-year, staggered terms. The city keeps an attorney on retainer. There are no boards or commissions for the city. Staff includes the city clerk/treasurer and the police chief. The city creates a budget annually, but does not have a capital improvement plan. Atalissa does participate in the National Flood Insurance Program and has a floodplain management ordinance. The city clerk is charged with enforcing the floodplain management within the city. The city is a taxing body and also assesses charges for sewer and solid waste management. Atalissa is covered by a volunteer fire department that has the ability to call additional personnel and resources from surrounding communities through a mutual aid agreement.

Critical Facilities

The City of Atalissa recognized six buildings in their list of critical facilities. Included in the list were city hall, the fire department, water plant, waste water treatment plant, lift station, and city garage.

Hazard Priorities

Threats to Atalissa are the same ones commonly experienced throughout the county. As a rural community, it has a somewhat higher exposure to grass and wild-land fire risks, but its hazard priorities align overall with the county as a whole.

Conesville

Population (2010 Census): 432
1.01% of the total county's population
Ranks 6 of 8 jurisdictions in population

Land area 0.36 sq. miles
0.08% of the total county's land area
Rank 6 of 8 in land area

NFIP status: Non-participating (no SFHA within jurisdictional boundaries)

Geography

The City of Conesville is located in southwestern Muscatine County along Highway 70. Conesville and the surrounding area are flat with 0-2% slopes. Conesville, while located to the west of the Cedar River, is not located within the floodplain. The city is primarily residential.

Government Structure

The City of Conesville has a mayor-council form of local government. The mayor and five-member city council are elected to four-year, staggered terms. The city keeps an attorney on retainer. There are no boards or commissions for the city. Staff includes the city clerk/treasurer and the police chief. The city creates a budget annually, but it does not have a capital improvement plan. The city has no identified special flood hazard areas and does not participate in the National Flood Insurance Program. The city is a taxing body and also assesses charges for sewer and solid waste management. Conesville is covered by a volunteer fire department that has the ability to call additional personnel and resources from surrounding communities through a mutual aid agreement.

Critical Facilities

The City of Conesville listed three critical facilities: city hall, the fire station, and the sewage treatment facility.

Hazard Priorities

Threats to Conesville are the same ones commonly experienced throughout the county. As a rural community, it has a somewhat higher exposure to grass and wild-land fire risks, but its hazard priorities align overall with Muscatine County as a whole.

Fruitland

Population (2010 Census): 977
2.29% of the total County's Population
Ranks 5 of 8 jurisdictions in population

Land area: 1.80 SQ. Miles
0.41% of the total County's Land Area
Ranks 4 of 8 in land area

NFIP status: Participating

Geography

Fruitland is located in the southeast corner of Muscatine County, within the Muscatine Island Levee District. Fruitland is part of Muscatine Island, which was at one time an island in the Mississippi River that became part of the state of Iowa when the river changed its course. Fruitland is located close to the Mississippi River, which is approximately 2 miles east of the town border. The slope of the area is flat with 0-2% grade within the town. Surrounding Fruitland are steeper grades of 10-20%. Fruitland is a bedroom community that is bordered by the City of Muscatine to the north, Fruitland Township to the east, Louisa County to the south, and U.S. Highway 61 to the west. Transportation features include U.S. Highway 61 that runs along the west; Iowa Chicago & Eastern Railroad that runs through the northwest corner of town; and nearby access to Muscatine Municipal Airport, which lies northwest of town.

Government Structure

The City of Fruitland has a mayor-council form of local government. The mayor is elected to two-year terms, and the five-member city council are elected to four-year, staggered terms. The city keeps an attorney on retainer. Staff includes the city clerk, deputy clerk, assistant clerk, superintendent of public works, maintenance assistant, and building official. Fruitland has a zoning ordinance and a building code, and as such has a Planning & Zoning Board and Board of Adjustments. The city also has a park board. The city creates a budget annually, but it does not have a capital improvement plan. The city participates in the National Flood Insurance Program and has a floodplain management ordinance. The city is a taxing body and also assesses charges for road use, solid waste management, and other services. Fruitland is covered by a volunteer fire department that has the ability to call additional personnel and resources from surrounding communities through a mutual aid agreement.

Critical Facilities

The City of Fruitland recognized three buildings in their list of critical facilities: city hall, the fire station, and the post office.

Hazard Priorities

Threats to Fruitland are the same ones commonly experienced throughout the county, with the exception of levee failure, for which it is at a uniquely higher risk for direct impact. Its hazard priorities overall align with Muscatine County as a whole.

Muscatine

Population (2010 Census): 22,886
53.54% of the total county population
Ranks 1 of 8 jurisdictions in population

Land area 17.30 sq. miles
3.95% of total county's land area
Rank 2 of 8 in land area

NFIP status: Participating

Geography

The City of Muscatine is the largest municipality in terms of population. It is located along the Mississippi River where the river turns south in the south central portion of Muscatine County. The city extends along State Highway 92. The City of Muscatine is bordered by Fruitland in the southwest, and the Mississippi River acts at this jurisdiction's southwestern border. Since the 2010 *Muscatine County Multi-Jurisdictional Hazard Mitigation Plan*, the City of Muscatine has annexed a mobile home and manufactured home park along U.S. 61 and County Road G14. Transportation features include the Iowa Chicago & Eastern Railroad and Highway 22/92 along the southern border of the city, while U.S. 61 follows the city's northern and eastern city limits. Highway 38 provides for north/south transit movement. Due to the City of Muscatine's proximity to the Mississippi River, there are areas of steep slopes formed by the river bluffs found within the city limit where portions of the residential population can be found; however, the land located within Muscatine Island is relatively flat, with slopes of 0% - 2%.

Government Structure

The City of Muscatine has a mayor-council form of government with an appointed city administrator. The mayor is elected to 2-year terms ,while the city council has 4-year, staggered terms. The city council has five ward representatives and two at-large representatives. The city adopted an annual budget, is a taxing body, and has a capital improvement plan for long-term projects. Emergency management services are shared by the fire department, the police department, and public works. The fire department has two stations located within the city. The city has 15 boards and commissions including a New Construction Appeal & Advisory Board, Planning & Zoning Commission, and Zoning Board of Adjustment. The city has a full building and zoning ordinance enforced by staff in the public works department and community development department. The city participates in the National Flood Insurance Program with enforcement done by the Community Development Department. The city also has several other ordinances that could aid hazard reduction, such as the stormwater management ordinance and hazardous waste regulations. The full list of plans and policies for the city can be found in Table 2-1 in Chapter 2.

Critical Facilities

The City of Muscatine listed a total of 60 buildings and structures as critical facilities. Among those listed were City Hall; the Public Safety Building; the fire stations; power & water facilities; public works; the solid waste transfer station; the county jail; courthouse; other county operations; schools; communication facilities; the bridges over the Mississippi River, Mad Creek and Geneva Creek; and the sewer lift stations.

Hazard Priorities

Threats to Muscatine are the same ones commonly experienced throughout the county, with the exception of levee failure, for which it is at a uniquely higher risk for direct impact. Its hazard priorities align with Muscatine County as a whole.

Muscatine County – Rural /Unincorporated

Population (2010 Census): 11,227
26.27% of the total county's population
Ranks 2 of 8 jurisdictions in population

Land area: 413 sq. miles
94.63% of the total county's land area
Ranks 1 of 8 in land area

NFIP status: Participating

Geography

Rural/Unincorporated Muscatine County is located in the south-eastern part of the state of Iowa. It is bordered to the north by Cedar County and a small part of Scott County; to the east by Scott County and the Mississippi River on the south-eastern part; to the south by Louisa County; and to the west by Johnson County and part of Louisa County. The slope of the county varies from 0-50% depending on the area, with the majority of the unincorporated areas in the 0-2% range. There are two major rivers that are located within the county; the Mississippi River that runs along the south-eastern boarder of the county and the Cedar River that runs north-south through the western half of the county. The existing land use is mainly agricultural, which covers approximately 85% of the county. The rest of the area contains small pockets of residential and park, recreation, and conservation areas. Transportation features include 4 major highways: U.S. Highway 61, U.S. Highway 70, U.S. Highway 6, and U.S. Highway 22. There are also two railroad lines, Iowa Interstate Railroad and Iowa Chicago & Eastern Railroad.

Government Structure

Muscatine County is governed by a Board of Supervisors who are elected to 4-year terms. The elected officials are elected at-large. In addition, the county attorney, auditor, recorder, sheriff, and treasurer are elected positions with 4-year terms. County departments include Administration, Assessor's Office, Attorney's Office, Auditor's Office, Health, Building, Community Services, Conservation, Emergency Management, Engineer, Environmental Health, GIS, Information Technology, Medical Examiner, Recorder's Office, Sheriff's Office, Veteran's Affairs, and Zoning. Boards and commissions include Board of Adjustment, Board of Health, Zoning Commission, Veteran's Affairs Commission, and Conservation Board. The county has a building code, floodplain ordinance, and zoning code, which are enforced by the Planning and Zoning Administrator. Muscatine County participates in the National Flood Insurance Program. Muscatine County updated their comprehensive plan in 2014 and has several additional plans, ordinances, and policies that can be utilized to mitigate hazards. Muscatine County prepares a budget annually and is a taxing body.

Critical Facilities

In addition to all of the identified facilities within incorporated areas of Muscatine County, rural and unincorporated Muscatine County recognized one building in their list of critical facilities.

Included in the list was City Hall of Stockton, a non-participating jurisdiction. Muscatine County's facilities are primarily located within the City of Muscatine and include the jail, courthouse, and administration building.

Hazard Priorities

Threats to rural/unincorporated Muscatine County are the same ones commonly experienced throughout the county. Exposure to grass and wild-land fire risks are higher in the unincorporated areas than in incorporated areas, but the hazard priorities align overall with Muscatine County as a whole.

Nichols

Population (2010 Census): 374
0.87% of the total county's population
Ranks 7 of 8 jurisdictions in population

Land area: 0.23 sq. miles
0.05% of the total county's land area
Ranks 7 of 8 in land area

NFIP status: Participating

Geography

Nichols is located within the west-central part of Muscatine County, close to the border of Johnson County. The slope of Nichols is flat with a 0-2% grade. The existing land use in town is mostly residential, with pockets of park, recreation, and conservation, as well as a commercial section located in the northwest end of town. Transportation features include U.S. Highway 70, which runs north-south through town, and U.S. Highway 22, which runs east-west through town.

Government Structure

The City of Nichols has a mayor-council form of local government. The mayor and five-member city council are elected to two-year, staggered terms. The city keeps an attorney on retainer. Staff includes the city clerk and city treasurer. Nichols has no boards or committees. The city creates a budget annually and is a taxing body, but it does not have a capital improvement plan. The city participates in the National Flood Insurance Program and has a floodplain management ordinance that is enforced by the city clerk. The city is a taxing body and also assesses charges for road use, solid waste management, and other services. Nichols is covered by a volunteer fire department that has the ability to call additional personnel and resources from surrounding communities through a mutual aid agreement.

Critical Facilities

The City of Nichols listed 16 critical facilities, including two vulnerable populations. Included in the list were city hall, the fire station, the sewer pumping station, electrical transmission lines, and city parks.

Hazard Priorities

Threats to Nichols are the same ones commonly experienced throughout the county. As a rural community, it has a somewhat higher exposure to grass and wild-land fire risks, but its hazard priorities align overall with Muscatine County as a whole.

West Liberty

Population (2010 Census): 3,736
8.71% of the total county's population
Ranks 3 of 8 jurisdictions in population

Land area: 1.73 sq. miles
0.40% of the total county's land area
Ranks 5 of 8 in land area

NFIP status: Participating

Geography

The City of West Liberty is located in northwestern Muscatine County between the Middle Branch of the Wapsinonoc Creek and the West Branch of the Wapsinonoc Creek. West Liberty topography ranges from flatter land with 1-3% slopes to steeper areas of up to 9-14% slopes. Due to its proximity to the creeks, West Liberty can experience flooding. Transportation features include the Iowa Interstate Railroad and U.S. 6/IA 70. West Liberty's residential areas are primarily low-density. Other land uses include agricultural, commercial, institutional, and industrial. West Liberty has several recreational areas including parks and the Muscatine County Fairgrounds.

Government Structure

The City of West Liberty has a council-manager form of local government. The mayor is elected to a two-year term, and the five-member city council are elected to four-year staggered terms with an appointed city manager. The city keeps an attorney on retainer. Staff includes the city clerk/finance officer; electric, water/sewer, and waste water treatment plant superintendents; police chief; fire chief; library director; and parks & recreation director. West Liberty has a zoning ordinance and a building code and, as such, has a Planning & Zoning Board and Board of Adjustments. The city also has a library board and park and recreation committee. The city participates in the National Flood Insurance Program and has a floodplain management ordinance enforced by the city manager. The city is a taxing body and also assesses charges for road use, solid waste management, and other services. West Liberty is covered by a volunteer fire department that has the ability to call additional personnel and resources from surrounding communities through a mutual aid agreement.

Critical Facilities

West Liberty listed seven structures as critical facilities. These are primarily local government facilities including the city hall, fire department, public works garage, and water treatment plant. Other critical facilities include the power plant and Liberty Communications. Vulnerable populations in the area include several retirement homes, the schools, and a child care center. West Liberty also has a high population of residents that speak a language other than English.

Hazard Priorities

Threats to West Liberty are the same ones commonly experienced throughout the county. Its hazard priorities align overall with Muscatine County as a whole.

Wilton

Population (2010 Census): 2,802
6.56% total county
Ranks 4 of 8 jurisdictions in population

Land area 1.95 sq. miles
0.45% total county area
Rank 3 of 8 jurisdictions in land area

NFIP status: Participating

Geography

The City of Wilton is located in northern Muscatine County, and a small portion of Wilton is located in Cedar County. U.S. 6/IA 38 runs north/south through the city while the Iowa Interstate Railroad crosses the area in an east/west direction. Mudd Creek, a tributary of the Cedar River, flows to the south of Wilton creating a floodplain within Wilton's city limits. The land in and surrounding Wilton is flat with very few areas of steep slopes. Wilton consists primarily of agricultural or open land and low density residential with a corridor of commercial along 5th Street. Approximately 25% of Wilton is industrial with the larger industrial area located north of the Iowa Interstate Railroad and east of U.S. 6/IA 38. The City of Wilton's storm water is currently handled by drainage swales, ditches, and curb and gutter systems. No storm water detention areas have been developed within the city.

Government Structure

The City of Wilton has a mayor-council form of local government. The mayor is elected to a two-year term, and the five-member city council are elected to four-year staggered terms with an appointed city administrator. The city keeps an attorney on retainer. Staff includes the city clerk/treasurer, police chief, public works director, economic development coordinator, and community center director. Wilton has a zoning ordinance and a building code, and as such, has a Planning & Zoning Board and Board of Adjustments. The city also has a library board, community center board, municipal light board, pool board, and park board. The city creates a budget annually, is a taxing body, and has a capital improvement plan. The city participates in the National Flood Insurance Program and has a floodplain management ordinance enforced by the city administrator. The city is a taxing body and also assesses charges for road use, solid waste management, and other services. Wilton is covered by a volunteer fire department that has the ability to call additional personnel and resources from surrounding communities through a mutual aid agreement.

Critical Facilities

The City of Wilton listed a total of 41 critical facilities, five of those identified as facilities with vulnerable populations. Critical facilities include the water plant, sewer plant, public works, electric plant, city hall/library, and fire station. Vulnerable populations include the city's schools, assisted living, and day care facilities.

Hazard Priorities

Threats to Wilton are the same ones commonly experienced throughout the county. As a rural community, it has a somewhat higher exposure to grass and wild-land fire risks, but its hazard priorities align overall with Muscatine County as a whole.

4 MITIGATION STRATEGY

This section presents the mitigation strategy developed by the Hazard Mitigation Planning Committee based on the risk assessment. The mitigation strategy was developed through a collaborative group process. The *Local Mitigation Planning Handbook* from March 2013 provided by Federal Emergency Management Agency (FEMA) states that goals are to be agreed upon by the planning team, elected officials, and the public and are to provide the basis for prioritizing mitigation actions. They are usually long-term, broad, policy-type statements. Mitigation actions are specific actions that help achieve goals and objectives.

In the 2010 plan, general goals were selected to guide jurisdictions in their efforts to mitigate disaster effects and to create mitigation actions that each jurisdiction can put in place to reduce vulnerability to hazards and their associated losses.

Local Hazard Mitigation Goals

The Planning Committee developed goals to provide direction for reducing hazard-related losses in Muscatine County. Goals 2-5 were originally Goals 1-4 in the 2010 plan. Goal 1 was added in the 2015 update because the Planning Committee felt it made the goals cover all aspects of hazard mitigation. As part of the update process for the 2020 plan, these goals were reviewed and reaffirmed as reflecting the current conditions and priorities for hazard mitigation planning in Muscatine County.

- **Goal 1:** Protect human life, property conservation, and public health from the effects of hazards.
- **Goal 2:** Minimize vulnerability of the people and property of Muscatine County to the effects of hazards.
- **Goal 3:** Protect critical facilities, infrastructure, and other community assets from the effects of hazards.
- **Goal 4:** Improve education and awareness regarding hazards and risk in Muscatine County.
- **Goal 5:** Strengthen communication among communities and between communities and the public.

Identification and Analysis of Mitigation Actions

FEMA guidance for local hazard mitigation planning requires examining a comprehensive range of mitigation actions and projects for each hazard. Six broad categories are used in FEMA guidance documents to describe a range of mitigation measures.

Range of Mitigation Measures

1. **Preventative Measures (PM):** Government administrative or regulatory actions or processes are developed and implemented that influence the way land and buildings are developed and built. These actions also include public activities to reduce hazard losses. Preventive measures are used to keep problems from getting started or getting worse. Mitigation measures that fall into this group include planning and zoning, building codes, conducting technical studies, inspection, enforcement, implementation, hazard analysis and risk assessment, security, capital improvement programs, open space preservation,

and storm water management regulations. Community participation in the National Flood Insurance Program (NFIP) also protects both individuals and the community as a whole from devastating losses.

2. **Property Protection (PP):** These are measures that involve the modification of existing buildings or structures to protect them from a hazard(s), or removal from the hazard area. They are implemented in order to remove people, property, and businesses permanently out of unsafe areas where, in terms of wise disaster planning, they should not have been in the first place. Property protection measures include acquisition, elevation, relocation, and structural retrofits.

3. **Public Education and Awareness (PE):** These measures help to inform and educate citizens, elected officials, and property owners about the hazards and potential ways to mitigate them. These measures include outreach projects, real estate disclosure, hazard information centers, and school age and adult education programs.

4. **Natural Resource Protections (NR):** These are actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural systems. These actions include sediment and erosion control, stream corridor protections and restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.

5. **Emergency Services (ES):** These actions protect people and property during and after a disaster event in order to minimize its impact and preserve the community's health and safety. Emergency services include warning systems, monitoring systems, response and recovery planning, emergency response services, evacuations, protection of critical facilities, acquisition of equipment to facilitate the delivery of these services, and training for responders in an emergency situation.

6. **Structural Projects (SP):** These projects involve the construction and maintenance of structures to reduce or redirect the impact of a hazard away from at-risk populations and facilities. Such structures include, but are not limited to, dams, levees, floodwalls, seawalls, retaining walls, and safe rooms.

As described in Chapter 3, the Planning Committee determined that the primary focus would be on hazards identified as High Priority. The High Priority hazards from the 2015 plan and the updated 2020 plan are:

2020 Plan

- Tornado
- Windstorm
- Flash Flood
- River Flood
- Thunderstorm & Lightning
- Levee Failure

2015 Plan

- Tornado
- Severe Winter Storm
- Thunderstorm & Lightning
- Windstorm
- Flash Flood
- River Flood

The identified hazards and their ranking may differ somewhat for individual jurisdictions based on their unique conditions within Muscatine County; however, all jurisdictions are impacted directly or indirectly by the High Priority hazards that occur in the county, and the overall prioritization was agreed upon by the Planning Committee.

Evaluation of Mitigation Actions

In the original 2010 plan, the Planning Committee brainstormed possible mitigation actions to address the first priority hazards. These were then sorted by the six categories within the comprehensive range of mitigation actions to identify whether other actions might be considered. The original action concepts were edited into consistent language of actionable items. Next, the actions were assigned to appropriate goals. For the 2020 update, the Planning Committee elected to keep the same methodology.

The original mitigation actions were reviewed by the Planning Committee and updated as necessary by the individual communities. Committee members also reviewed the January 2013 publication *Mitigation Ideas: A Resource for Reducing Risks to Natural Hazards* provided by Federal Emergency Management Agency (FEMA) to identify a broad range of additional and alternative actions that could be pursued. Updates are included in the following tables with a more detailed analysis of each action, including alternative actions considered, included in Appendix 4-1.

For the 2010 and 2015 plans, actions were evaluated using the STAPLEE method as a way of considering actions in terms of Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLEE) factors for implementation. Although this provided a very thorough and systematic means of evaluating each action, it was also felt to be a bit cumbersome. As committee members reflected on those mitigation actions from the 2010 and 2015 plans, there also did not seem to be a clear correlation between the STAPLEE scores and the actions that were and were not implemented.

Because of this, the Planning Committee chose to develop a process for evaluating and prioritizing mitigation actions based more on a simplified review of the potential benefits and costs, as these seemed to be the determining factors as to which actions were implemented. Using this methodology, each mitigation action was categorized as being either high cost or moderate to low cost. For these purposes, “high cost” was defined as projects for which the cost was beyond the current capabilities of the community and for which financial assistance and/or a special bond issue would be required to fund the majority of the project. “Moderate to low cost” was defined as a project for which the cost was not prohibitive and/or could be incorporated into the normal operational budget for the individual jurisdiction with some or no financial assistance.

At the same time, each mitigation action was also categorized as being “high benefit” or “moderate benefit.” (Actions that were judged as having little or no benefit were automatically ruled out of consideration for inclusion in the plan.) “High benefit” actions were defined as those that met two or more of the goals previously defined on page 131. “Moderate benefit” actions were defined as those that met no more than one goal.

Using these categorizations, a matrix was developed as follows:

	Moderate to Low Cost	High Cost
Moderate Benefit	**Medium Priority**	**Low Priority**
High Benefit	**High Priority**	**Medium Priority**

Mitigation actions that were determined to be of moderate to low cost and high benefit were assigned the highest priority consideration. Actions that were moderate to low cost and moderate benefit, as well as actions determined to be high cost but also high benefit were both categorized as medium priority. Any mitigation actions that were high cost but of moderate benefit were given the lowest priority consideration.

Following Planning Committee review and concurrence, the priority actions selected are summarized in Table 4-1. The top multi-jurisdictional priority action is in bold. A more detailed analysis of each action item is included as Appendix 4-1, including the potential benefit of the action, alternatives considered, estimated costs, funding source, person/entity best suited to serve as project lead, timeframe for completion, and priority rating.

Table 4-1
Multi-Jurisdictional Priority Actions

Action ID	Action	Objective	Goals	Hazards Addressed	Status	New for 2020	Include in 2020 Plan
4.1	Public information and signage of the location of emergency storm shelters.	PE	4	Tornado; Extreme Heat; Extreme Cold	Completed for short-term shelters for heat/cold; will compile list of long term shelters next	No	Yes
4.2	Educate the public on the importance of purchasing NOAA weather radios.	PE	4	All	Completed; local broadcasting stations sponsor purchasing drives at local grocery stores	No	No
4.3	Education of early warning systems and how to respond	PE	4	Tornado; Windstorm; Severe Winter Storm; Thunderstorm & Lightning	Continuous cycle coinciding with statewide tornado drills in March	No	move to plan maintenance
4.4	Public education on what to do during a storm or hazard event	PE	4	All	Continuous cycle also coinciding with March tornado drills and efforts ahead of other hazards	No	move to plan maintenance
4.5	Create educational materials about High Priority Hazards identified in Muscatine County Multi-Jurisdictional Hazard Plan	PE	4	All	In progress; identifying materials available through FEMA	No	Yes
4.6	Create public educational materials regarding flood areas, regulations, mitigation measures, and insurance limitations available.	PE	4	River Flood; Flash Flood	Materials available on case by case basis; hosting public meetings related to changes in FIRM maps	No	Yes
4.7	**Distribute bilingual FEMA educational materials throughout county**	**PE**	**4, 5**	**All**	**Materials available in EMA office; distributing to libraries, Salvation Army, and County Administration building next**	**No**	**Yes**

Jurisdiction Mitigation Actions

In addition to the priority actions identified for the planning area as a whole, each participating jurisdiction identified at least one of its own actions to carry out. Each jurisdiction completed the evaluation method previously detailed on pages 133-134 for the mitigation actions their jurisdiction intended to carry out. The individual jurisdiction priority actions are summarized in Table 4-2. The top priority mitigation action for each jurisdiction is in bold. In instances where the high priority actions (as determined by the prioritization evaluation matrix) were already completed or underway, some jurisdictions opted to select a medium priority item as their top priority action.

Table 4-2
Jurisdictional Priority Actions

Action ID	Action	Objective	Goal	Hazard Addressed	Included in 2015 Plan	Status	New for 2020	Include in 2020 Plan
Muscatine County								
1.1	Evaluate Safe Room construction where vulnerable populations may not have other sources of shelter and construct where financially and technically feasible	SP	1,2	Tornado	Yes	No safe rooms have been constructed within unincorporated Muscatine County; focus for safe rooms on population centers	No	No
1.2	**Implement voluntary flood acquisition/demolition programs when financially feasible**	**PP**	**1,2**	**River Flood; Flash Flood**	**Yes**	**In progress**	**No**	**Yes**
1.3	Establish warming and cooling centers	ES	1,2	Severe Winter Storms; Extreme Heat	Yes	No centers in unincorporated areas; others established in Nichols, Wilton, and the City of Muscatine	No	No
1.4	Update and enforce building codes to current International Code Series	PM	1,2	Tornado; Windstorm; Flash Flood; River Flood; Severe Winter Storm; Earthquakes	Yes	2015 International Codes adopted in 2017, enforcement ongoing.	No	Move to plan maintenance
1.7	Participate in the Muscatine Levee Stakeholder group meetings with the end goal of determining the cost/benefit relationship to raise the levee to the 500 year flood level with 3 foot of freeboard.	SP	1,3	Levee Failure	No	Continue to participate in discussions. Raising levee will be pending funding options and Corps of Engineers approval.	Yes	Yes

Action ID	Action	Objective	Goal	Hazard Addressed	Included in 2015 Plan	Status	New for 2020	Include in 2020 Plan
2.1	Ensure that mobile homes have adequate tie downs	PM	2	Tornado; Windstorm; Thunderstorm & Lightning	Yes	Complete – enforced as part of current construction and inspections	No	Move to plan maintenance
2.2	Continue NFIP compliance by enforcing flood plain ordinances based on the State of Iowa Model Code.	PP	2,3	River Flood; Flash Flood	Yes	Complete – enforcement ongoing	No	Move to plan maintenance
2.3	Reduce repetitive loss properties by requiring elevation of properties	PP	2	River Flood; Flash Flood	Yes	Required but some difficulty in compliance	No	Yes
2.4	Implement uniform method of additional early warning system county wide	PM	2,4	Tornado; Windstorm; Severe Winter Storm; Thunderstorm & Lightning	Yes	Utilizing outdoor signals and social media; currently exploring other mass notification options	No	Yes
2.5	Implement uniform method of additional early warning system countywide	PM	2,4	Tornado; Windstorm; Thunderstorm & Lightening	Yes	Utilizing outdoor signals and social media; currently exploring other mass notification options	No	Yes
3.1	Pursue Community Rating System	PM	3	River Flood; Flash Flood	Yes	Need to pursue	No	Yes
3.2	Identify critical facilities, such as lift stations, where back-up power generators should be installed	ES	3	Tornado; Windstorm; Thunderstorm & Lightning	Yes	In progress – jail and highway dept. buildings have generators; other locations pending funding	No	Yes

Action ID	Action	Objective	Goal	Hazard Addressed	Included in 2015 Plan	Status	New for 2020	Include in 2020 Plan
Atalissa								
1.3	**Establish warming or cooling centers**	**ES**	**1,2**	**Severe Winter Storms; Extreme Heat**	**Yes**	**Fire station now serves as a warming station as needed; options for cooling centers being investigated.**	**No**	**Yes**
2.2	Continue NFIP compliance by enforcing flood plain ordinances based on the State of Iowa Model Code.	PP	2,3	River Flood; Flash Flood	Yes	Complete – updates to ordinances as needed on a continuing basis	No	Move to plan maintenance
3.2	Identify critical facilities, such as lift stations, where back-up power generators should be installed and install	ES	3	Tornado; Windstorm; Thunderstorm & Lightning	Yes	Complete – portable generator at water plant installed	No	No
Conesville								
1.1	Construct safe room where vulnerable populations may not have other sources of shelter where financially and technically feasible	SP	1,2	Tornado	Yes	Complete – two churches have basements serving as safe rooms and 20 concrete shelters distributed to individual households	No	No
1.3	Establish warming or cooling centers	ES	1,2	Severe Winter Storms; Extreme Heat	Yes	Incomplete – fire station identified as suitable location but no formal warming/cooling center established	No	Yes
1.5	Encourage development of check-on-neighbor programs for (seniors, disabled, and special needs citizens).	PM and PE	1,5	Tornado; Severe Winter Storm; Thunderstorm & Lightning; Windstorm	Yes	Complete – Fire Department and city staff checks on vulnerable citizens as needed	No	Move to plan maintenance

Action ID	Action	Objective	Goal	Hazard Addressed	Included in 2015 Plan	Status	New for 2020	Include in 2020 Plan
2.5	**Provide NOAA weather radios for schools, municipal buildings, and public assembly facilities; such as soccer fields and sports stadiums**	**PM**	**2**	**All**	**Yes**	**Not yet complete – would like them for fire station, city hall, and church**	**No**	**Yes**
3.2	Obtain generators for fire department, city hall, and church.	ES	3	Tornado; Windstorm; Thunderstorm & Lightning	Yes	Complete – city has access to five refurbished generators that can be deployed as needed.	No	No
Fruitland								
1.5	**Encourage development of check-on-neighbor programs for seniors, disabled, and special needs citizens.**	**PM and PE**	**1**	**Tornado; Severe Winter Storm; Thunderstorm & Lightning; Windstorm**	**Yes**	**Incomplete – options being evaluated for 2020 communications/outreach effort**	**No**	**Yes**
2.2	Continue NFIP compliance by enforcing flood plain ordinances based on the State of Iowa Model Code.	PP	2,3	River Flood; Flash Flood	Yes	Ordinances updated in 2019 – updates to continue as needed	No	Move to plan maintenance
5.1	Test Warning Systems integrated with MUSCOM	PM	5	Windstorm; Thunderstorm & Lightning; Severe Winter Storm; Tornado	Yes	Complete – city tests siren and batteries twice a month	No	Move to plan maintenance
Muscatine								
1.4	Update and enforce building codes to current International Code Series	PM	1,2	Tornado; Windstorm; Flash Flood; River Flood; Severe Winter Storm; Earthquakes	Yes	Fire Department and Building & Zoning will update code versions on the same cycle as the state of Iowa.	No	Move to plan maintenance

Action ID	Action	Objective	Goal	Hazard Addressed	Included in 2015 Plan	Status	New for 2020	Include in 2020 Plan
1.6	Maintain legally enforceable floodplain management regulations that are compliant with Title 44 CFR 60 to ensure Muscatine residents and businesses are eligible to participate in the NFIP	PP	1, 2	River Flood; Flash Flood	Yes	Complete – new ordinance adoption for revised FIRMs in January 2014. FIRMs effective April 2014, enforcement of regulations continue	No	Move to plan maintenance
1.7	Participate in the Muscatine Levee Stakeholder group meetings with the end goal of determining the cost/benefit relationship to raise the levee to the 500 year flood level with 3 feet of freeboard.	SP	1,3	Levee Failure	No	Continue to participate in discussions. Levee raising be pending funding options.	Yes	Yes
3.2	Identify critical facilities, such as communications center and lift stations, where back-up power generators should be installed and install	ES	3	Tornado; Windstorm; Thunderstorm & Lightning	Yes	Critical facilities have been identified, but generators have not yet been purchased and/or installed. Pending funding.	No	Yes
3.3	Continue routine inspection & maintenance of levees as needed	SP	3	Levee Failure	Yes	All levees have been certified; annual inspections for routine maintenance will continue.	No	Move to plan maintenance
3.4	**Separate combined sewer systems at the Papoose Creek pumping station**	**SP, NR**	**3,1**	**River Flood; Flash Flood**	**Yes**	**Scheduled phases underway - estimated completion in 2028.**	**No**	**Yes**
Nichols								
1.1	Safe room construction where vulnerable populations may not have other sources of shelter where feasible	SP	1,2	Tornado	Yes	Incomplete – investigating facility upgrade to a portion of fire station to serve as safe room	No	Yes

Action ID	Action	Objective	Goal	Hazard Addressed	Included in 2015 Plan	Status	New for 2020	Include in 2020 Plan
1.3	Establish warming or cooling centers	ES	1,2	Severe Winter Storms; Extreme Heat	Yes	Complete – have begun using fire station for daytime use as warming/cooling station	No	No
2.2	Continue NFIP compliance by enforcing flood plain ordinances based on the State of Iowa Model Code.	PP	2,3	River Flood; Flash Flood	Yes	Complete – updates to ordinances as needed on a continuing basis	No	Move to plan maintenance
2.6	Establish real-time systems for notifying emergency responders and the public of road closings due to flash floods	ES	2,5	River Flood; Flash Flood	Yes	Incomplete – funding has not been available	No	Yes
3.2	**Identify critical facilities, such as lift stations, where back-up power generators should be installed and install**	**ES**	**3**	**Tornado; Windstorm; Thunderstorm & Lightning**	**Yes**	**Critical facilities identified; funding has not been available for lift station generator**	**No**	**Yes**
West Liberty								
1.1	Safe room construction at Dutton Park to provide shelter during severe weather for visitors to the park; investigate where other vulnerable populations may not have other sources of shelter and possibility of safe room construction to meet this need	SP	1,2	River flood, flash flood	No	New project; funding opportunities sought	Yes	Yes
2.5	Provide NOAA weather radios for schools, municipal buildings, and public assembly facilities	PM	1,3	All	Yes	Obtained	No	No

Action ID	Action	Objective	Goal	Hazard Addressed	Included in 2015 Plan	Status	New for 2020	Include in 2020 Plan
2.6	Establish real-time systems for notifying emergency responders and public of road closures	ES	2,5	All	Yes	Complete – Utilizing popular social media apps to disseminate real time information. Emergency responders have several ways of communicating real time information throughout the county.	No	No
3.2	**Identify critical facilities, such as lift stations, where back-up power generators should be installed and install**	**ES**	**3**	**Tornado, Windstorm, Thunderstorm & Lightning**	**Yes**	**Lift station generators are priority in FY 20/21. All other critical facilities have back-up generators.**	**No**	**Yes**
Wilton								
1.3	Establish warming or cooling centers	ES	1,2	Severe Winter Storms; Extreme Heat	Yes	Complete – City Hall and fire station established as warming/cooling centers	No	No
1.4	Update and enforce building codes to current International Code Series	PM	1,2	Tornado; Windstorm; Flash Flood; River Flood; Severe Winter Storm; Earthquakes	Yes	Incomplete – ongoing council discussion	No	Yes
1.8	**Update storm sewer to mitigate flash flooding**	**PP**	**1,3**	**Flash Flood**	**No**	**New**	**Yes**	**Yes**
2.2	Continue NFIP compliance by enforcing flood plain ordinances based on the State of Iowa Model Code.	PP	2,3	River Flood; Flash Flood	Yes	Complete; updates to ordinances as needed on a continuing basis	No	Move to plan maintenance
3.2	Identify critical facilities, such as lift stations, where back-up power generators should be installed and install.	ES	3	Tornado; Windstorm; Thunderstorm & Lightning	Yes	Complete; generator installed at fire station, which was the only remaining critical facility identified in last plan and not yet equipped.	No	No

Action ID	Action	Objective	Goal	Hazard Addressed	Included in 2015 Plan	Status	New for 2020	Include in 2020 Plan
3.3	Separate combined sewer systems	SP, NR	3	River Flood; Flash Flood	Yes	Complete; new sewer line added that eliminated remaining combined lines	No	No
5.1	Test Warning Systems	PM	5	Windstorm; Thunderstorm & Lightning; Severe Winter Storm; Tornado	Yes	Complete; regular test schedule established and ongoing	No	Move to plan maintenance

5 PLAN MAINTENANCE PROCESS

Between the adoption of the 2015 plan and the plan update, jurisdictions worked individually toward completing their mitigation actions, and those achievements are discussed in Chapter 4. Notably, every jurisdiction made some progress on the mitigation actions outlined in the previous plan; where progress was not made, insufficient funding and staff changes were the two most common determining factors. After review of the procedures outlined in the 2010 plan, the Planning Committee agreed the plan maintenance process outlined made sense. Moving forward, the Muscatine County Emergency Management Department will coordinate annual meetings to review, evaluate, and update the plan as necessary with the assistance of the Bi-State Regional Commission. For record keeping purposes, an annual update form will be used to track any changes to each jurisdiction and how they were affected by various hazards. The form can be found in Appendix 5.1.

Monitoring the Plan

Muscatine County will be the lead in the overall monitoring of the plan. The Planning Committee structure as described in the "Planning Process" section will be maintained to assure that each jurisdiction participates. Jurisdictions will be asked to fill vacancies at least annually to maintain a primary contact for the plan maintenance process. The Muscatine County Emergency Management Department will schedule an annual meeting of the Planning Committee to track progress made on implementation of priority actions for both the planning area as a whole and individual jurisdictions. Generally, jurisdictions with their own ordinances and enforcement procedures will be responsible for monitoring their individual mitigation actions. At the annual meeting, the Planning Committee will also review the plan and make recommendations whether plan amendments or updates are needed due to changing conditions.

Evaluating the Plan

As part of the annual meeting described above, the Planning Committee will evaluate whether events of the previous year have affected the priority ranking of identified hazards. The plan will be evaluated based on the success of carrying out priority mitigation actions as identified in the plan. The Muscatine County Emergency Management Department will be responsible for preparing periodic progress reports on the plan utilizing the annual report form as described above. This report will be copied to the Chief Elected Officials of the participating jurisdictions and other primary contacts as appropriate. Finally, the Planning Committee will evaluate if the benefits of the priority actions are addressing the identified goals and objectives of the plan. If the completed actions from this plan are found to not benefit and address the goals and objectives of the plan, the Planning Committee may elect to update the plan early as described below.

Updating the Plan

The plan will be updated within five years of the date of the Federal Emergency Management Agency's (FEMA) approval of the plan as required by 44 CFR 201.6(c)(4)(i). The plan may be updated earlier at the discretion of the Planning Committee, or in the event of a Presidential Disaster Declaration, which requires an update by regulation. The Muscatine County Emergency Management Department will be responsible for collecting and maintaining information pertinent to future plan updates based on recommendations of the Planning Committee. Any

changes will be documented and appended to the plan document in a section titled "Amendments" until such time as a full update is scheduled. The Annual Update Reports from each jurisdiction will also be placed in this appendix. If no earlier update is needed, the Planning Committee will evaluate the need for funding assistance for the update at its third annual meeting. This will allow time to make an application for planning grant funds and identify whether a contract with a consultant will be necessary for the update process. Actions to undertake the plan update should be scheduled so that there is continuity of FEMA approval for the applicable plan document.

Incorporation Into Existing Planning Mechanisms

Early in the planning process, participating jurisdictions were asked to update their list of existing local planning mechanisms and ordinances in order to update what was already in place and to incorporate the mechanisms into the hazard mitigation plan. These lists are summarized in a matrix of existing planning mechanisms for the participating jurisdictions as shown in Chapter 2.

What:

Incorporating requirements of the mitigation plan will focus on existing planning mechanisms common among participating jurisdictions. These include:

- Comprehensive/Land Use Plans
- Subdivision Regulations
- Zoning Ordinances
- Building Codes
- Flood Plain Management Ordinances

Comprehensive/land use plans, or subdivision regulations for communities without a current comprehensive plan, provide the guidance for a community's ongoing and future development. The remaining ordinances and regulations listed above provide the enforcement tools for those development plans.

Who:

Muscatine County Emergency Management Department will collect information to review and incorporate as required as necessary into the hazard mitigation plan. Smaller communities that do not have their own planning and ordinance enforcement officials contract out their enforcement. Larger communities with their own planning and ordinance enforcement officials will review their own existing planning mechanisms. These larger communities can communicate any adjustments in their planning mechanisms through their representation on the Planning Committee and in the Annual Update Report form.

How:

Existing planning mechanisms will be reviewed for consistency with the requirements of the local hazard mitigation plan in order to avoid duplication of efforts among jurisdictional departments or enforcement officials. Risk analysis and vulnerability data from the local hazard mitigation plan shall be incorporated into the comprehensive/land use plans of each participating

jurisdiction during regular review and update cycles. Risk analysis and vulnerability data and mitigation actions will be incorporated into enforcement tools where appropriate. For example, references to the scale of earthquake intensity may be appropriate to building codes. Any adjustments or amendments to existing planning mechanisms will be made through the regular review cycle of the participating jurisdiction. Inconsistencies found between existing planning mechanisms and the local hazard mitigation plan shall be reported to the Muscatine County Emergency Management Department for the annual plan review meeting.

When:

Muscatine County Emergency Management Department will report at least annually on the progress of incorporating requirements of the mitigation plan through the meeting of the Planning Committee as described in the "Monitoring the Plan" section above. Any issues reported of inconsistency between the local hazard mitigation plan and existing planning mechanisms will be considered for plan amendments or updates.

Continued Compliance/Enforcement

While reviewing the mitigation actions from the 2015 plan, the Planning Committee identified a number of enforcement items for which the status had been designated as "ongoing." These included effort related to regulations, ordinances, codes, and system checks. Recognizing that such activities are part of a continuous cycle to maintain progress made toward hazard mitigation goals, the Planning Committee decided it was appropriate to move these items from the list of mitigation actions (as noted in Table 4-2) to the plan maintenance section of this document.

A summary of these enforcement items is presented in table 5-1.

Table 5-1
Enforcement Items to be Undertaken as Part of Plan Maintenance

Muscatine County Multi-Jurisdictional Priority Actions				
Action ID	**Action**	**Objective**	**Goal**	**Hazard Addressed**
4.4	Public education on what to do during a storm or hazard event	PE	4	All
4.3	Education of early warning systems and how to respond	PE	4	Tornado; Windstorm; Severe Winterstorm; Thunderstorm & Lightning
Unincorporated Muscatine County				
Action ID	**Action**	**Objective**	**Goal**	**Hazard Addressed**
1.4	Update and enforce building codes to current International Code Series	PM	1,2	Tornado; Windstorm; Flash Flood; River Flood; Severe Winter Storm; Earthquakes
2.1	Ensure that mobile homes have adequate tie downs	PM	2	Tornado; Windstorm; Thunderstorm & Lightning
2.2	Continue NFIP compliance by enforcing flood plain ordinances based on the State of Iowa Model Code.	PP	2,3	River Flood; Flash Flood

Atalissa				
Action ID	**Action**	**Objective**	**Goal**	**Hazard Addressed**
2.2	Continue NFIP compliance by enforcing flood plain ordinances based on the State of Iowa Model Code.	PP	2,3	River Flood; Flash Flood
Conesville				
Action ID	**Action**	**Objective**	**Goal**	**Hazard Addressed**
1.5	Maintain check-on-neighbor programs for seniors, disabled, and special needs citizens.	PM and PE	1,5	Tornado; Severe Winter Storm; Thunderstorm & Lightning; Windstorm
Fruitland				
Action ID	**Action**	**Objective**	**Goal**	**Hazard Addressed**
2.2	Continue NFIP compliance by enforcing flood plain ordinances based on the State of Iowa Model Code.	PP	2,3	River Flood; Flash Flood
5.1	Test Warning Systems integrated with MUSCOM	PM	5	Windstorm; Thunderstorm & Lightning; Severe Winter Storm; Tornado
Muscatine				
Action ID	**Action**	**Objective**	**Goal**	**Hazard Addressed**
1.4	Update and enforce building codes to current International Code Series	PM	1,2	Tornado; Windstorm; Flash Flood; River Flood; Severe Winter Storm; Earthquakes
1.6	Maintain legally enforceable floodplain management regulations that are compliant with Title 44 CFR 60 to ensure Muscatine residents and businesses continue to be eligible to participate in the NFIP	PP	1, 2	River Flood; Flash Flood
3.3	Continue routine inspection & maintenance of levees as needed	SP	3	Levee Failure
Nichols				
Action ID	**Action**	**Objective**	**Goal**	**Hazard Addressed**
2.2	Continue NFIP compliance by enforcing flood plain ordinances based on the State of Iowa Model Code.	PP	2,3	River Flood; Flash Flood
Wilton				
Action ID	**Action**	**Objective**	**Goal**	**Hazard Addressed**
2.2	Continue NFIP compliance by enforcing flood plain ordinances based on the State of Iowa Model Code.	PP	2,3	River Flood; Flash Flood
5.1	Test Warning Systems	PM	5	Windstorm; Thunderstorm & Lightning; Severe Winter Storm; Tornado

Continued Public Involvement

Muscatine County intends to make use of its website for continued public involvement. The website has been used in the plan process to keep the public informed about the plan document drafts in progress and Planning Committee meetings. The website will continue to be used to post the final local hazard mitigation plan document as adopted and approved by FEMA. The website also contains related hazard mitigation resources and links. Annual meetings of the Planning Committee will be publicized in the local newspaper of general circulation and the meeting notice will be posted on the website. Progress reports will also be posted on the website as issued. Public comments on the plan process or document will be recorded and reported at the annual meeting of the Planning Committee.

APPENDIX 1-1

Resolution Number # _____

A RESOLUTION OF THE CITY OF _____ IN SUPPORT OF THE APPROVAL AND ADOPTION OF THE MUSCATINE COUNTY MULTI-JURISDICTION LOCAL HAZARD MITIGATION PLAN

RESOLUTION

WHEREAS, the City of _____, with the assistance from Muscatine County and the Bi-State Regional Commission (BSRC) has gathered information and prepared the Muscatine County Multi-Jurisdictional Hazard Mitigation Plan; and,

WHEREAS, the Muscatine County Multi-Jurisdictional Hazard Mitigation Plan has been prepared in accordance with FEMA requirements at 44 C.F.R. 201.6; and,

WHEREAS, the Plan process has been subject to public review and comment during its development; and

WHEREAS, the Mayor and the City Council of the City of _____ has reviewed the Plan; and

NOW, THEREFORE BE IT RESOLVED by the Mayor and the City Council of the City of _____ that the City of _____ hereby approves and adopts the Muscatine County Multi-Jurisdiction Local Hazard Mitigation Plan as this jurisdictions Multi-Hazard Mitigation Plan pending FEMA approval of the Plan.

Adopted this ___ day of _____, 201_ at the meeting of the Mayor and City Council for the City of _____.

_____

_____, Mayor

Attest:

_____

_____, Clerk

APPENDIX 2-1

Muscatine County Multi-Jurisdictional Hazard Mitigation Plan

2020 Update Kick-Off Meeting

BI-STATE REGIONAL COMMISSION

AUGUST 19, 2019

Agenda

- What is hazard mitigation planning and why do it
- The current Muscatine County HazMit Plan
- Individual jurisdictions' responsibilities
- Proposed update process and streamlined timeline
- Next steps
- Questions

What is hazard mitigation planning?

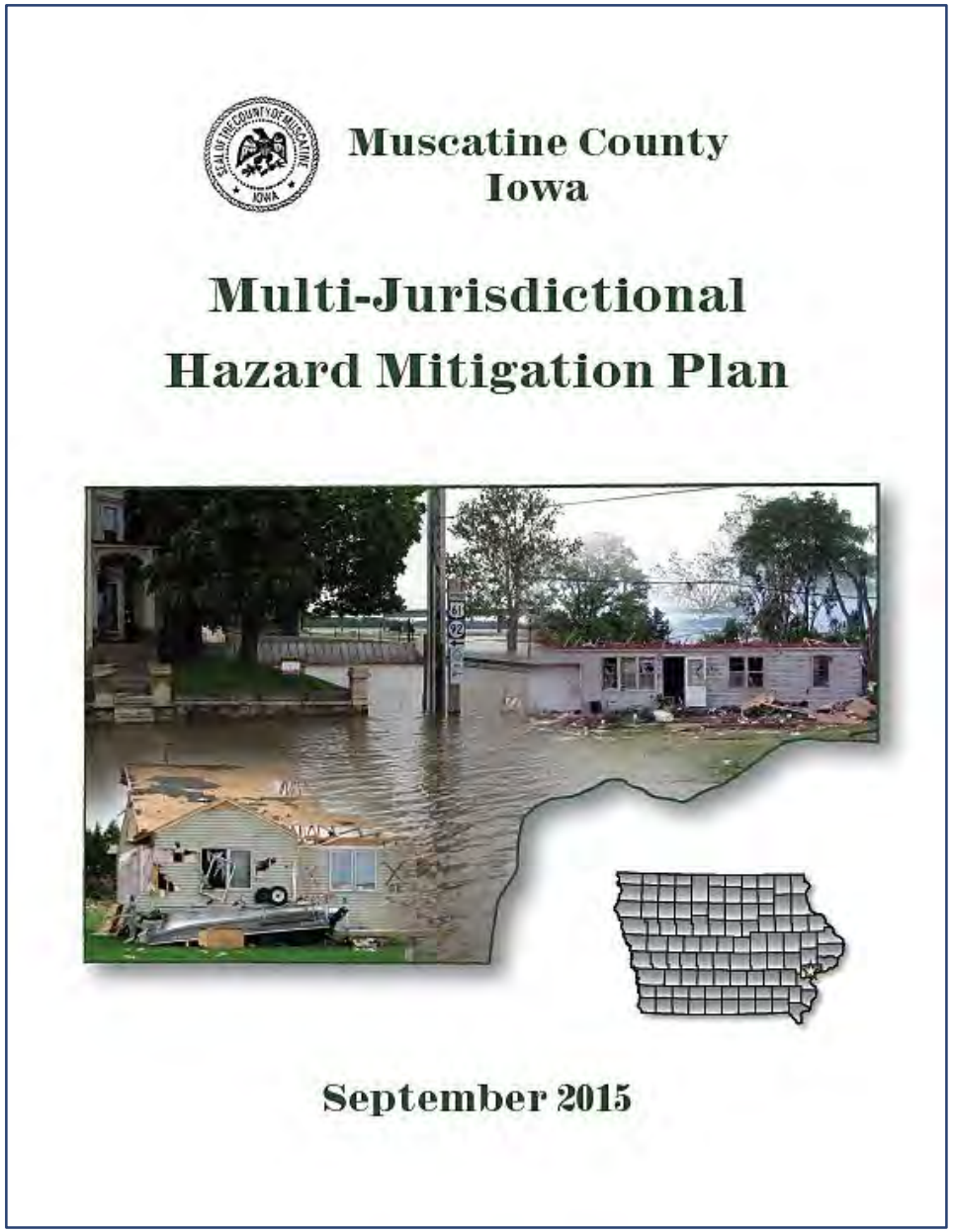
A process used to identify risks and vulnerabilities associated with natural disasters, and to develop long-term strategies for protecting people and property from future hazards

Why update a HazMit plan?

- Disaster Mitigation Act of 2000 provides the legal basis for FEMA mitigation planning requirements for State, local, and Tribal governments
- Keeping plan current allows communities to be eligible for FEMA Hazard Mitigation Assistance Grant Programs
- Plans must be updated every 5 years – current plan expires in September 2020

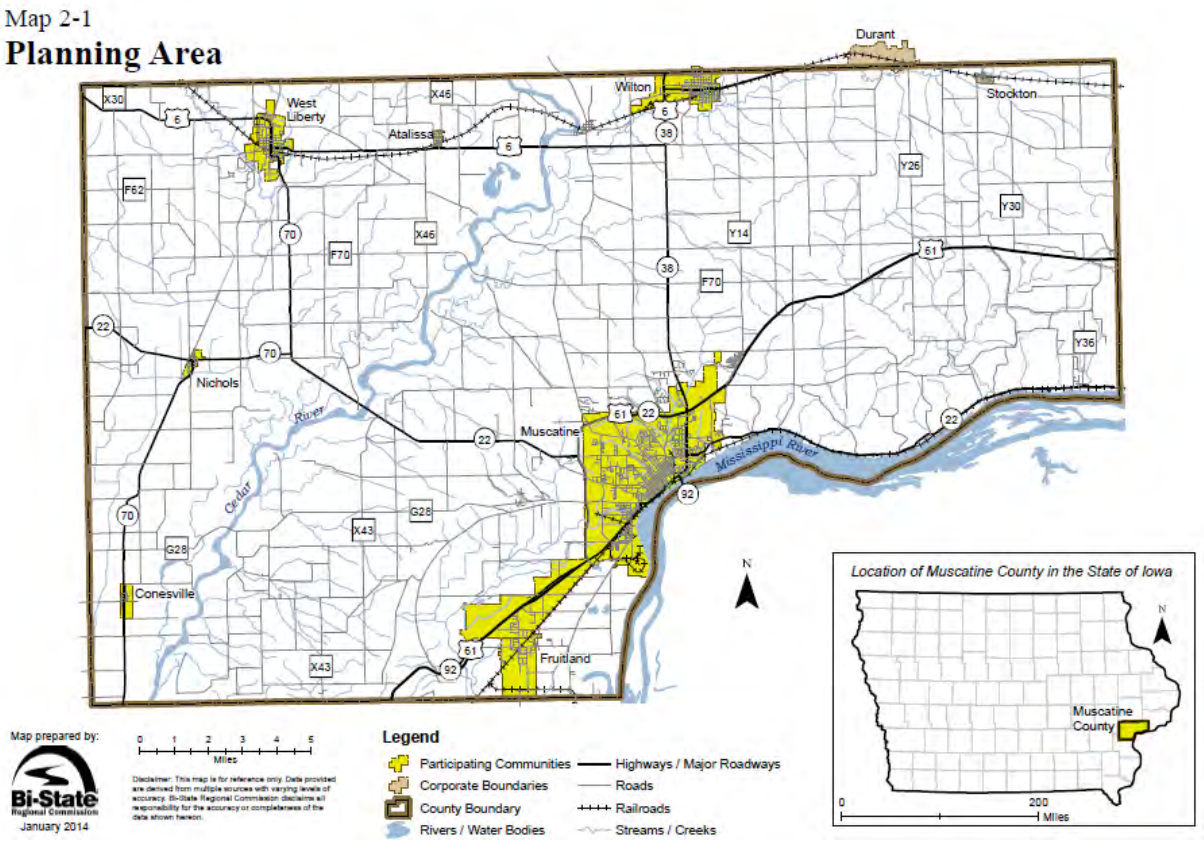
2015 Muscatine County HazMit Plan

- Chapter 1: Legal Prerequisites
- Chapter 2: Planning process
- Chapter 3: Risk Assessment
- Chapter 4: Mitigation Strategy
- Chapter 5: Plan Maintenance Process



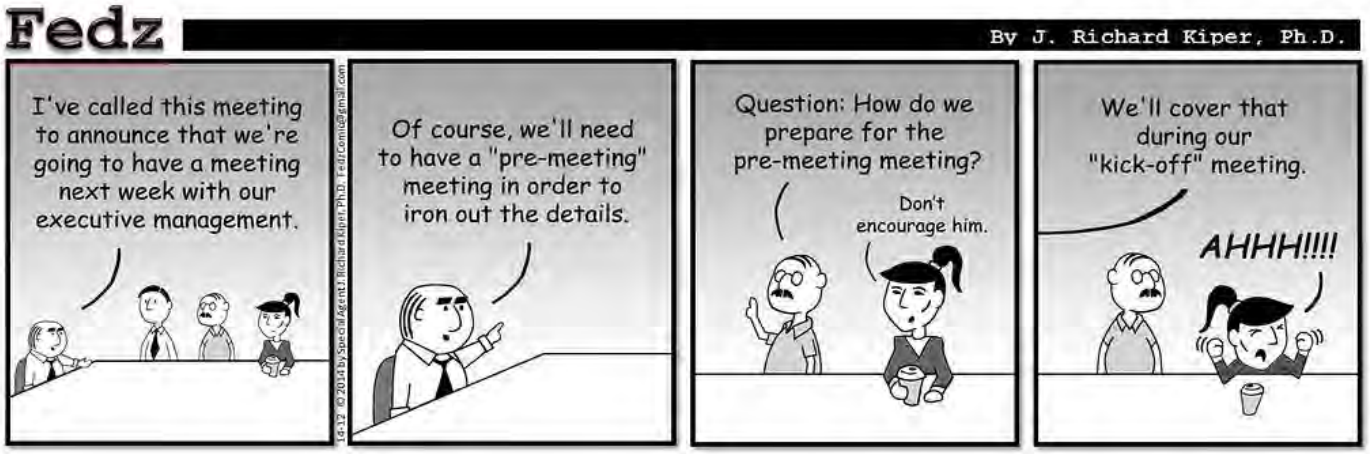
2015 Participants

- Atalissa
- Conesville
- Fruitland
- Muscatine
- Muscatine County
- Nichols
- West Liberty
- Wilton



Role of participating jurisdictions

- Participate in the planning process by:
  - Designate a primary contact:
  - Attend planning committee meetings (minimum requirement: _____)
  - Provide information as requested
  - Review planning documents and suggest edits
- Adoption of the Hazard Mitigation Plan



Public Input

- Important part of the planning process
- Ideas:
  - Kick-off meeting
  - Plan review and public comment
  - Make all planning meetings public
  - City council meeting announcement
  - Others??

Image source: BLM

Project Timeline

Aug. 2019	• Planning Committee Kick-Off Meeting
Sept. 2019	• Public Kick-Off Meeting
Oct. 2019	• Review and update hazard profiles, county profile, critical facilities, jurisdictional profiles • Planning committee meeting
Nov. 2019	• Update mitigation action tables for each jurisdiction • Email/phone
Nov. – Dec. 2019	• Revise individual chapters (Bi-State staff), review revised chapters and offer feedback (Planning committee members) • Email/phone
Early January 2020	• Review draft of plan update • Planning committee meeting
Jan.-Feb. 2020	• Review Period • Public meeting
Feb. 2020	• FEMA Review (6 month review period)
May 2020-Aug. 2020	• Plan adoptions by each jurisdiction
September 2020	• 2015 Plan Expires

Next steps

Kick-Off Public Meeting
- Time, location, advertising

Contact Advisory Committee
- (handout)

Review recent hazards and update hazard rankings as needed

Review county profile, critical facilities, jurisdictional profiles and update as needed

Set October meeting date:

Rank Order Based on Weighted Scoring from Highest to Lowest

2010 Plan

First Third		
1	Windstorm	21.54
2	Thunderstorm & Lightning	21.14
3	Severe Winter Storm	19.55
4	Hailstorm	19.19
5	Tornado	18.74
6	Hazardous Material	17.71
Second Third		
7	Flash Flood	17.26
8	Extreme Heat	15.71
9	Levee Failure	15.34
10	River Flood	15.12
11	Grass & Wild-land Fire	14.40
12	Drought	12.80
Last Third		
13	Earthquake	11.75
14	Landslide	8.79
15	Sinkholes	8.75
16	Expansive Soil	8.22
17	Dam Failure	7.74

Updated

High		
1	Tornado	3.25
2	Severe Winter Storm	3.04
3	Thunderstorm & Lightning	2.94
4	Windstorm	2.81
5	Flash Flood	2.81
6	River Flood	2.80
Medium		
7	Hailstorm	2.41
8	Drought	2.41
9	Hazardous Materials	2.39
10	Extreme Heat	2.18
11	Levee Failure	2.00
12	Grass & Wild-land Fire	2.00
Low		
13	Earthquake	1.90
14	Dam Failure	1.59
15	Sinkholes & Land Subsidence	1.53
16	Landslide	1.35
17	Expansive Soils	1.13

Hazard Score = (probability x 0.45) + (severity x 0.30) + (warning time x 0.15) + (duration x 0.1)

Bi-State will provide data on recent hazards

You provide rankings for your jurisdiction

Bi-State will compile and do the math

Muscatine County Scoring 2019

EVENT	PROBABILITY	MAGNITUDE/ SEVERITY	WARNING TIME	DURATION	RISK
	Likelihood this will occur	*Possibility of death or injury, personal property, and infrastructure*	*Potential amount of warning time before hazard occurs*	*The duration of time that a hazard will affect the state*	*Weighted Score**
SCORE	*1 - Unlikely*	*1 - Negligible*	*1 - More than 24 hours*	*1 - Less than 6 hours*	*The higher the score the greater the risk*
	2 - Occasional	*2 - Limited*	*2 - 12 to 24 hours*	*2 - Less than 1 day*	
	3 - Likely	*3 - Critical*	*3 - 6 to 12 hours*	*3 - Less than 1 week*	
	4 - Highly Likely	*4 - Catastrophic*	*4 - Minimal or no warning (up to 6 hours)*	*4 - More than 1 week*	
Tornado					**0.00**
Severe Winter Storm					**0.00**
Thunderstorm & Lightening					**0.00**
Windstorm					**0.00**
Flash Flood					**0.00**
River Flood					**0.00**
Hailstorm					**0.00**
Drought					**0.00**
Hazardous Materials					**0.00**
Extreme Heat					**0.00**
Levee Failure					**0.00**
Grass & Wild-land Fire					**0.00**
Earthquake					**0.00**
Dam Failure					**0.00**
Sinkholes & Land Subsidence					
Landslide					
Expansive Soils					**0.00**

Questions?

Sarah J. Gardner, Senior Planner
SGardner@BiStateOnline.org
309-793-6300 x1148

Bi-State Regional Commission

APPENDIX 2-2

2020 MUSCATINE COUNTY MULTI-JURISDICTIONAL HAZARD MITIGATION PLAN

Planning Committee Members

Jurisdiction	Primary Contact and Title	Additional Participants
Bi-State Regional Commission	Sarah Gardner, *Senior Planner*	Denise Bulat, *Executive Director*
Muscatine County EMA	Brian Wright, *Director*	
Muscatine County Building, Zoning and Environment	Eric Furnas, *PZE Administrator*	
City of Atalissa	Samantha Parry, *Clerk/Treasurer*	
City of Conesville	Robert Probst, *Clerk*	
City of Fruitland	Marty Hills, *Mayor*	
City of Muscatine	Jerry Ewers, *Fire Chief*	Malcolm Oswald, *Council Member,* *Salvation Army Officer*
City of Nichols	Aeneas Schmidt, *Floodplain Ordinance Enforcement,* *Clerk/Treasurer*	Russel Grim, *Council Member*
West Liberty	Robert Rock, *Council Member*	Lawrence McNaul, *Floodplain Ordinance Enforcement/City Manager*
Wilton	Chris Ball, *Floodplain Ordinance Enforcement/City Administrator*	

APPENDIX 2-3

Bi-State
Regional Commission

Serving local governments in Muscatine and Scott Counties, Iowa;
Henry, Mercer and Rock Island Counties, Illinois

To All Organizations and Interested Parties:

This notice is to invite you or another representative of your organization to participate in a planning process to update the Muscatine County Multi-Jurisdictional Hazard Mitigation Plan. Muscatine County, Iowa contracted with Bi-State Regional Commission to guide the preparation of the update of the 2015 Muscatine County Multi-Jurisdictional Hazard Mitigation Plan. In addition to Muscatine County and the local jurisdiction representatives, the planning process requires a broad range of input and expertise from individuals and organizations with interest in hazard mitigation within Muscatine County (and neighboring organizations).

The plan will meet the requirements of the Disaster Mitigation Act of 2000, also known as DMA 2000. The Act, which was signed into law on October 30, 2000, streamlines delivery and utilization of disaster recovery assistance and places increased emphasis on local mitigation planning. It requires local governments to develop and submit mitigation plans as a condition of receiving project grants under four FEMA programs: Pre-Disaster Mitigation (PDM), Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA), Severe Repetitive Loss (SRL). Plans must be updated every 5 years in order to remain eligible.

Those participating are asked to review materials as the planning document develops. Participants are invited to attend planning group meetings as scheduled. A planning committee meeting will be held on **Monday, October 28, 2019 at 10:30 a.m.** at the Muscatine County Environmental Learning Center, 3300 Cedar Street, Muscatine, Iowa. A subsequent meeting will be scheduled in January 2020 to review a draft of the updated plan. You will also be notified in advance of that meeting.

Please let us know if you or another representative of your organization would be willing to participate in this planning process, so that we may develop an accurate contact list. Also, if you know of other organizations that should be included in this process, please let us know. Bi-State Regional Commission will be assisting Muscatine County in the plan update and you may be contacted regarding correspondence and questions. Contact information is provided below. Thank you for your assistance with this planning process, and we hope to see you at the meeting on October 28.

Questions regarding the ongoing planning process may be directed to Sarah Gardner at Bi-State Regional Commission (309) 793-6300 x 1148 or sgardner@bistateonline.org.

Sarah Gardner, Senior Planner
Bi-State Regional Commission
1504 3rd Avenue
Rock Island, IL 61201
(309) 793-6300 x 1148
sgardner@bistateonline.org

Note: If you would NOT like to be contacted please email Sarah Gardner at sgardner@bistateonline.org and we will remove you from the list.

APPENDIX 2-4

MUSCATINE COUNTY MULTI-JURISDICTIONAL HAZARD MITIGATION PLAN
ADVISORY GROUP

Neighboring Communities/ Non-Participating Communities

Organization	Contact Name	Title
City of Durant	Scott Spengler	Mayor
City of Stockton	Patrick Baker	Mayor
Scott County EMA	Dave Donovan	Director

State. Regional and Local Government Representatives

Organization	Contact Name	Title
Muscatine County Sheriff	C.J. Ryan	Sheriff
Iowa State Patrol Distict 12 Office	Lt. Brian Votroubek	Lieutenant
IHSEMD	Dan Schmitz	Deputy State Hazard Mitigation Officer
IHSEMD	Aimee Bartlett	StateHazard Mitigation Officer
Iowa NFIP Coordinator	Bill Cappuccio	State Floodplain Manager
Iowa State Climatologist	Dr. Justin Glisan	Climatologist
Iowa State Geologist	Dr. Keith Schilling	Geologist

Business and Developmental Agencies

Organization	Contact Name	Title
Muscatine Chamber of Commerce	Greg Jenkins	President & CEO
Wilton Chamber of Commerce	Jackie Barten	
West Liberty Chamber of Commerce/ WeLead	Becky Algood	

Federal Agency Representatives

Organization	Contact Name	Title
USACE	Jerry Skalak	Project Manager / Floodplain Manager
National Weather Service	Donna Dubberke	Meterologist

Neighborhood Groups and Non-Profits

Organization	Contact Name	Title
Red Cross	Brooke Mehaffey	Unit Director
United Way	Shane J. Orr	Executive Director
Muscatine County Conservation Board	Curt Weiss	Director

School Districts

Organization	Contact Name	Title
Muscatine CSD	Jerald Riibe	Superintendent
West Liberty CSD	Kara Dennis	Superintendent
Wilton CSD	Joe Burnett	Superintendent
EICC - Muscatine Campus	Naomi DeWinter	President

Media

Organization	Contact Name	Title
KWQC-TV 6	Ken Freedman	General Manager
WHBF -TV 4	Marshall Porter	General Manager
WQAD-TV 8	Jim Kiser	President and General Manager
Muscatine Journal	Debbie Anselm	Publisher
West Liberty Index	Stuart Clark and Jake Krob	Publisher
Wilton-Durant Advocate		Publisher

APPENDIX 2-5

*** Proof of Publication ***

The undersigned, being first duly sworn, on oath does say that he/she is an authorized employee of THE MUSCATINE JOURNAL, morning edition, a daily newspaper printed and published by Lee Enterprises, Incorporated, in the City of Davenport, Scott County, Iowa, and that a notice, a printed copy of which is made a part of this affidavit, was published in said THE MUSCATINE JOURNAL, on the dates listed below.

BI-STATE REGIONAL COMMISSION

PO BOX 3368

ROCK ISLAND, IL 61204

ORDER NUMBER 50698

The affiant further deposes and says that all of the facts set forth in the foregoing affidavit are true as he/she verily believes.

PUBLIC NOTICE

Muscatine County is in the process of preparing an update of the 2015 Muscatine County Multi-Jurisdictional Local Hazard Mitigation Plan. The County is partnering with the Bi-State Regional Commission to prepare the plan update. Two introductory meetings for public participation will be held. The first will take place Thursday, Sept. 12, 2019 at 6:30 p.m. at the West Liberty Public Library, 400 North Spencer Street, West Liberty, Iowa. The second will take place Tuesday, Sept. 17, 2019 at 4:30 p.m. at Muscatine Community College, Larson Hall Room 62 (Muscatine Access Nine Video Studio), 152 Colorado Street, Muscatine, Iowa. Jurisdictions participating in the plan in addition to Muscatine County in the past have include the Cities of Muscatine, Atalissa, Conesville, Fruitland, Nichols, West Liberty, and Wilton. The School Districts have also been invited to participate in the plan. Public participation and comments are invited as the plan update is developed. All planning meetings are open to the public. The schedule of meetings, related documents, and plan drafts will be posted for review on the County's website at http://www.co.muscatine.ia.us. Questions regarding the ongoing update process may be directed to Sarah Gardner at the Bi-State Regional Commission, (309) 793-6300, or Brian Wright with Muscatine County, (563) 288-3909.

SEP 16 2019

Section: Notices & Legals

Category: 2520 Miscellaneous Notice

PUBLISHED ON: 09/06/2019

TOTAL AD COST: 23.72

FILED ON: 9/6/2019

Subscribed and sworn to before me by said affiant this 6 day of Sep 2019.

Notary Public in and for Scott County, Iowa

NOTARIAL SEAL IOWA
CHERYL LOU SCHEMMEL
Commission Number 815098
My Commission Expires
February 04, 2022

NOTARIAL SEAL IOWA
CHERYL LOU SCHEMMEL
Commission Number 815098
My Commission Expires
February 04, 2022

*** Proof of Publication ***

The undersigned, being first duly sworn, on oath does say that he/she is an authorized employee of THE MUSCATINE JOURNAL, morning edition, a daily newspaper printed and published by Lee Enterprises, Incorporated, in the City of Davenport, Scott County, Iowa, and that a notice, a printed copy of which is made a part of this affidavit, was published in said THE MUSCATINE JOURNAL, on the dates listed below.

BI-STATE REGIONAL COMMISSION

PO BOX 3368

ROCK ISLAND, IL 61204

ORDER NUMBER 61489

NOTICE OF PUBLIC REVIEW
Muscatine County has prepared the 2020 Muscatine County Multi-Jurisdictional Local Hazard Mitigation Plan as an update to the 2015 Plan. Informational meetings for the public will be held on Tuesday, February 11 at 5:30 p.m. at the Musser Public Library, Room 104, 408 E. 2nd St., Muscatine, Iowa and on Thursday, February 13 at 6 p.m. at the West Liberty Public Library, 400 N. Spencer St., West Liberty. Jurisdictions participating in the plan in addition to the County include the Cities of Atalissa, Conesville, Fruitland, Muscatine, Nichols, West Liberty, and Wilton. Public participation and comments are invited as the plan development is finalized before plan adoption. The plan draft will be available at both libraries for two weeks following the meetings and posted for review on the County's website at www.co.muscatine.ia.us. Questions or comments regarding the plan may be directed to Sarah Gardner at the Bi-State Regional Commission, (309) 793-6300, or Brian Wright with Muscatine County, (563) 288-3909.

The affiant further deposes and says that all of the facts set forth in the foregoing affidavit are true as he/she verily believes.

Jessica Kelly

Section: Notices & Legals

Category: 2627 Miscellaneous Notices

PUBLISHED ON: 02/04/2020

TOTAL AD COST:	14.04
FILED ON:	2/4/2020

Subscribed and sworn to before me by said affiant this 4 day of February 2020.

Notary Public in and for Scott County, Iowa

NOTARIAL SEAL IOWA
CHERYL LOU SCHEMMEL
Commission Number 815098
My Commission Expires
February 04, 2022

APPENDIX 2-6

Bi-State
Regional Commission
1504 Third Avenue. P.O. Box 3368
Rock Island, IL 61204-3368
Phone: (309) 793-6300 • Fax: (309) 793-6305
Website: http://www.bistateonline.org

Muscatine County Residents:

This binder contains a draft of the 2020 Muscatine County Multi-Jurisdictional Hazard Mitigation Plan. The Federal Disaster Mitigation Act of 2000 requires jurisdictions to develop plans like these and update them every five years in order to be eligible for certain project grants, including the Flood Mitigation Assistance (FMA) and Hazard Mitigation Grant Program (HMGP).

The plan is also an opportunity for communities to review information about potential hazards in their area, consider which may have the greatest impacts to their residents and institutions, and develop mitigation strategies.

Simply put, mitigation strategies are projects a community can do before a disaster strikes to lessen its impact. These projects can include things like building safe rooms in public buildings to protect visitors against tornados or making sure buildings have adequate flood protection.

In addition to input from your local governments, the planning process requires a broad range of input from individuals and organizations with interest in hazard mitigation within Muscatine County. Importantly, this includes residents such as yourself.

The Bi-State Regional Commission has been working with communities in Muscatine County to create this draft of the 2020 Muscatine County Multi-Jurisdictional Hazard Mitigation Plan. As part of that process, we have held several public meetings and have arranged for a draft copy of the plan to be left here at your local library.

After you look at the document, if you have any questions or comments you would like to share, please reach out to Sarah Gardner at the Bi-State Regional Commission, who can be reached at (309) 793-6300 x 1148 or sgardner@bistateonline.org.

We welcome your insights and ideas!

APPENDIX 3-1

Muscatine County Multi-Jursidictional Hazard Mitigation Plan
Hazard Scoring Methodology

Each hazard will be scored in 4 catagories: Probability, Magnitude/Severity, Warning Time, and Duration

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.

SCORE	DESCRIPTION	
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	Occassional	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% 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% the event is likely to occur.
4	Highly Likely	More than 33% probability in any given year (event has 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 county.

SCORE	DESCRIPTION	
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.

SCORE	DESCRIPTION
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 (up to 6 hours warning).

Duration: A measure of the duration of time that the hazard will affect the state.

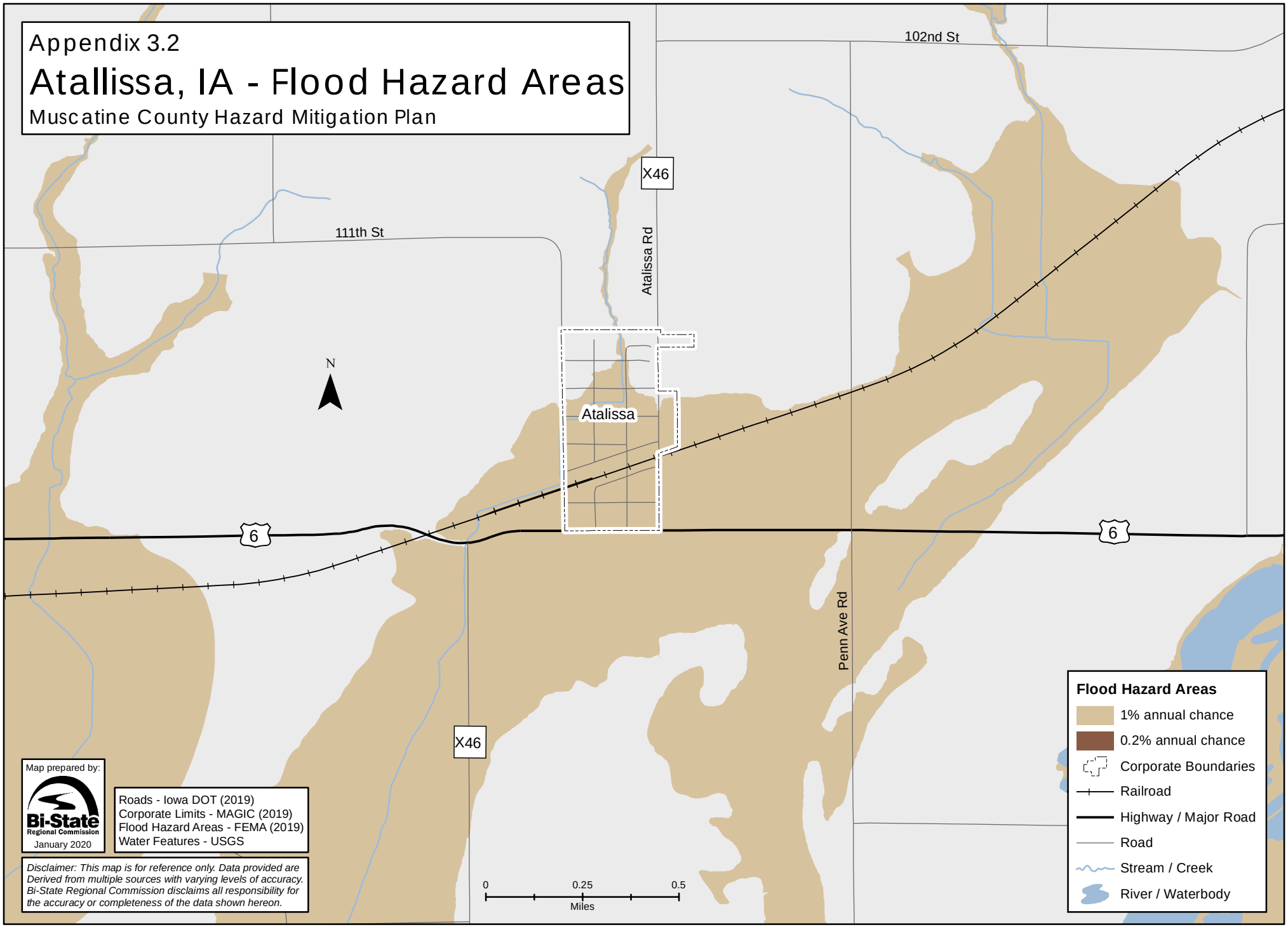
SCORE	DESCRIPTION
1	Less than 6 hours.
2	Less than 1 day.
3	Less than 1 week.
4	More than 1 week.

APPENDIX 3-2

Appendix 3.2

Atallissa, IA - Flood Hazard Areas

Muscatine County Hazard Mitigation Plan



Map prepared by:
Bi-State Regional Commission
January 2020

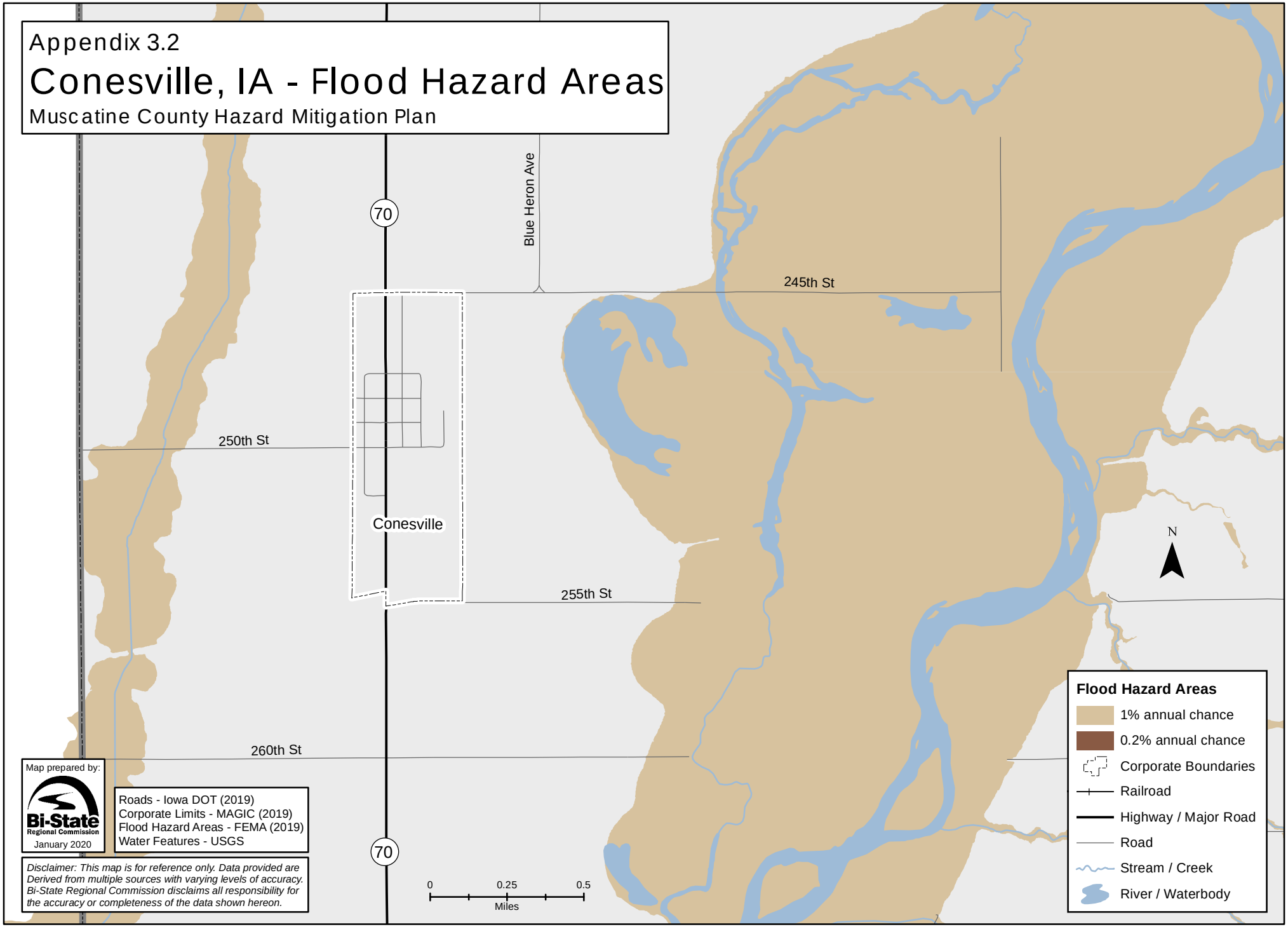
Roads - Iowa DOT (2019)
Corporate Limits - MAGIC (2019)
Flood Hazard Areas - FEMA (2019)
Water Features - USGS

Disclaimer: This map is for reference only. Data provided are Derived from multiple sources with varying levels of accuracy. Bi-State Regional Commission disclaims all responsibility for the accuracy or completeness of the data shown hereon.

Appendix 3.2

Conesville, IA - Flood Hazard Areas

Muscatine County Hazard Mitigation Plan



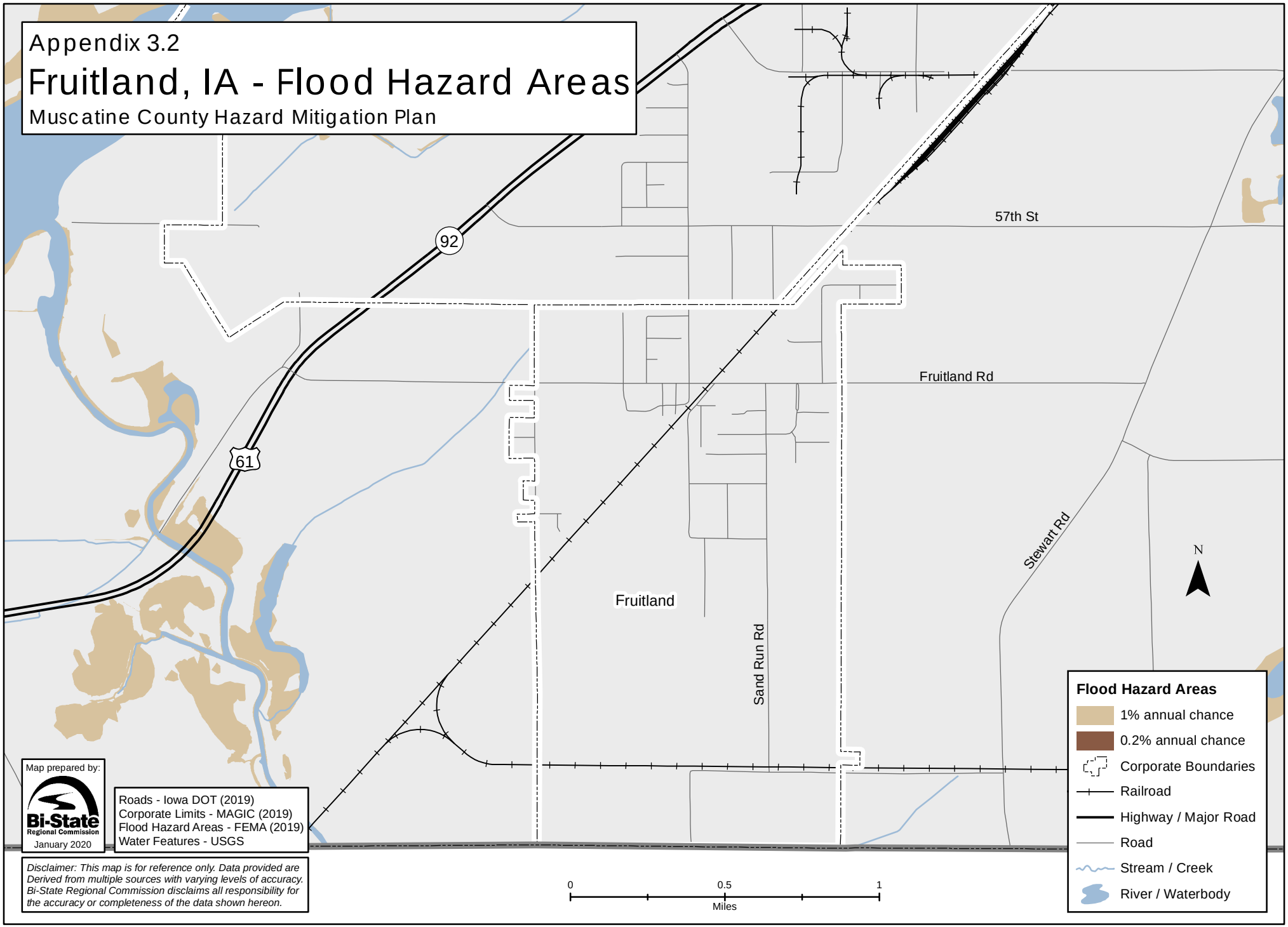
Map prepared by:

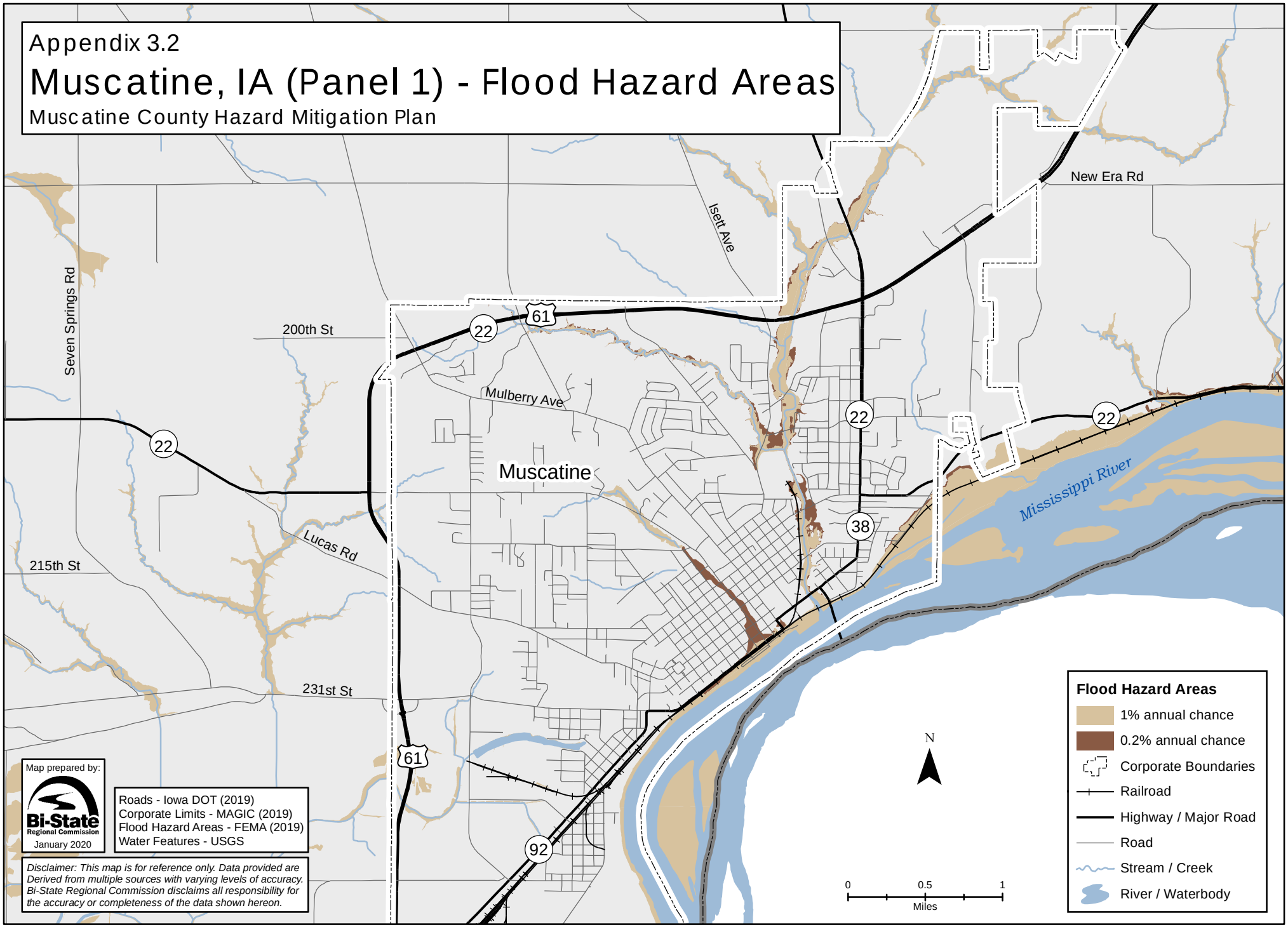
Bi-State Regional Commission

January 2020

Roads - Iowa DOT (2019)
Corporate Limits - MAGIC (2019)
Flood Hazard Areas - FEMA (2019)
Water Features - USGS

Disclaimer: This map is for reference only. Data provided are Derived from multiple sources with varying levels of accuracy. Bi-State Regional Commission disclaims all responsibility for the accuracy or completeness of the data shown hereon.

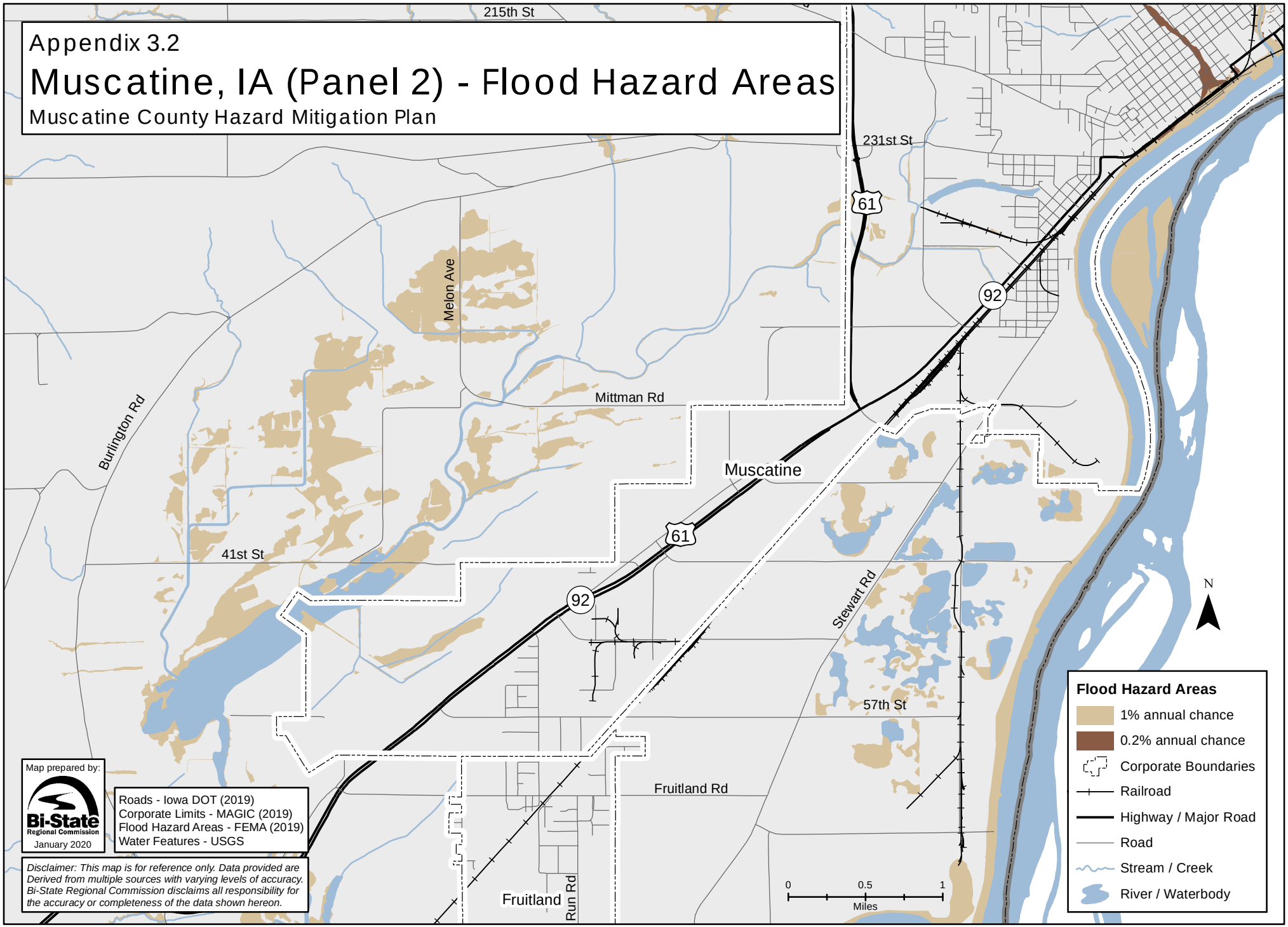

Appendix 3.2
Fruitland, IA - Flood Hazard Areas
Muscatine County Hazard Mitigation Plan
57th St
92
Fruitland Rd
61
Stewart Rd
N
Fruitland
Sand Run Rd
Flood Hazard Areas
1% annual chance
0.2% annual chance
Corporate Boundaries
Railroad
Highway / Major Road
Road
Stream / Creek
River / Waterbody
Map prepared by:
Bi-State Regional Commission
January 2020
Roads - Iowa DOT (2019)
Corporate Limits - MAGIC (2019)
Flood Hazard Areas - FEMA (2019)
Water Features - USGS
Disclaimer: This map is for reference only. Data provided are Derived from multiple sources with varying levels of accuracy. Bi-State Regional Commission disclaims all responsibility for the accuracy or completeness of the data shown hereon.
0
0.5
1
Miles


Appendix 3.2
Muscatine, IA (Panel 1) - Flood Hazard Areas
Muscatine County Hazard Mitigation Plan
New Era Rd
Isett Ave
Seven Springs Rd
200th St
22
61
Mulberry Ave
Muscatine
Mississippi River
38
Lucas Rd
215th St
231st St
92
N
0
0.5
1
Miles
Flood Hazard Areas
1% annual chance
0.2% annual chance
Corporate Boundaries
Railroad
Highway / Major Road
Road
Stream / Creek
River / Waterbody
Map prepared by:
Bi-State Regional Commission
January 2020
Roads - Iowa DOT (2019)
Corporate Limits - MAGIC (2019)
Flood Hazard Areas - FEMA (2019)
Water Features - USGS
Disclaimer: This map is for reference only. Data provided are Derived from multiple sources with varying levels of accuracy. Bi-State Regional Commission disclaims all responsibility for the accuracy or completeness of the data shown hereon.

Appendix 3.2

Muscatine, IA (Panel 2) - Flood Hazard Areas

Muscatine County Hazard Mitigation Plan



Map prepared by:
Bi-State Regional Commission
January 2020

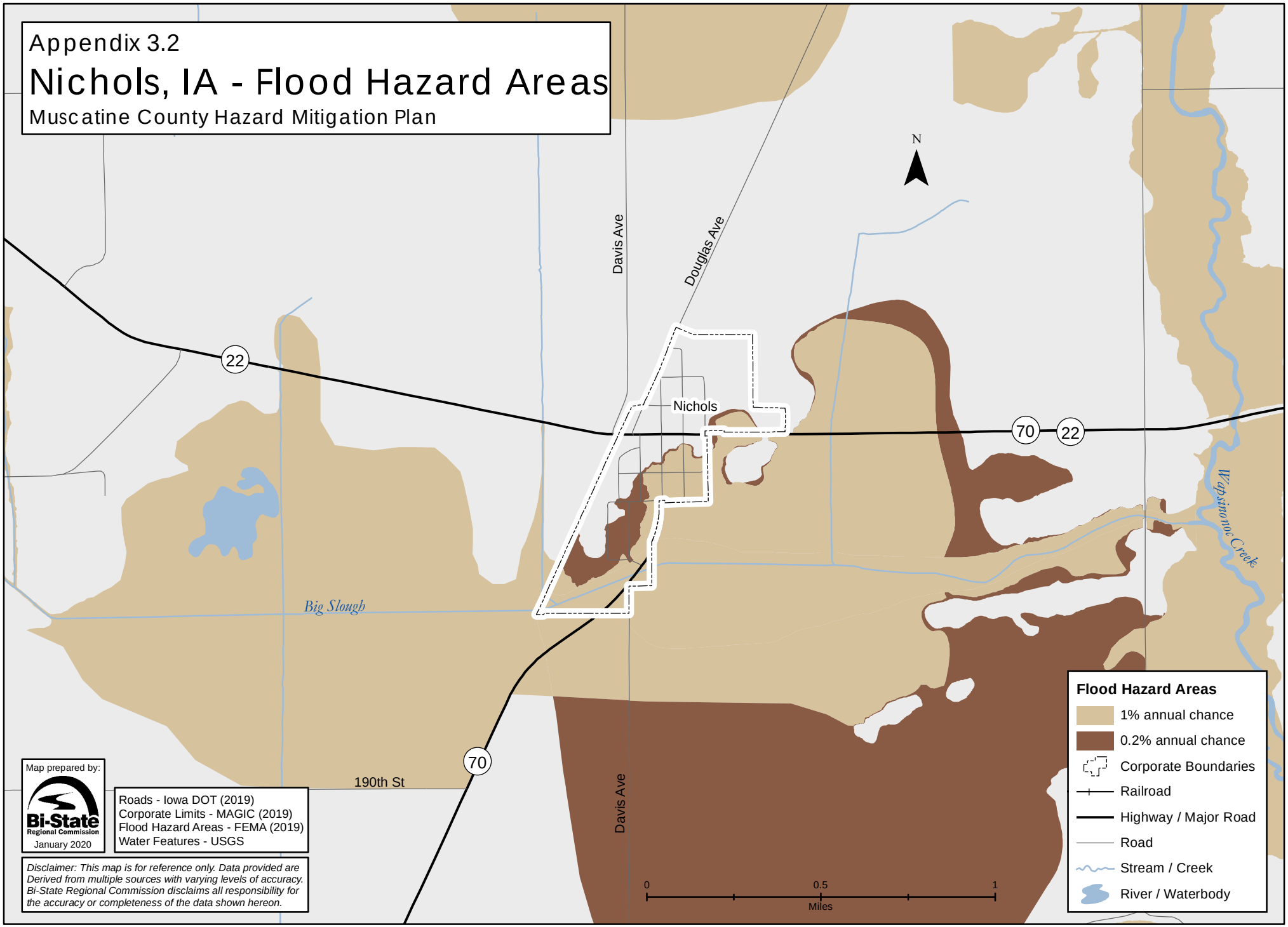
Roads - Iowa DOT (2019)
Corporate Limits - MAGIC (2019)
Flood Hazard Areas - FEMA (2019)
Water Features - USGS

Disclaimer: This map is for reference only. Data provided are Derived from multiple sources with varying levels of accuracy. Bi-State Regional Commission disclaims all responsibility for the accuracy or completeness of the data shown hereon.

Appendix 3.2

Nichols, IA - Flood Hazard Areas

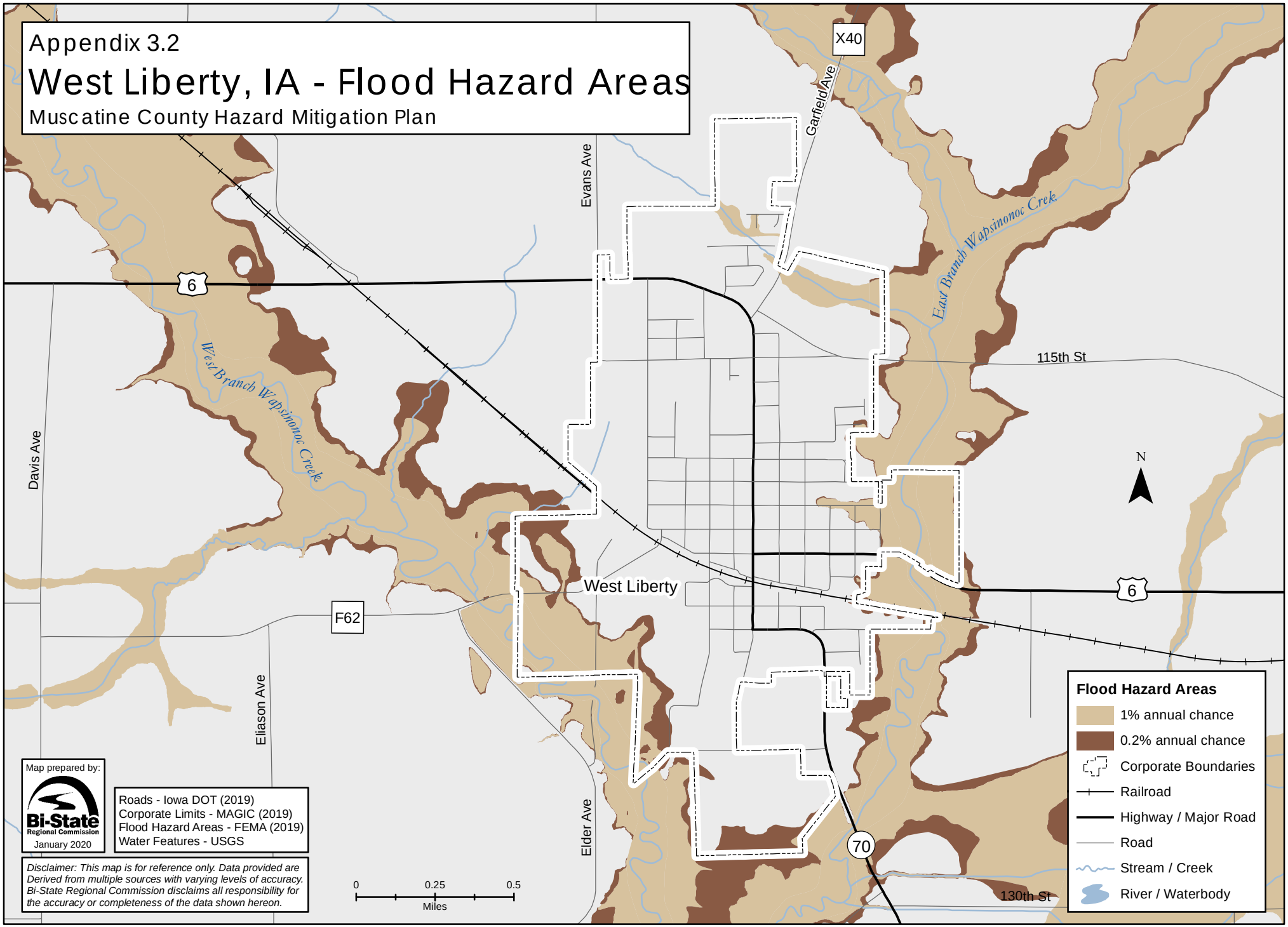
Muscatine County Hazard Mitigation Plan



Map prepared by:
Bi-State Regional Commission
January 2020

Roads - Iowa DOT (2019)
Corporate Limits - MAGIC (2019)
Flood Hazard Areas - FEMA (2019)
Water Features - USGS

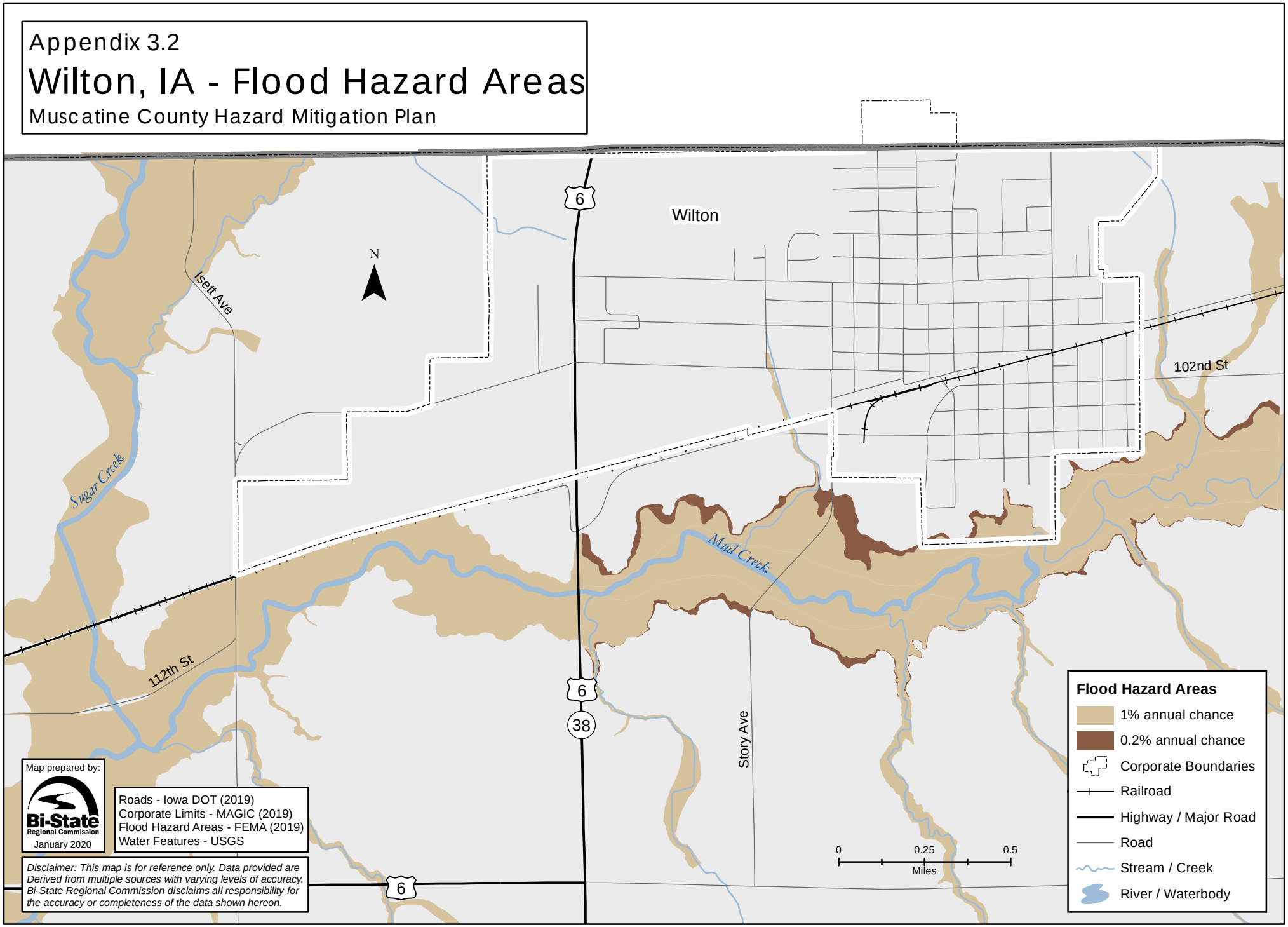
Disclaimer: This map is for reference only. Data provided are Derived from multiple sources with varying levels of accuracy. Bi-State Regional Commission disclaims all responsibility for the accuracy or completeness of the data shown hereon.


Appendix 3.2
West Liberty, IA - Flood Hazard Areas
Muscatine County Hazard Mitigation Plan
X40
Garfield Ave
Evans Ave
East Branch Wapsinonoc Creek
West Branch Wapsinonoc Creek
6
115th St
Davis Ave
N
West Liberty
F62
Eliason Ave
Elder Ave
70
130th St
Flood Hazard Areas
1% annual chance
0.2% annual chance
Corporate Boundaries
Railroad
Highway / Major Road
Road
Stream / Creek
River / Waterbody
Map prepared by:
Bi-State Regional Commission
January 2020
Roads - Iowa DOT (2019)
Corporate Limits - MAGIC (2019)
Flood Hazard Areas - FEMA (2019)
Water Features - USGS
Disclaimer: This map is for reference only. Data provided are Derived from multiple sources with varying levels of accuracy. Bi-State Regional Commission disclaims all responsibility for the accuracy or completeness of the data shown hereon.
0
0.25
0.5
Miles

Appendix 3.2

Wilton, IA - Flood Hazard Areas

Muscatine County Hazard Mitigation Plan



APPENDIX 4-1

MULTI-JURISDICTIONAL

ACTION ID: 4.1

Action Considered: Public information and signage of the location of emergency storm shelters.	
Comments:	A system of notifying the public of the location of short-term warming and cooling shelters in each jurisdiction has been deployed. Public tornado shelters have signs. Focus on developing list of long-term shelters next.
Benefit:	Potential life-saving action; shelter for vulnerable populations
Alternatives considered:	Distribute paper copies of shelter lists to citizens; partner with local media to help get word out
Cost/Funding Source:	Staff time and additional costs for new signs.
Responsible Party:	Muscatine County EMA Director
Timeframe for Completion:	Locations that can serve as long terms shelters are changing; a year may be needed to create a finalized list. Announcement of instruction to use short-term shelters in event of anticipated storm or hazard event will continue.
Priority Level:	Medium priority

ACTION ID: 4.2

Action Considered: Continue to educate the public on the importance of purchasing NOAA weather radios.	
Comments:	Local broadcasting stations now regularly sponsor purchasing drives at local grocery stores
Benefit:	Advanced warning of weather-related events.
Alternatives considered:	Pursue grant funding to provide radios to citizens); expand education to include weather apps and other notification services
Cost/Funding Source:	Staff time for education. Individuals can purchase NOAA radios for approximately $50; broadcasting stations offer a discount.
Responsible Party:	Local broadcasting stations
Timeframe for Completion:	Completed; local broadcasting stations sponsor purchasing drives at local grocery stores
Priority Level:	Medium Priority

ACTION ID: 4.3

Action Considered: Education of early warning systems and how to respond.	
Comments:	In the form of press releases and information on websites; include weather apps and other notification services in education material. Can also work with National Weather Service
Benefit:	Potential life-saving action.
Alternatives considered:	Conduct tornado drills in public buildings; begin meetings by saying what to do in the event of a weather emergency
Cost/Funding Source:	Staff time for education and cost of materials.
Responsible Party:	Muscatine County Emergency Management Director
Timeframe for Completion:	To occur on a regular basis in conjunction with March statewide tornado drills and other preparedness pushes; move to plan maintenance
Priority Level:	Medium Priority

ACTION ID: 4.4

Action Considered: Public education on what to do during a storm or hazard event.	
Comments:	In the form of press releases and information on websites; include weather apps and other notification services in education material. Can also work with National Weather Service
Benefit:	Potential life-saving action.
Alternatives considered:	Conduct tornado drills in public buildings); begin meetings by saying what to do in the event of a weather emergency
Cost/Funding Source:	Staff time for education and possible printing costs.
Responsible Party:	Muscatine County Emergency Management Director
Timeframe for Completion:	To occur on a regular basis in conjunction with March statewide tornado drills and other preparedness pushes; move to plan maintenance
Priority Level:	Medium Priority

ACTION ID: 4.5

Action Considered: Create educational materials about High Priority hazards identified in Muscatine County

Comments:	Shift from all hazards to High Priority hazards to focus efforts; utilize information from plan and resources available through FEMA
Benefit:	Potential life-saving action.
Alternatives considered:	Create educational materials about all hazards; Find and distribute materials on wind-resistant building techniques
Cost/Funding Source:	Staff time for education and printing costs.
Responsible Party:	Muscatine County Emergency Management Director and city/county governments
Timeframe for Completion:	Identifying relevent materials. May choose to roll out information on each hazard separately on a rolling 1-2 month basis.
Priority Level:	Medium Priority

ACTION ID: 4.6

Action Considered: Create public educational materials on flood hazard areas, flood regulations, mitigation measures, and insurance limitations available.	
Comments:	Available on a case by case basis depending on property. County has been hosting ongoing public information meeting on proposed FIRM changes.
Benefit:	Potential life-saving and property damage reducing action.
Alternatives considered:	Encourage permeable driveways, rain gardens, and other stormwater management measures among homeowners; coordinate outreach efforts with Lower Cedar River WMA
Cost/Funding Source:	Staff time for education and printing costs.
Responsible Party:	Zoning and Floodplain Managers
Timeframe for Completion:	Public information meeting contingent on completion of FIRM update
Priority Level:	Medium Priority

ACTION ID: 4.7

Action Considered: Make sure educational materials regarding hazards are bilingual.	
Comments:	Bilingual materials available in EMA office; next logical step is to distribute in other locations including at public libraries, county administration building, and through the Salvation Army
Benefit:	Potential life-saving action.
Alternatives considered:	Produce Spanish-language version of Hazard Mitigation plan
Cost/Funding Source:	Free materials obtained by EMA Director through FEMA
Responsible Party:	Muscatine County EMA Director with assistance from West Liberty
Timeframe for Completion:	6 months
Priority Level:	High Priority

MUSCATINE COUNTY

ACTION ID: 1.1

Action Considered: Evaluate Safe Room construction where vulnerable populations may not have other sources of shelter and construct where financially and technically feasible.	
Comments:	No safe rooms have been constructed within unincorporated Muscatine County; evaluation suggests most cost effective to focus efforts on population centers within incorporated areas
Benefit:	Potential life-saving action.
Alternatives considered:	Require wind-resistant building techniques in new schools, daycares, and nursing homes, and public structures
Cost/Funding Source:	Determined by the size of structure. Outside funding would be required.
Responsible Party:	Muscatine County EMA Director
Timeframe for Completion:	None; may revisit with next plan update.
Priority Level:	Low Priority; Remove from 2020 Plan for Unincorporated Muscatine County

ACTION ID: 1.2

Action Considered: Implement voluntary flood acquisition/demolition programs when financially feasible	
Comments:	Anticipate continued need for acquisition/demolition of structures based on recent flooding
Benefit:	Permanently removes residents from flood hazard areas.
Alternatives considered:	Add or increase "freeboard" requirements in new construction; prohibit all first floor enclosures below base flood elevation for structures in flood hazard areas
Cost/Funding Source:	Limited by availability of FEMA funding. Possibility to use local funding if budgeted long-term.
Responsible Party:	Environmental, Zoning & Board of Health Administrator
Timeframe for Completion:	On going as funding is available. To be determined by Federal funding and local funding. Muscatine County did property acquisition and demolition for properties substantially damaged by DR-1763.
Priority Level:	Medium Priority; Selected as top priority based on actions currently underway

ACTION ID: 1.3

Action Considered: Establish warming and/or cooling centers.	
Comments:	No safe rooms have been constructed within unincorporated Muscatine County; evaluation suggests most cost effective to focus efforts on population centers within incorporated areas
Benefit:	Provides centers that will be ready to accept populations vulnerable to hazards.
Alternatives considered:	Educate citizens regarding dangers of extreme heat/cold and steps to protect themselves; Educate property owners about freezing pipes
Cost/Funding Source:	Local funding and Red Cross. Costs not established at this time. Will be based on the number of people center can have.
Responsible Party:	Muscatine County EMA Director
Timeframe for Completion:	Completed in many communities in Muscatine County
Priority Level:	Low Priority; Remove from 2020 Plan for Unincorporated Muscatine County

ACTION ID: 1.4

Action Considered: Update and enforce building codes to current International Code Series	
Comments:	2015 International Codes adopted in 2017, enforcement ongoing.
Benefit:	Ensure construction meets latest standards of safety.
Alternatives Considered:	Adopt ASCE 24-05 Flood Resistant Design and Construction
Cost/Funding Source:	No additional costs for ongoing enforcement procedures.
Responsible Party:	Environmental, Zoning & Board of Health Administrator
Timeframe for Completion:	Building Code enforcement will occur continuously based on permits and inspections. Code adoption will happen as net codes are available, upon review by administrator and county board. Codes come out approximately every 3 years and may take 2-3 years before adoption occurs. Move to Plan Maintenance
Priority Level:	High Priority

ACTION ID: 1.7

Action Considered: Attend and participate in the Muscatine Levee Stakeholder group meetings with the end goal of determining the cost/benefit relationship to raise the levee to the 500 year flood level with 3 foot of freeboard.	
Comments:	Muscatine Levee Stakeholder group newly convened; continue to participate in discussions about feasibility/funding.
Benefit:	Increased flood protection
Alternatives considered:	Alternatives to be considered as part of ongoing stakeholder group meetings

Cost/Funding Source:	To be determined as part of ongoing stakeholder group meetings
Responsible Party:	Stakeholder Group
Timeframe for Completion:	Raising levee will be pending funding options and Corps of Engineers approval
Priority Level:	Medium Priority

ACTION ID: 2.1

Action Considered: Ensure that mobile homes have adequate tie downs.	
Comments:	Enforced as part of current cosntruction and inspections
Benefit:	Preventative measure for manufactured homes.
Alternatives considered:	Prohibit use of carports attached to manufactured homes; Use natural environmental features as wind buffers in site design
Cost/Funding Source:	No additional costs for ongoing enforcement.
Responsible Party:	Environmental, Zoning & Board of Health Administrator
Timeframe for Completion:	Completed; move to Plan Maintenance for ongoing enforcement
Priority Level:	Medium Priority

ACTION ID: 2.2

Action Considered: Continue NFIP compliance by enforcing flood plain ordinances based on the State of Iowa Model Code.	
Comments:	Applies to new community assets and substantial improvement requirements for existing assets.
Benefit:	Reduces or eliminates losses from flood hazards.
Alternatives considered:	Conduct NFIP community workshops to provide information and incentives for property owners to acquire flood insurance
Source:	No additional costs for on-going enforcement.
Responsible Party:	Environmental, Zoning & Board of Health Administrator
Timeframe for Completion:	Completed; move to Plan Maintenance for ongoing enforcement
Priority Level:	Medium Priority

ACTION ID: 2.3

Action Considered: Reduce repetitive loss properties by requiring elevation of properties.	
Comments:	Applies to existing community assets. Required but some difficulty in compliance.
Benefit:	Reduces NFIP claims and protects people and property in the flood hazard area.
Alternatives considered:	Implement voluntary flood acquisition/demolition
Cost/Funding Source:	Responsibility of individual property owner with up to $30,000 reimbursable from the NFIP Increase Cost of Compliance (ICC) program.
Responsible Party:	House Owner in partnership with Environmental, Zoning & Board of Health Administrator
Timeframe for Completion:	On going, as homes meet substantially damaged criteria
Priority Level:	High Priority

ACTION ID: 2.5

Action Considered: Implement uniform method of additional early warning system county-wide	
Comments:	Currently utilizing outdoor signals and exploring mass notification
Benefit:	Potential life-saving action.
Alternatives considered:	Conduct tornado drills in public buildings; begin meetings by saying what to do in the event of a weather emergency
Alternatives considered:	Implement voluntary flood acquisition/demolition (included in Plan as Mitigation Action 1.2; when financially feasible, might be offered as an alternative)

Cost/Funding Source:	Costs and funding sources have not been identified for mass notification system
Responsible Party:	MUSCOM
Timeframe for Completion:	Undetermined as this time. Will explore as funding is available.
Priority Level:	High Priority

ACTION ID: 3.1

Action Considered: Pursue Community Rating System	
Comments:	Discuss feasibility with State Floodplain Manager
Benefit:	Provides lower NFIP premiums for structures with jurisdiction.
Alternatives considered:	Floodproof residential and non-residential structures
Cost/Funding Source:	Staff time for implementation.
Responsible Party:	Environmental, Zoning & Board of Health Administrator
Timeframe for Completion:	Ongoing discussion; the length of time to join the CRS has not been determined.
Priority Level:	Medium Priority

ACTION ID: 3.2

Action Considered: Identify critical facilities, such as lift stations; where back up power generators should be	
Comments:	In progress; jail and highway dept buildings have generators; other locations pending funding
Benefit:	Ensures continuation of essential services.
Alternatives considered:	Floodproof residential and non-residential structures
Cost/Funding Source:	Outside funding may be required for lift stations
Responsible Party:	Public Works
Timeframe for Completion:	Funding will need to be required before installation can take place.
Priority Level:	Medium Priority

ATALISSA

ACTION ID: 1.3

Action Considered: Establish warming and cooling centers.	
Comments:	Fire station now serves as a warming station as needed; options for cooling centers being investigated
Benefit:	Health and safety of vulnerable populations.
Alternatives considered:	Educate citizens regarding dangers of extreme heat/cold and steps to protect themselves; Educate property owners about freezing pipes
Source:	for several days and nights). Will work with Red Cross to identify possible costs/funding.
Responsible Party:	Fire Chief
Completion:	Contact Red Cross within 6 months of plan approval. Establishment of center may take 1-2 years
Priority Level:	High Priority; Selected as top priority

ACTION ID: 2.2

Action Considered: Continue NFIP compliance by enforcing flood plain ordinances based on the State of Iowa Model Code.	
Comments:	Complete; updates to ordinances as needed on a contiuing basis
Benefit:	Reduces or eliminates losses from flood hazards
Alternatives considered:	Conduct NFIP community workshops to provide information and incentives for property owners to acquire flood insurance

Cost/Funding Source:	No additional costs for on-going enforcement
Responsible Party:	Floodplain Manager/City Clerk
Timeframe for Completion:	Completed; move to Plan Maintenance for ongoing enforcement
Priority Level:	High Priority

ACTION ID: 3.2

Action Considered: Identify critical facilities, such as lift stations; where back up power generators should be	
Comments:	Complete; portable generator at water plant installed
Benefit:	Ensure continuation of essential services.
Alternatives considered:	Floodproof residential and non-residential structures
Source:	Generators varies in cost depending on size and use. Outside funding may be required.
Responsible Party:	City Council
Timeframe for Completion:	Complete; may revisit in a future plan
Priority Level:	Medium Priority

CONESVILLE

ACTION ID: 1.1

Action Considered: Construct safe room construction where vulnerable populations may not have other sources of shelter where technically and financially feasible.	
Comments:	Completed; two churches have basements serving as safe rooms and 20 concrete shelters have been distributed to individual households
Benefit:	Potential life-saving action.
Alternatives considered:	Require wind-resistant building techniques in new schools, daycares, and nursing homes, and public structures
Cost/Funding Source:	Determined by size of structure. Outside funding would be required.
Responsible Party:	Fire Chief / City Council
Completion:	Completed
Priority Level:	Medium Priority

ACTION ID: 1.3

Action Considered: Establish warming and cooling centers at fire station.	
Comments:	Fire station has been identified as suitable location, but no formal warming/cooling center established there
Benefit:	Health and safety of vulnerable populations.
Alternatives considered:	Educate citizens regarding dangers of extreme heat/cold and steps to protect themselves; Educate property owners about freezing pipes
Source:	Information not available at this time. Work with Red Cross
Responsible Party:	Fire Chief / City Council
Timeframe for Completion:	Based on availability of funding. Will contact Red Cross within 6 months of plan approval. Overall may take 1-2 years to finalize center
Priority Level:	High Priority

ACTION ID: 1.5

Action Considered: Encourage development of check-on-neighbor programs for; seniors, disabled, and special needs citizens.	
Comments:	Completed. Fire Department and city staff checks on vulnerable citizens as needed.
Benefit:	Reduces risk to vulnerable populations.
Alternatives considered:	Educate citizens regarding dangers of extreme heat/cold and steps to protect themselves; Educate property owners about freezing pipes

Source:	Staff time and coordination with Red Cross to establish necessary procedures.
Responsible Party:	Fire Chief / City Council
Completion:	Completed; move to Plan Maintenance
Priority Level:	High Priority

ACTION ID: 2.5

Action Considered: Provide NOAA weather radios for schools, municipal buildings, and public assembly	
Comments:	Have not yet completed. Would like at fire station, city hall, and Grace United Church.
Benefit:	Advanced warning of weather related events for vulnerable populations and critical facilities.
Alternatives considered:	Conduct tornado drills in public buildings; begin meetings by saying what to do in the event of a weather emergency
Cost/Funding Source:	NOAA radios cost approximately $50 each.
Responsible Party:	Mayor
Timeframe for Completion:	To be completed within 1 year of plan adoption
Priority Level:	Medium Priority

ACTION ID: 3.2

Action Considered: Obtain generators for fire department, city hall and church.	
Comments:	Completed; city has access to five refurbished generators that can be deployed as needed
Benefit:	Ensure continuation of essential services.
Alternatives considered:	Floodproof residential and non-residential structures
Cost/Funding Source:	Unknown costs and funding source. Will investigate further upon plan approval
Responsible Party:	City Council
Timeframe for Completion:	Completed
Priority Level:	Medium Priority

FRUITLAND

ACTION ID: 1.5

Action Considered: Encourage development of check-on-neighbor programs for; seniors, disabled, and special	
Comments:	Options being evaluated for 2020 communications/outreach effort
Benefit:	Reduces risk to vulnerable populations.
Alternatives considered:	Educate citizens regarding dangers of extreme heat/cold and steps to protect themselves; Educate property owners about freezing pipes
Cost/Funding Source:	Staff time and coordination with Red Cross.
Responsible Party:	Mayor and City Council
Completion:	On-going
Priority Level:	Medium Priority; Selected as top priority

ACTION ID: 2.2

Action Considered: Continue NFIP compliance by enforcing flood plain ordinances based on the State of Iowa Model Code.	
Comments:	Ordinances updated in 2019; updates to continue as needed
Benefit:	Reduces or eliminates losses from flood hazards.
Alternatives considered:	Conduct NFIP community workshops to provide information and incentives for property owners to acquire flood insurance

Cost/Funding Source:	No additional cost for ongoing enforcement.
Responsible Party:	Mayor and City Council
Completion:	Completed; move to Plan Maintenance for continued enforcement
Priority Level:	High Priority

ACTION ID: 5.1

Action Considered: Test warning systems.	
Comments:	System integrated with MUSCOM. City tests siren and batteries twice a month
Benefit:	Potential life saving action.
Alternatives considered:	Conduct tornado drills in public buildings; begin meetings by saying what to do in the event of a weather emergency
Source:	No additional cost for ongoing activity.
Responsible Party:	Mayor
Timeframe for Completion:	Completed; move to Plan Maintenance for ongoing testing
Priority Level:	Medium Priority

MUSCATINE

ACTION ID:	**1.4**
Action Considered: Update and enforce building codes to current International Code Series.	
Comments:	Fire Department and Building & Zoning will update code version on the same cycle as the State of Iowa
Benefit:	Ensure construction meets latest standards of safety.
Alternatives considered:	Adopt ASCE 24-05 Flood Resistant Design and Construction
Cost/Funding Source:	No additional costs for ongoing enforcement procedures.
Responsible Party:	Building and Zoning Administrator
Timeframe for Completion:	New codes are released every 3 years. It takes 2-3 years to review and adopt. Move to Plan Maintenance for ongoing enforcement
Priority Level:	High Priority

ACTION ID: 1.6

Action Considered: Maintain legally enforceable floodplain management regulations that are compliant with Title 44 CFR 60 to ensure Muscatine residents and businesses are eligible to participate in NFIP.	
Comments:	New ordinance adoption for revised FIRMs in January 2014. FIRMs effective April 2014, enforcement of regulations continue
Benefit:	Reduces or eliminates losses from flood hazards.
Alternatives considered:	Floodproof residential and non-residential structures
Cost/Funding Source:	No additional cost for ongoing enforcement.
Responsible Party:	Floodplain Manager/Building & Zoning Administrator
Completion:	Completed; move to Plan Maintenance for ongoing enforecement
Priority Level:	High Priority

ACTION ID: 1.7

Action Considered: Attend and participate in the Muscatine Levee Stakeholder group meetings with the end	
Comments:	Muscatine Levee Stakeholder group newly convened; continue to participate in discussions about feasibility/funding.
Benefit:	Increased flood protection
Alternatives considered:	Alternatives to be considered as part of ongoing stakeholder group meetings
Cost/Funding Source:	To be determined as part of ongoing stakeholder group meetings
Responsible Party:	Stakeholder Group

Timeframe for Completion:	Raising levee will be pending funding options and Corps of Engineers approval
Priority Level:	Medium Priority

ACTION ID: 3.2

Action Considered: Identify critical facilities, such as communications center and lift stations, where back up power generators should be installed and install

Comments:	Critical facilities have been identified, but generatiors have not yet been purchased and/or installed. Pending funding.
Benefit:	Ensure continuation of essential services.
Alternatives considered:	Floodproof residential and non-residential structures
Cost/Funding Source:	Generators varies in cost depending on size and use. Outside funding may be required.
Responsible Party:	Director of Public Works
Timeframe for Completion:	3-5 years, pending funding
Priority Level:	Medium Priority

ACTION ID: 3.3

Action Considered: Continue routine maintenance of levees; as needed.	
Comments:	All levees have been certified; annual inspections for routine maintenance will continue
Benefit:	Provides long-term flooding solution to river flooding in those areas.
Alternatives considered:	Elevate or retrofit structures and utilities currently protected by levee; Protect and restore natural flood mitigation featues
Cost/Funding Source:	Costs will depending on needed maintenance repairs or upgrades. Will be incorporated into City's CIP
Responsible Party:	Director of Public Works
Completion:	Ongoing; move to Plan Maintenance
Priority Level:	Medium Priority

ACTION ID: 3.4

Action Considered: Separate combined sewer systems at the Papoose Creek pumping station.	
Comments:	Scheduled phases underway; estimated completion in 2028.
Benefit:	Identifies systems that need a higher level of protection to avoid discharges from waste water systems during flood conditions.
Alternatives considered:	Encourage use of porous pavement, vegetative buffers, and islands in large parking areas
Source:	Estimated at $50 million and is part of the City's CIP
Responsible Party:	Director of Public Works
Completion:	2028
Priority Level:	Medium Priority; Selected as Top Priority based on actions underway

NICHOLS

ACTION ID: 1.1

Action Considered: Safe room construction where vulnerable populations may not have other sources of	
Comments:	Investigating facility upgrade to a portion of fire station to serve as safe room; if any other city buildings are constructed, the city will consider if safe room construction is feasible.
Benefit:	Potential life-saving action.
Alternatives considered:	Require wind-resistant building techniques in new schools, daycares, and nursing homes, and public structures
Cost/Funding Source:	Determine by size of structure. Outside funding would be required.
Responsible Party:	Mayor

Timeframe for Completion:	TBD, as project and funding becomes available
Priority Level:	Medium Priority

ACTION ID: 1.3

Action Considered: Establish warming and cooling centers.	
Comments:	Completed; have begun using fire station for daytime use as a warming/cooling station
Benefit:	Health and safety of vulnerable populations.
Alternatives considered:	Educate citizens regarding dangers of extreme heat/cold and steps to protect themselves; Educate property owners about freezing pipes
Cost/Funding Source:	Information not available at this time.
Responsible Party:	Fire Chief
Timeframe for Completion:	Completed
Priority Level:	High Priority

ACTION ID: 2.3

Action Considered: Continue NFIP compliance by enforcing flood plain ordinances based on the State of Iowa	
Comments:	Complete; updates to ordinances as needed on a continuing basis
Benefit:	Reduces or eliminates losses from flood hazards
Alternatives considered:	Conduct NFIP community workshops to provide information and incentives for property owners to acquire flood insurance
Cost/Funding Source:	No additional costs for on-going enforcement
Responsible Party:	Floodplain Manager/City Clerk
Timeframe for Completion:	Completed; move to Plan Maintenance for ongoing enforcement
Priority Level:	High Priority

ACTION ID: 3.2

Action Considered: Identify critical facilities, such as lift stations; where back up power generators should be	
Comments:	Critical facilities identified, funding has not been available to purchase generators; considering portable generator if permanent ones are cost prohibitive
Benefit:	Ensure continuation of essential services.
Alternatives considered:	Floodproof residential and non-residential structures
Source:	Generators varies in cost depending on size and use. Outside funding may be required.
Responsible Party:	Mayor
Timeframe for Completion:	4-5 years after approval of the plan
Priority Level:	High Priority; Selected as Top Priority

ACTION ID: 2.6

Action Considered: Establish real-time systems for notifying emergency responders and the public of road closings due to flash floods.	
Comments:	Look into using social media or non-emergency police number to self-reporting for local roads; County and state roads have established ways of communicating closures on their roads
Alternatives considered:	Conduct a stormwater drainage study for known problem areas; Increase dimensions of drainage culverts in flood-prone areas
Benefit:	Potential life-saving action. Cuts down on emergency response time. Improves communication both between communities and with the public.
Cost/Funding Source:	Costs not identified at this time.
Responsible Party:	Fire Chief
Timeframe for Completion:	2-3 years after approval of the plan, pending funding
Priority Level:	Medium Priority

WEST LIBERTY

ACTION ID: **1.1**

to the park; investigate where other vulnerable populations may not have other sources of shelter and possibility of safe room construction to meet this need.	
Comments:	New project; funding opportunities being sought
Benefit:	Potential life-saving action.
Alternatives considered:	Require wind-resistant building techniques in new schools, daycares, and nursing homes, and public structures
Cost/Funding Source:	Determine by size of structure. Outside funding would be required.
Responsible Party:	Mayor
Timeframe for Completion:	TBD, as project and funding becomes available
Priority Level:	Medium Priority

ACTION ID: **2.3**

Action Considered: Continue NFIP compliance by enforcing flood plain ordinances based on the State of Iowa	
Comments:	Complete; updates to ordinances as needed on a continuing basis
Benefit:	Reduces or eliminates losses from flood hazards
Alternatives considered:	Conduct NFIP community workshops to provide information and incentives for property owners to acquire flood insurance
Cost/Funding Source:	No additional costs for on-going enforcement
Responsible Party:	Floodplain Manager/City Clerk
Completion:	Completed; move to Plan Maintenance for ongoing enforcement
Priority Level:	High Priority

ACTION ID: **2.5**

Action Considered: Provide NOAA weather radios for schools, municipal buildings, and public assembly facilities; such as soccer fields and sports stadiums.	
Comments:	Completed
Benefit:	Advanced warning of weather related events for vulnerable populations and critical facilities.
Alternatives considered:	Conduct tornado drills in public buildings; begin meetings by saying what to do in the event of a weather emergency
Cost/Funding Source:	NOAA radios cost approximately $50 each.
Responsible Party:	Mayor
Timeframe for Completion:	Obtained
Priority Level:	High Priority

ACTION ID: **2.6**

Action Considered: Establish real-time systems for notifying emergency responders and the public of road closings due to flash floods.	
Comments:	Utilizing popular social media apps to desseminate real time information. Emergency responders have several ways of communicating real time information throughout the County
Benefit:	Potential life-saving action. Cuts down on emergency response time. Improves communication both between communities and with the public.
Alternatives considered:	Conduct a stormwater drainage study for known problem areas; increase dimensions of drainage culverts in flood-prone areas
Cost/Funding Source:	Costs not identified at this time
Responsible Party:	Fire Chief
Timeframe for Completion:	Completed; remove from plan
Priority Level:	High Priority

ACTION ID: **3.2**

Action Considered: Identify critical facilities, such as lift stations; where back up power generators should be	
Comments:	Lift station generators are a priority in FY20/21. All other critical facilities have generators.
Benefit:	Ensure continuation of essential services.
Alternatives considered:	Floodproof residential and non-residential structures
Cost/Funding Source:	Generators varies in cost depending on size and use. Outside funding may be required.
Responsible Party:	Water/Wastewater Superintendent and City Administrator
Timeframe for Completion:	1 year following plan adoption
Priority Level:	Medium Priority; Selected as Top Priority

WILTON

ACTION ID: 1.3

Action Considered: Establish warming and cooling centers at fire station.	
Comments:	Complete; City Hall and fire station established as warming/cooling centers
Benefit:	Health and safety of vulnerable populations.
Alternatives considered:	Educate citizens regarding dangers of extreme heat/cold and steps to protect themselves; Educate property owners about freezing pipes
Source:	Information not available at this time. Work with Red Cross
Responsible Party:	Fire Chief
Completion:	Completed
Priority Level:	High Priority

ACTION ID: 1.4

Action Considered: Update and enforce building codes to current International Code Series.	
Comments:	Incomplete; ongoing city council discussion
Benefit:	Ensure construction meets latest standards of safety.
Alternatives Considered:	Adopt ASCE 24-05 Flood Resistant Design and Construction
Cost/Funding Source:	No additional costs for ongoing enforcement procedures.
Responsible Party:	Building and Zoning Administrator
Timeframe for Completion:	New codes are released every 3 years. It takes 2-3 years to review and adopt.
Priority Level:	High Priority

ACTION ID: 1.8

Action Considered: Update storm sewer to mitigate flash flooding	
Comments:	New item
Benefit:	Reduces or eliminates losses from flood hazards.
Alternatives considered:	Conduct a stormwater drainage study for known problem areas; increase dimensions of drainage culverts in flood-prone areas
Cost/Funding Source:	Cost estimates being obtained (new project); outside funding likely needed
Responsible Party:	City staff/City Council
Timeframe for Completion:	Unknown, pending funding
Priority Level:	Medium Priority; Selected as Top Priority based on other actions underway

ACTION ID: 2.2

Action Considered: Continue NFIP compliance by enforcing flood plain ordinances based on the State of Iowa	
Comments:	Complete; updates to ordinances as needed on a continuing basis
Benefit:	Reduces or eliminates losses from flood hazards.

Alternatives considered:	Conduct NFIP community workshops to provide information and incentives for property owners to acquire flood insurance
Cost/Funding Source:	No additional cost for ongoing enforcement.
Responsible Party:	Floodplain Manager/City Clerk
Timeframe for Completion:	Completed; move to Plan Maintenance for ongoing enforcement
Priority Level:	High Priority

ACTION ID: 3.2

Action Considered: Identify critical facilities, such as lift stations, where back-up generators should be installed and install.	
Comments:	Complete; Generator installed at fire station, which was the only remaining critical facility identified in last plan update and not yet equiped
Benefit:	Ensure continuation of essential services.
Alternatives considered:	Floodproof residential and non-residential structures
Source:	Generators varies in cost depending on size and use. Outside funding may be required.
Responsible Party:	Water/Wastewater Superintendent and City Administrator
Timeframe for Completion:	Completed
Priority Level:	Medium Priority

ACTION ID: 3.4

Action Considered: Separate combined sewer systems	
Comments:	Complete; new sewer line added that eliminated remaining combined lines
Benefit:	Identifies systems that need a higher level of protection to avoid discharges from waste water systems during flood conditions.
Cost/Funding Source:	staff time. Once needs are determined, outside funding resources may be needed to upgrade waste water infrastructure.
Responsible Party:	Water/Wastewater Supervisor and City Administrator
Timeframe for Completion:	Completed
Priority Level:	Medium Priority

ACTION ID: 5.1

Action Considered: Test Warning Systems	
Comments:	Complete; regular test schedule established and ongoing
Benefit:	Potential life saving action.
Alternatives considered:	Conduct tornado drills in public buildings; begin meetings by saying what to do in the event of a weather emergency
Cost/Funding Source:	No additional cost for ongoing activity.
Responsible Party:	City Clerk, Fire Department and City Administrator
Timeframe for Completion:	Completed; move to Plan Maintenance for ongoing testing
Priority Level:	Medium Priority

APPENDIX 5-1

MUSCATINE COUNTY HAZARD MITIGATION PLAN ANNUAL UPDATE

REPORTING PERIOD: April 1, _____ TO March 31, _____

Jurisdiction:

Name/Title:

Email:

Phone:

SECTION 1: PLAN INCORPORATION

Did your jurisdiction attend the annual planning committee meeting (y/n)?

Has the Muscatine County Multi-Jurisdictional Hazard Mitigation (MCHM) Plan been incorporated into an new planning of land use documents? If yes, please list.

Has the MCHM Plan been incorporated into any new zoning documents? If yes, please list.

Has the MCHM Plan been incorporated into any new building code documents? If yes, please list.

Has the MCHM Plan been incorporated into any grant applications? If yes, please list.

Has any grant funding been received based on mitigation actions? If yes, please list (with amount received).

SECTION 2: MITIGATION ACTIONS

Has your jurisdiction completed any mitigation actions? If yes, please list.

Has your jurisdiction added any mitigation actions? If yes, please list.

SECTION 3: PUBLIC INVOLVEMENT

How has your jurisdiction kept the public involved with the MCHM Plan? Please describe.

Has your jurisdiction conducted any public education? If yes, please describe.

This form must be submitted no later than April 30 to:

MUSCATINE EMA

Brian Wright

brian.wright@co.muscatineiowa.gov

BI-STATE REGIONAL COMMISSION

Sarah Gardner

sgardner@bistateonline.org