MAQUOKETA RIVER WATERSHED MANAGEMENT PLAN

PHASE II: SUBWATERSHED IMPLEMENTATION

Tanner Osing, Maya Simon, Henry Wakamiya

The University of Iowa
IOWA INITIATIVE
FOR SUSTAINABLE COMMUNITIES

IOWA | School of Planning and Public Affairs

Planning Team

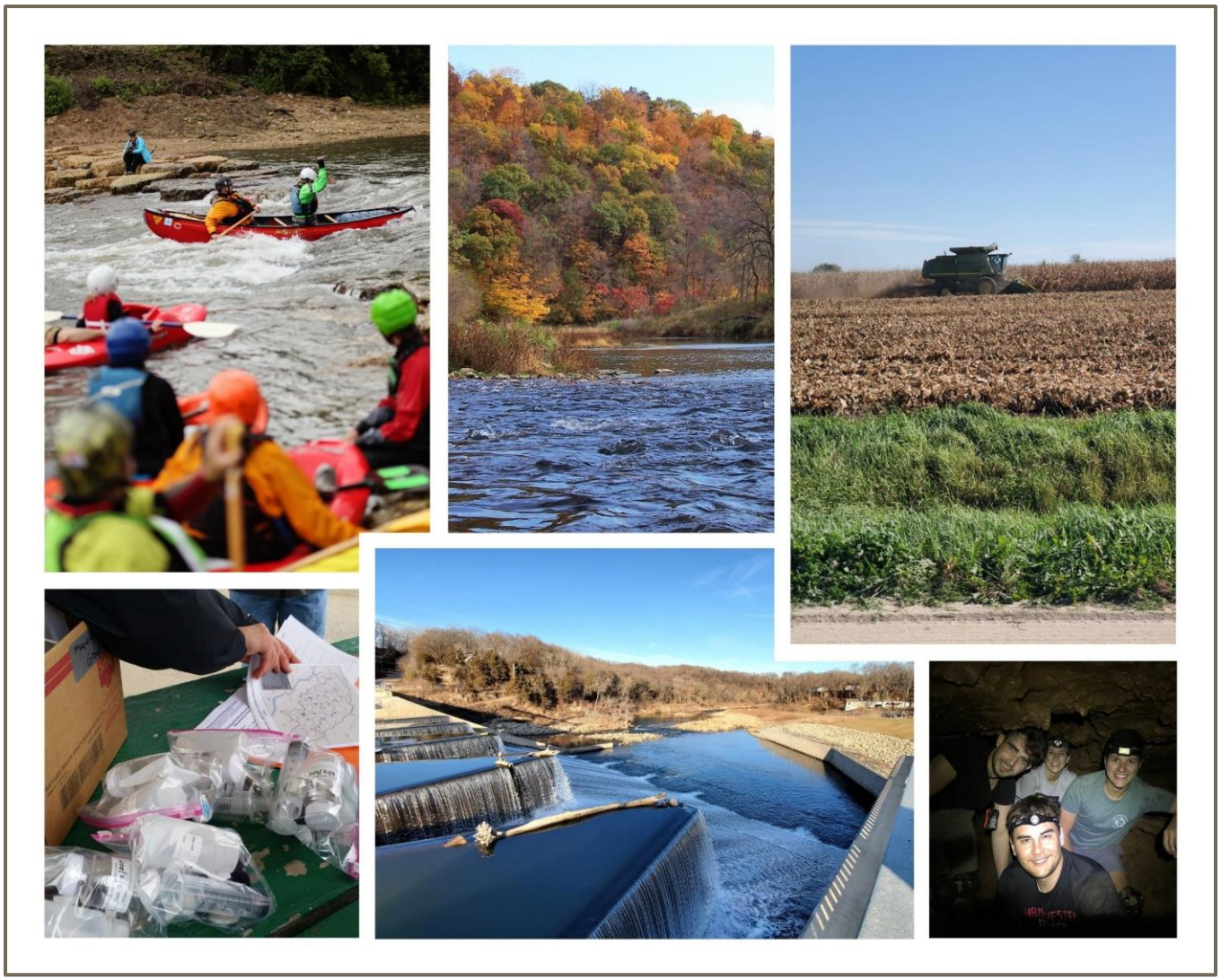

Figure 1: Photos from across the Maquoketa River Watershed. Clockwise from top left: Whitewater Park in Manchester, fall colors along the Maquoketa River, combining in the watershed, water quality monitoring samples from WMA volunteers, Lake Delhi Dam, and exploring Maquoketa Caves State Park.

Acknowledgements

Original Residents

The Maquoketa River Watershed is located on the homelands of the Očhéthi Šakówiŋ (Sioux), Wahpeton (Sisseton-Wahpeton Oyate of the Lake Traverse Reservation), Sauk and Meskwaki (Sac & Fox Tribe of the Mississippi in Iowa), Iowa (Bha Kho-je People of the Grey Snow), and Kiikaapoi (Kickapoo) Nations. The following tribal nations: Umoǰhoǰ (Omaha Tribe of Nebraska and Iowa), Páǰka (Ponca Tribe of Nebraska), Meskwaki (Sac and Fox of the Mississippi in Iowa), and Ho-Chunk (Winnebago Tribe of Nebraska) Nations continue to thrive in the State of Iowa.[i]

As watershed residents, it is our responsibility to acknowledge the sovereignty and the traditional territories of these tribal nations, the treaties that were used to remove these tribal nations, and the histories of dispossession. Understanding the historical and current experiences of Native peoples will help inform our relationship to the watershed.

Project Partners

Thank you to the stakeholders, mentors, and partners who contributed to Phase II of the Maquoketa Watershed Management Plan. Those who were instrumental to this document include:

- Maquoketa River Watershed Management Authority and their members

City of Andrew	City of Baldwin
City of Cascade	City of Delaware
City of Delhi	City of Dyersville
City of Epworth	City of Goose Lake
City of Hopkinton	City of Lamont
City of La Motte	City of Manchester
City of Maquoketa	City of Monticello
City of Preston	City of Ryan
City of Spragueville	City of Strawberry Point
City of Worthington	City of Wyoming
Buchanan County	Clinton County
Delaware County	Delaware County SWCD
Dubuque County	Dubuque County SWCD
Jackson County	Jackson County SWCD
Jones County	Jones County SWCD

Linn County Linn County SWCD Lake Delhi District

- Limestone Bluffs RC&D staff (Lori Scovel, Erin Erickson)
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- The University of Iowa School of Planning and Public Affairs
- Iowa Initiative for Sustainable Communities
- Faculty Advisors (Scott Spak, Travis Kraus)
- Alumni Mentor (Parker Just)
- Former team members (Spencer Gibson, Constantin Diete)

Executive Summary

The purpose of the Maquoketa River Watershed Management Authority (MR WMA) is to improve water quality and mitigate flooding through a holistic approach to watershed planning and management. With the increasing frequency and intensity of flood events and persistent water quality issues, the WMA has been working diligently to improve water resources. A watershed plan was developed through a partnership with the IISC in 2020-2021 that serves as a guidebook and vision to achieve broad goals related to these issues. The Watershed Management Plan Phase II: Sub-watershed Implementation takes planning efforts further by providing insight into where resources should be directed to meet the WMA's goals based on a technical analysis and continued engagement with local stakeholders.

Interviews with representatives from agencies providing farm services added insight into agricultural trends:

1. Conservation has always been a focus in agriculture, but the type of practices have shifted over time from structural projects to soil health.
2. Farmers have a variety of general and personal hesitations to implement best management practices, including farming values, implementation cost, and technical expertise.
3. Farmers are more likely to continually implement practices if they see successful projects on neighboring properties.

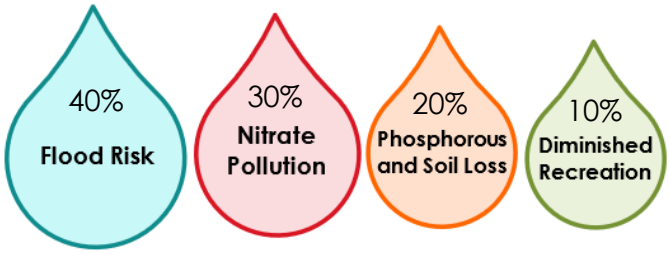
Over the course of ten months, starting in August 2021, the planning team defined the plan's scope and methodology, interviewed community representatives, profiled and analyzed sub-watersheds, and developed individual plans for priority sub-watersheds. The plan scope and methodology were defined based on a site visit to the watershed, conversations with WMA members, and research of existing watershed management plans in Iowa. Through these conversations, the team identified four key issues for the watershed: **flooding risk**, **nitrate pollution**, **phosphorous and soil loss**, and **diminished recreation**.

Interviews with incorporated city representatives showed common themes throughout the watershed:

1. Communities recognize that there are many water-related assets within the watershed, and they have already undertaken extensive water management projects.
2. Cities are interested in projects that ideally benefit both recreation and economic development, such as the Manchester Whitewater Park, which provides abundant recreational opportunities, became a center piece of the city, and improved the health of the river.
3. The WMA can serve as a catalyst for better watershed-wide planning and management. Cities support for WMA activities, but the level of participation from communities varies.

The bulk of this plan focuses on sub-watershed analysis, prioritization, and plans. In the Sub-watershed Analysis, variables related to each of the four key issues are broken down to the HUC-12 level in order to examine spatial trends of existing conditions. Results showed that the conditions in the northern half of the watershed currently contribute to issues more than other areas. The 56 HUC-12 sub-watersheds were prioritized based on a survey given to the WMA Technical Committee in which they ranked issues and associated variables. Of these 56, the five highest priority sub-watersheds are located in the northern half of the watershed.

Key Issue Priority Weights



Each of the priority HUC-12s has an individual plan to provide more detailed information about why it is a priority, where existing and potential agricultural best management practices are, and a list of goals and objectives to help improve conditions. The WMA, communities, and residents should select cost-effective projects that address plan Phase I goals and objectives by following guidance included in the Plan Implementation section. Criteria such as the strength of improvement, negative impacts, and project cost need to be thoroughly considered when selecting specific sites for a range of management practices.

To engage with communities across the watershed, the WMA should not only follow priority sub-watershed plans, but also focus on lower priority HUC-12s for planning and project implementation. Every five years, the WMA should reassess the success of this plan by examining key issues and metrics used in the sub-watershed analysis to account for the everchanging conditions and impacts from conservation practice implementation.

How to use this plan:

Read profiles and sub-watershed analysis to understand **existing** conditions.

Look at ranking maps and priority HUC-12 plans to identify areas for **short-term** project implementation.

Follow project selection guidance and objective priorities to maximize available resources and **meet long-term** watershed goals.

Who is this plan for?

WMA staff to focus their efforts.

Landowners to choose appropriate conservation practices and get WMA support.

Local communities to understand broader conditions and foster collaboration between cities and the WMA.

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Definitions and Acronyms

Watershed	Watershed Management Authority (WMA)	Hydrological Unit Code (HUC)
• The land area from which all precipitation drains to a single outflow point. • The size can range from a single lake to an entire river system.	• A WMA is an intergovernmental agreement between jurisdictions to address flooding, water quality, and watershed education. • WMAs were authorized by the Iowa state legislature in 2010.	• This is a series of numbers used to identfy the size and hierarchy of a watershed. • Maquoketa River is level 8, and contains ten HUC-10s and 56 HUC-12s. • Average size of a HUC-12 is 10,000 to 40,000 acres.

Figure 2: Important definitions for understanding this plan. (NOAA, IA DNR, NRCS)

ACPF: Agricultural Conservation Planning Framework
BMP: Best Management Practice
CAFO: Concentrated Animal Feeding Operation
CRP: Conservation Reserve Program
CSR: Corn Suitability Rating
DNR: Department of Natural Resources
FHA: Flood Hazard Area (100-year floodplain)
GIS: Geographic Information Systems
HUC: Hydrological Unit Code
IFC: Iowa Flood Center
ISU: Iowa State University
IPCC: Intergovernmental Panel on Climate Change
NOAA: National Oceanic and Atmospheric Administration
NRCS: National Resource Conservation Service
MR: Maquoketa River
MRW: Maquoketa River Watershed
RUSLE: Revised Universal Soil Loss Equation
SWCD: Soil and Water Conservation District
US EPA: United States Environmental Protection Agency
USGS: United State Geological Survey
WASCOB: Water and Sediment Control Basin
WMA: Watershed Management Authority

Introduction

This is an action plan created for the Maquoketa River Watershed (MRW) by a team of planners from the University of Iowa School of Planning and Public Affairs. It is complimentary to Phase I of the Maquoketa River Watershed Management Plan, which was completed in May of 2021. In Phase I, a previous planning team researched characteristics of the watershed and led several rounds of community engagement to formulate a vision for the watershed. That vision includes five broad goals, which are shown in Figure 3 below, each with three to five objectives as well as specific action steps. To ensure these goals are achieved, Phase II, created from August 2021 to May 2022, looks at existing conditions and potential land management locations within the MRW that could contribute to water quality improvement, flood mitigation, watershed awareness, ecosystem preservation, and WMA guidance.

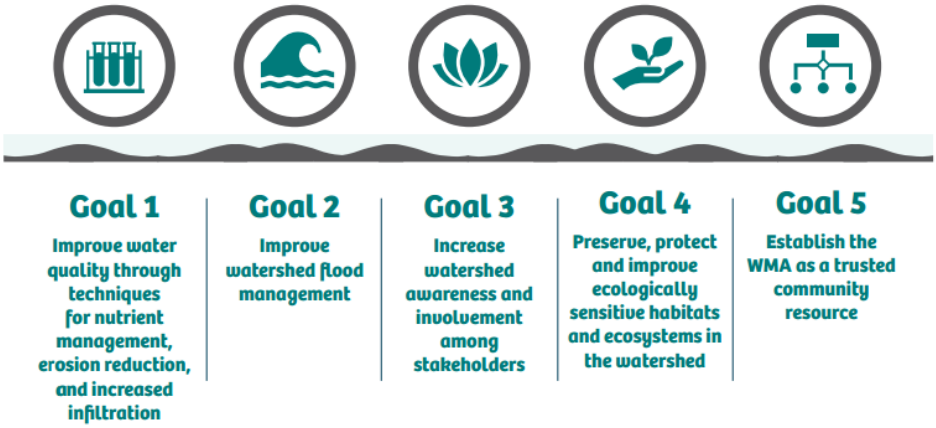


Figure 3: Goals of the MRW Management Plan Phase I. (MR WMA, 2021)

Plan Purpose

This watershed management plan provides a framework for how the Maquoketa River Watershed can be better managed to address issues and provide options for current and future generations. A watershed crosses many jurisdictional boundaries, so the plan engages with government officials, the agricultural community, area residents, environmental experts, and others. It is meant to be accessible to people with varying technical backgrounds.

The purpose of Phase II is to guide local authorities and residents in putting Phase I of the plan, where broad goals and potential action steps were delineated, into practice. Phase II of the Maquoketa River Watershed Management Plan will use technical analysis and continued engagement with local stakeholders to identify projects where resources could be directed to meet the goals determined by the community. Projects that will have the biggest impact with the most efficient resource use should be prioritized. The plan focuses on finding priority locations and explicit solutions to mitigate future flooding events, enhance water quality, and promote recreational opportunities within the watershed.

The planning team has focused on three key watershed planning issues: The propensity and impact of flood events, causes and consequences of water quality impairment, and the need for more collaboration from governments, agencies, and residents within the watershed. The concerns associated with each of these are described in Figure 4.

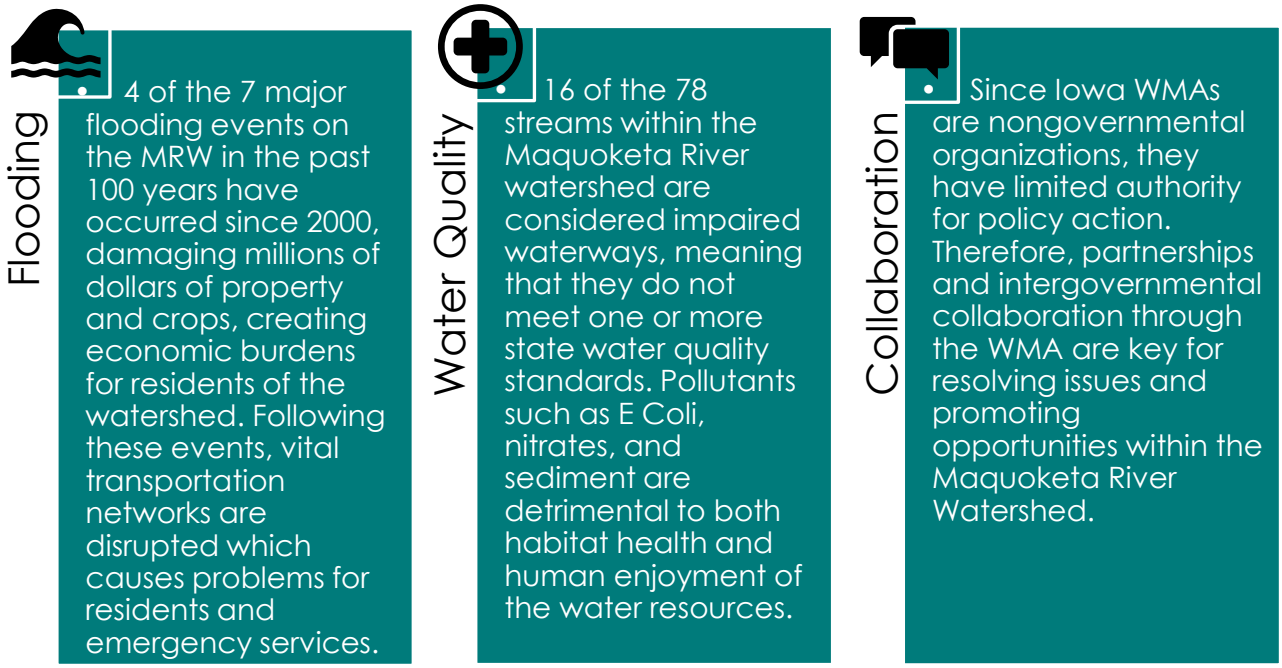


Figure 4: A graphic describing the need to address flooding, water quality, and collaboration in the MRW. (authors)

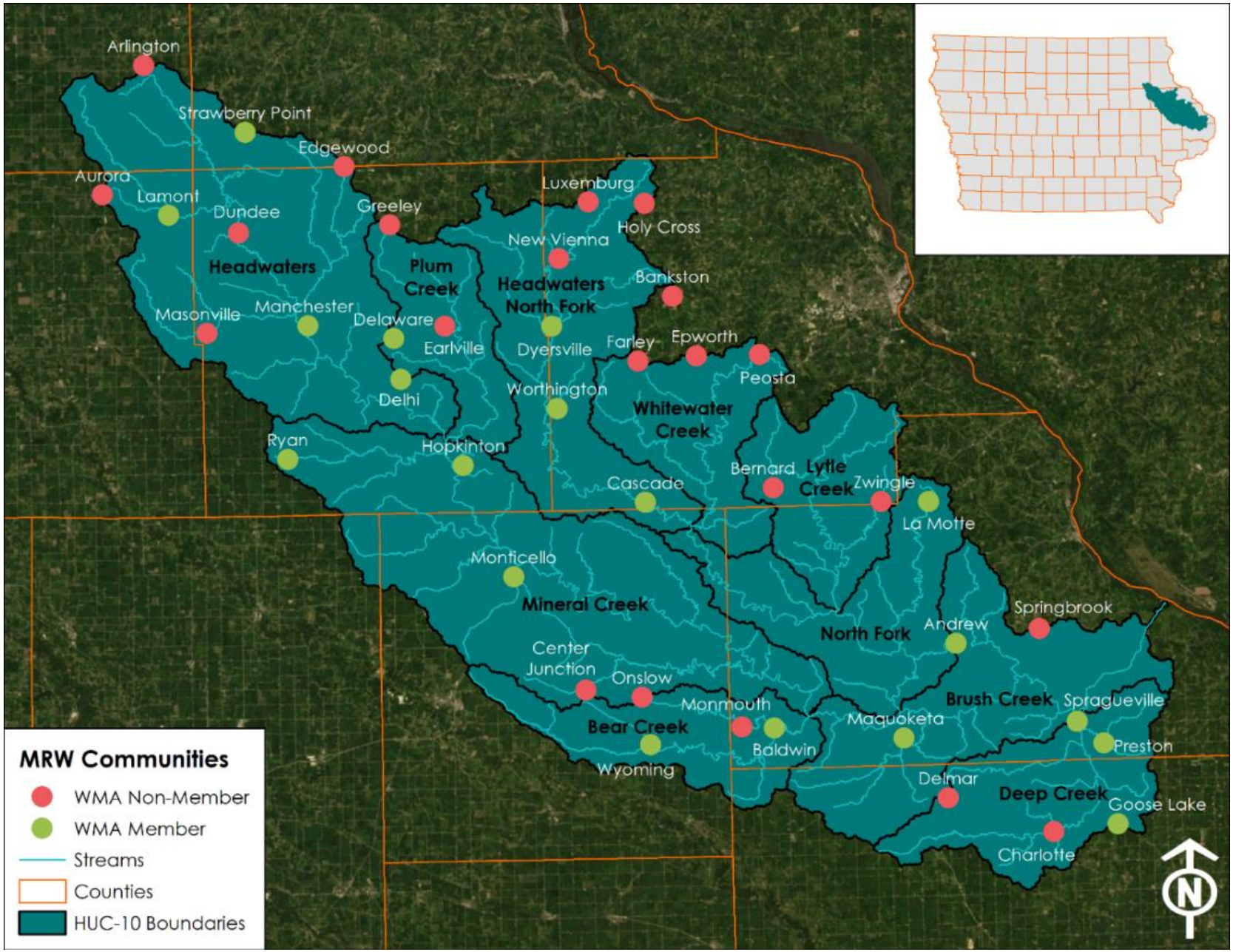


Figure 5: MRW location map and WMA membership status of incorporated cities within the watershed. (authors)

Community Profile

Phase I has a detailed description of the characteristics of the MRW. Key points that are important to understanding the watershed and Phase II specifically include:

Population Demographic

- Biggest towns by population are Maquoketa, Manchester, Dyersville, and Monticello
- The MRW is 97% white
- 58% of residents are between the ages of 18 and 64
- Diverse employment sectors

Land Use and Land Cover

- 80% agriculture, 12% natural areas, 7.7% developed
- 95% privately-owned
- Average slope of 6%
- Slope varies by sub-watershed with the Upper Maquoketa being flatter and Lower Maquoketa being steeper

Topography and Geology

- Floodplains are widest near Manchester, Monticello, and Maquoketa
- Bedrock is less than 25 feet down in most areas
- Karst topography (bedrock that is easily dissolvable) leads to pollutant infiltration and sinkholes

Soils

- Soil type determines water and pollutant infiltration
- Types in the MRW absorb between 1.5 and 2 inches of water per foot of soil
- 90% of soil erosion in the area is from cropland

Hydrology

- Seasonal changes in precipitation and river discharge (the velocity of water in the channel)
- Water runoff is increasing in irregularity and intensity
- Residents use groundwater for municipal supplies as well as livestock and industrial uses

Water Concerns

- 16 streams and 3 lakes on the Iowa Impaired Waters List
- High risk of flash flooding throughout the MRW
- Several major flood events since 1925, including the 2010 breach of Lake Delhi Dam
- Floods have damaged millions of dollars' worth of property and crops

Wildlife and Habitat

- 23 animal and 67 plant species listed as under concern, threatened, or endangered

Recreation

- 84% of survey respondents believe the MRW is a recreational asset and destination for Eastern Iowa
- Popular activities include trout fishing, paddle sports, scenery viewing, hunting, swimming, and hiking

Climate

- Climate change will intensify and increase precipitation across the watershed
- Higher temperatures and increased drought frequency will extend growing season and affect biodiversity

These data and profiles of each HUC-10 in the MRW created for this plan give context to Phase II, revealing a watershed that is largely rural, but connected to several small cities, and agriculturally productive. Figure 5 (above) and Figure 6 (below) illustrate the location and human characteristics of the entire MRW, including land use data and the WMA membership status of incorporated cities as of 2022. Given the recent release of 2020 US Census data, the planning team has included updated population calculations in each HUC-10 profile below. The unique variations in elevation, geology, soil types, and hydrology are suitable to the sub-watershed profiles and individual implementation recommendations in Phase II.

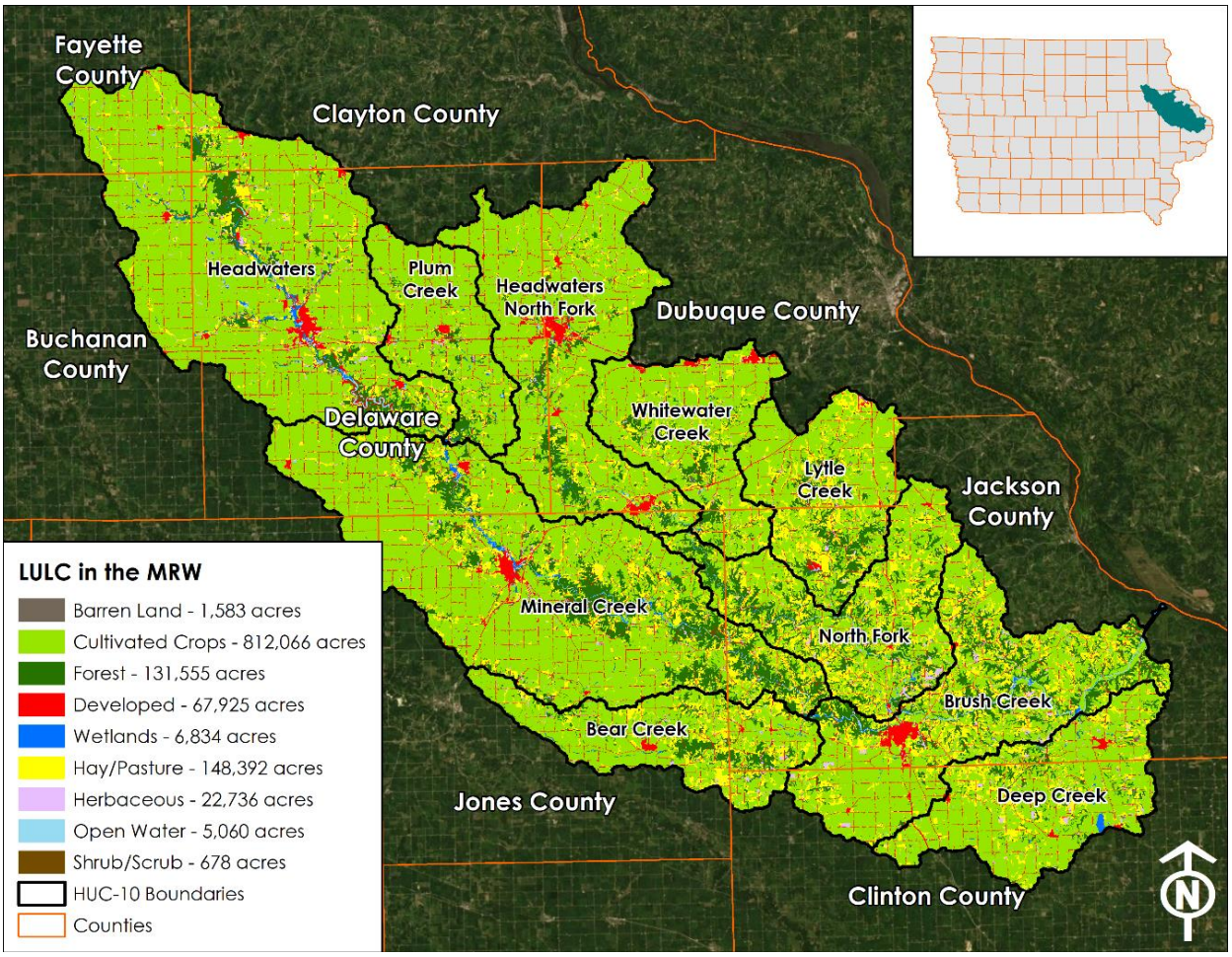


Figure 6: Map of location and types of Land Use Land Cover in the MRW. (National Land Cover Dataset, 2019, map by authors)

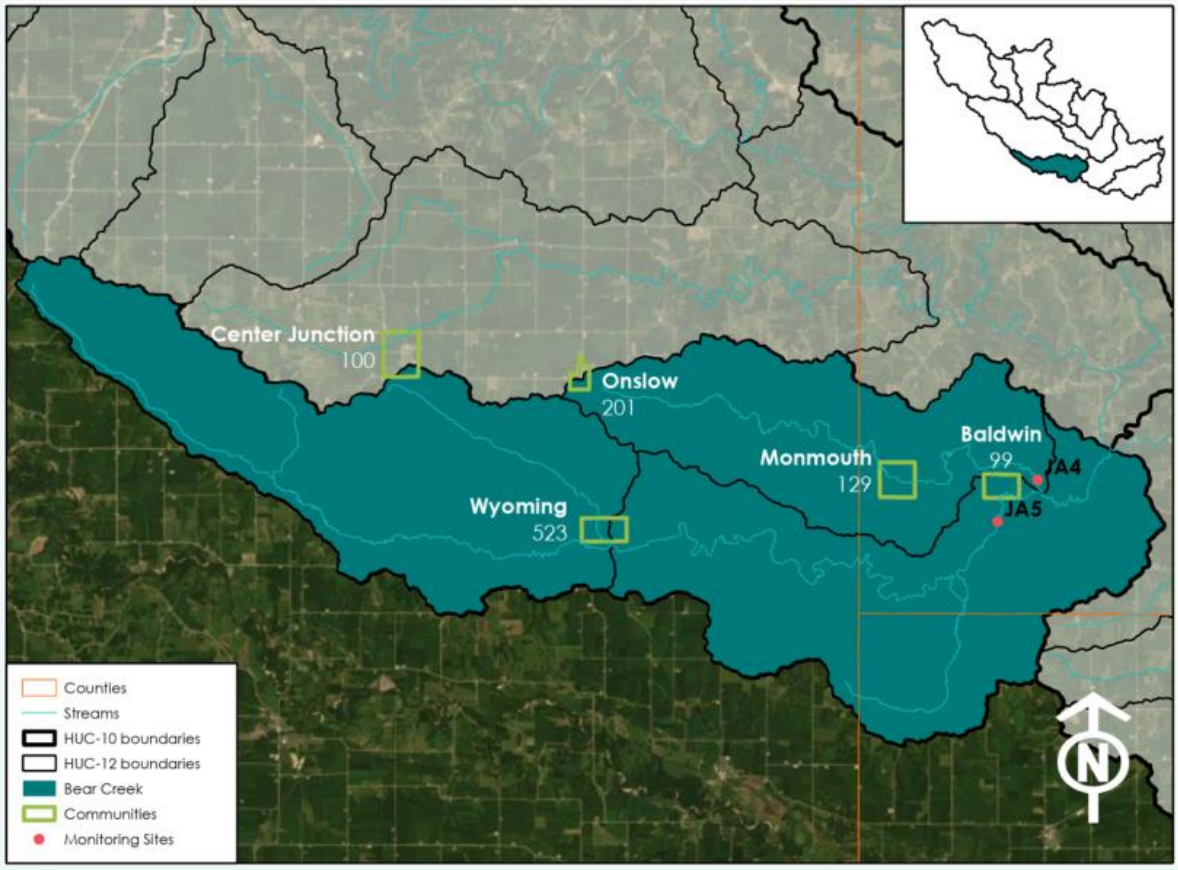
Sub-Watershed Profiles

In order to visualize how demographics, natural features, and water concerns vary across the MRW, the planning team has created profiles of each HUC-10 within the watershed. These can be used together to compare spatial differences or individually to present a more local snapshot of watershed characteristics. They are designed so they can be shown separately from the plan, such as by the WMA to help frame public discussions or in conversations with local stakeholders and landowners. As such, figures and tables within them are not labeled.

Each profile includes the following information: HUC-10 name and brief description; population and land cover statistics to showcase human aspects; natural features that affect flood risk and water quality improvement; and water quality measures that are important to recreational opportunities. Additionally, each profile includes any key points identified by the prioritization process for HUC-12s within that HUC-10.

HUC-10 Profile: Bear Creek

Bear Creek is in the southeast portion of the Maquoketa River Watershed. It comprises 70,917 acres and three HUC-12s. This sub-watershed contains all or parts of five communities and three counties (Jackson, Jones, and Clinton). Notable features include Eden Valley Refuge, a destination for camping and hiking, and Baldwin Marsh, a 67-acre area with a restored wetland and native plantings.



- Relatively low flood risk throughout Bear Creek HUC-10.
- Less population and urban area at risk of floodling.

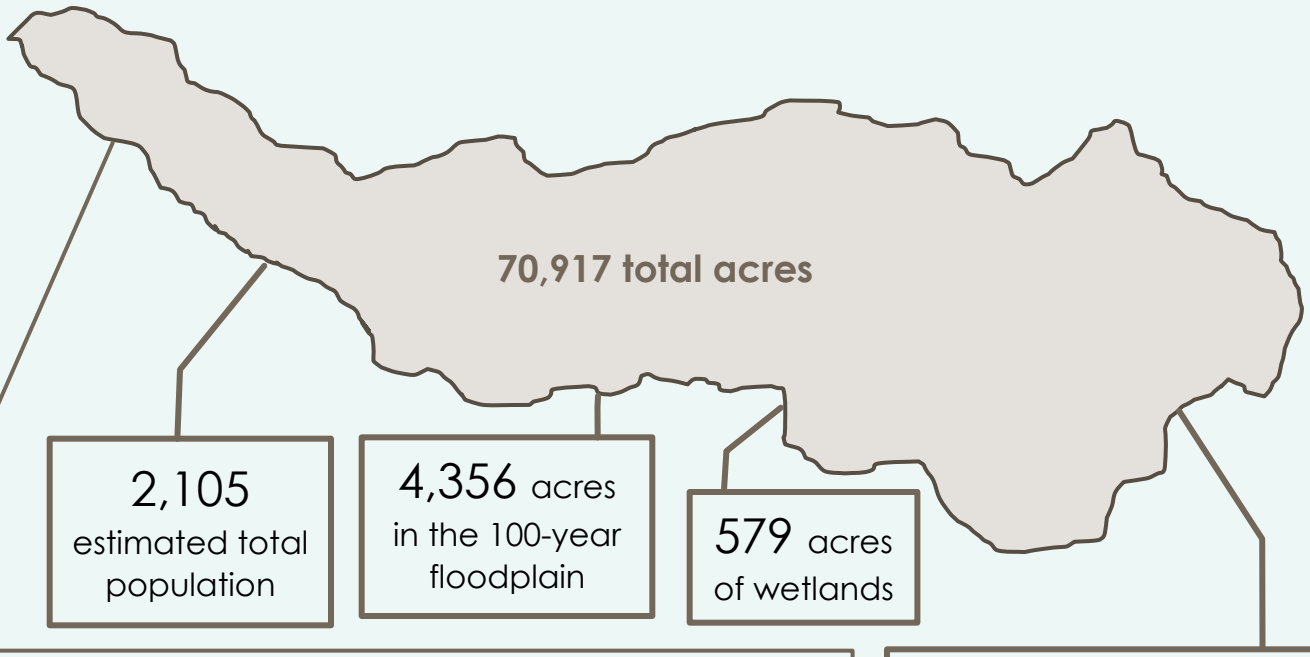
- Medium priority for nitrate and phosphorous pollution throughout.
- High runoff potential with few existing management practices.

- All HUC-12's have relatively good recreational opportunities.
- Few wetlands and public lands are in this sub-watershed but no impaired streams.

What the heck is a HUC?

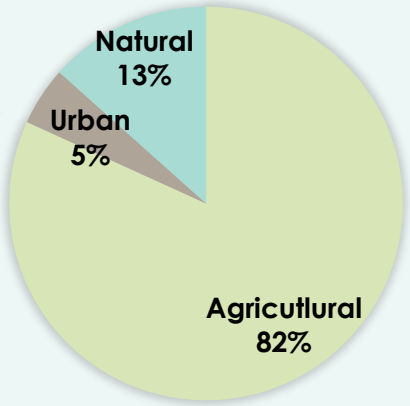
HUC (Hydrological Unit Code) is a number assigned to identify a sub-watershed. They range from 2 to 12 digits, with the entire Maquoketa River Watershed being a HUC-8.

MAQUOKETA RIVER WATERSHED Management Plan



Total Miles of Streams: 78.2

Land Use:



Existing Management Practices:

25 buffer strips

4,698 grassed waterways

175 terraces

281 water and sediment control basins

249 pond dams

45 strip crop sites

Existing Point-Source Pollution:

9 Permitted CAFOs and Open Feed Lots

3 Permitted wastewater treatment facilities

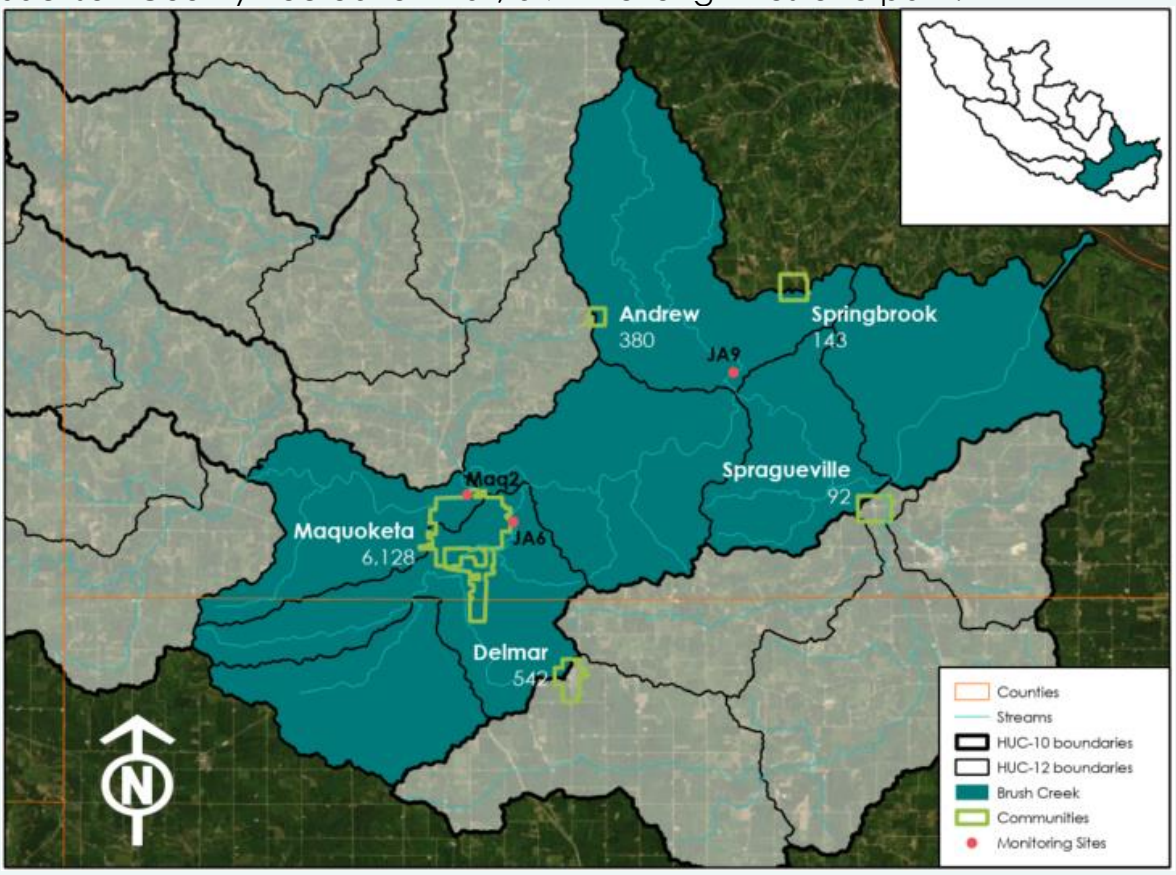
Water Quality Monitoring Results (2019-2021 average)

Sites	Chloride (mg/L)	Dissolved Phosphorous (mg/L)	E. Coli Bacteria (CFU/100ml)	Nitrate (mg/L)	Sulfate (mg/L)	Turbidity (NTUs)
JA4	14.51	0.26	1,635.56	3.52	15.76	40.67
JA5	12.88	0.25	4,247.13	3.52	14.79	36.61
Standard	5 to 250	1	235	10	500 to 2000	25

Standards are from the US EPA and IA DNR. Chloride and sulfate standards depend on the water hardness. E. Coli criteria listed is for waterbodies designated for swimming. Turbidity listed is the limit for each point source.

HUC-10 Profile: Brush Creek

Brush Creek is in the southern portion of the Maquoketa River Watershed and drains the watershed to the Mississippi River. It comprises 130,889 acres and seven HUC-12s. This sub-watershed contains the City of Maquoketa as well as all or part of four other smaller incorporated cities and is split between Jackson and Jones counties. Notable features include the Prairie Creek Recreation Area, a 273-area that features limestone bluffs and woodlands, and the Jackson County Recreation Trail, a 7-mile long limestone path.



- Relatively low flood risk throughout this HUC-10.
- Due to more built-up area, the HUC-12 around Maquoketa is higher priority.

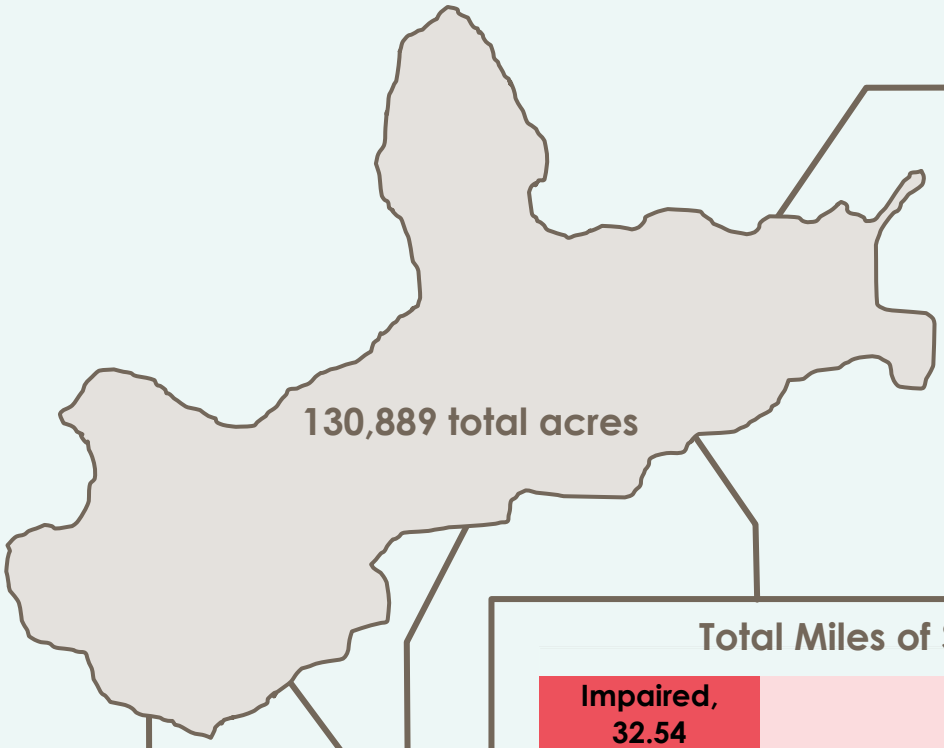
- This HUC-10 is low priority for nitrate and phosphorous pollution.
- Water quality monitoring does not capture the entire HUC-10 area.

- All HUC-12's have relatively good recreational opportunities.
- Recreation is not significantly impacted by water quality issues in this sub-watershed.

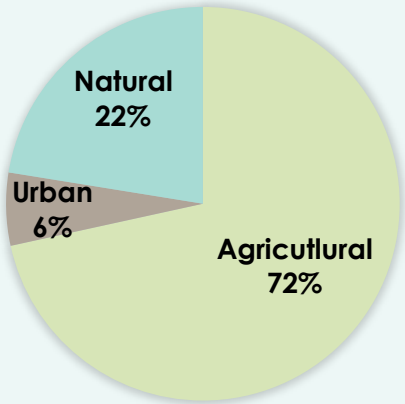
What the heck is a HUC?

HUC (Hydrological Unit Code) is a number assigned to identify a sub-watershed. They range from 2 to 12 digits, with the entire Maquoketa River Watershed being a HUC-8.

MAQUOKETA RIVER WATERSHED Management Plan



Land Use:



Total Miles of Streams: 126.7

Impaired, 32.54	Unimpaired, 94.16

Reasons for impairment include fish kills, loss of native mussels, and E. Coli.

9,545 estimated total population

2,245 acres of wetlands

5,464 acres in the 100-year floodplain

Existing Point-Source Pollution:

17 Permitted CAFOs and Open Feed Lots

4 Permitted wastewater treatment facilities

Existing Management Practices:

220 buffer strips

9,400 grassed waterways

285 terraces

494 water and sediment control basins

446 pond dams

41 strip crop sites

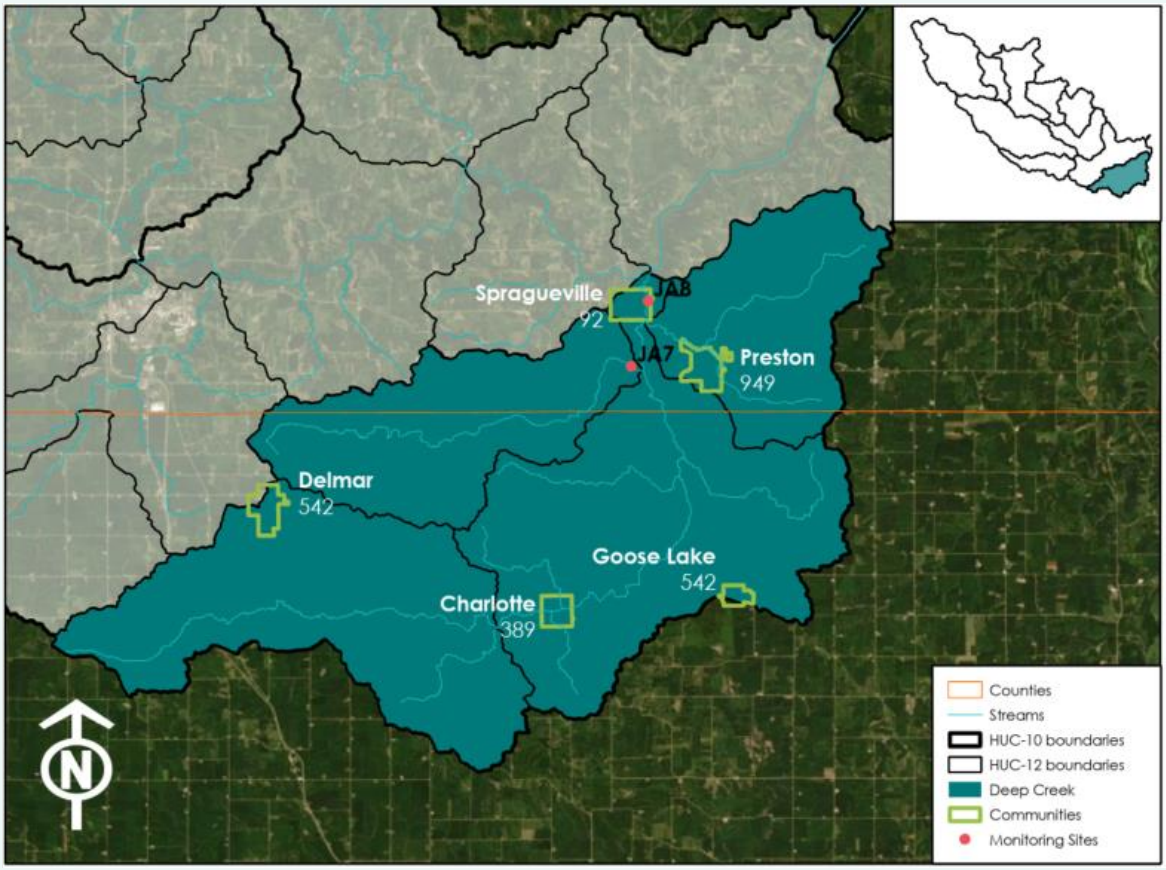
Water Quality Monitoring Results (2019-2021 average)

Sites	Chloride (mg/L)	Dissolved Phosphorous (mg/L)	E. Coli Bacteria (CFU/100ml)	Nitrate (mg/L)	Sulfate (mg/L)	Turbidity (NTUs)
JA6	18.21	0.24	661.88	4.47	19.28	36.33
JA9	13.14	0.27	4,054.13	4.75	15.06	25.83
Maq2	15.09	0.08	131.00	3.62	19.19	25.67
Standard	5 to 250	1	235	10	500 to 2000	25

Standards are from the US EPA and IA DNR. Chloride and sulfate standards depend on the water hardness. E. Coli criteria listed is for waterbodies designated for swimming. Turbidity listed is the limit for each point source.

HUC-10 Profile: Deep Creek

Deep Creek is the southern most HUC-10 in the Maquoketa River Watershed. It comprises 88,709 acres and four HUC-12s. This sub-watershed contains all or part of five smaller incorporated cities and is split between Jackson and Clinton County. Notable features include the Goose Lake Wildlife Management Area, a 1,290-acre area with marsh and forested area, and Jackson County Recreation Trail, a 7-mile long limestone path.



- All HUC-12's within this area are low or medium priority for flooding.

- The southeastern HUC-12 is high priority for nitrate and phosphorous pollution, while the remaining HUC-12's are lower priority.

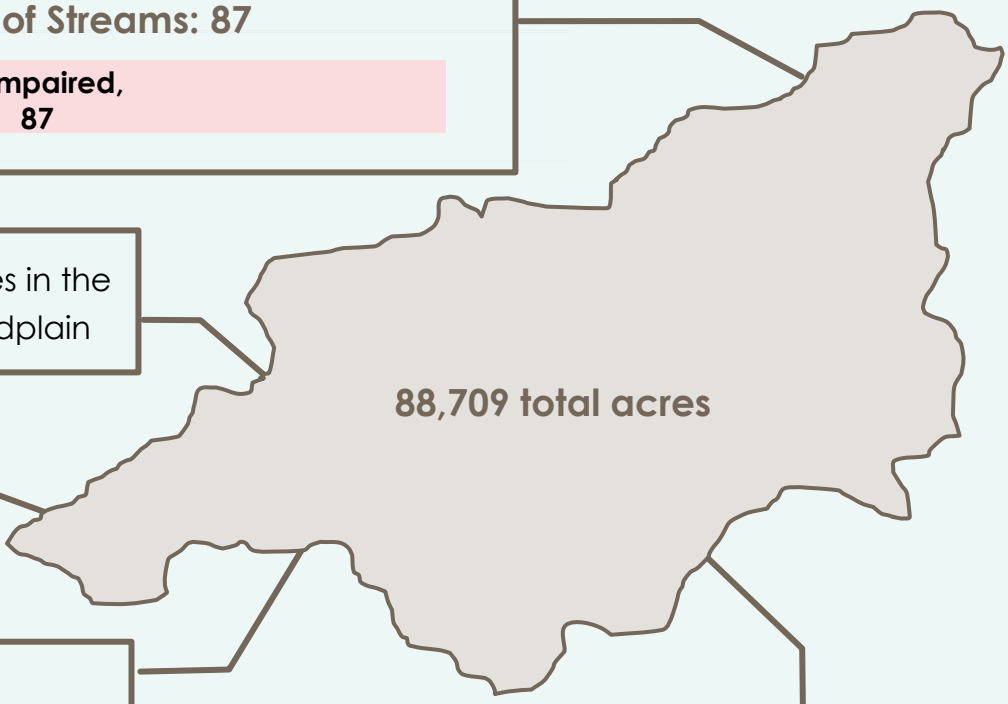
- All HUC-12's have relatively good recreational opportunities.
- Recreation is not significantly impacted by water quality issues in this area.

What the heck is a HUC?
HUC (Hydrological Unit Code) is a number assigned to identify a sub-watershed. They range from 2 to 12 digits, with the entire Maquoketa River Watershed being a HUC-8.

MAQUOKETA RIVER WATERSHED Management Plan

Total Miles of Streams: 87

Impaired, 0 | Unimpaired, 87

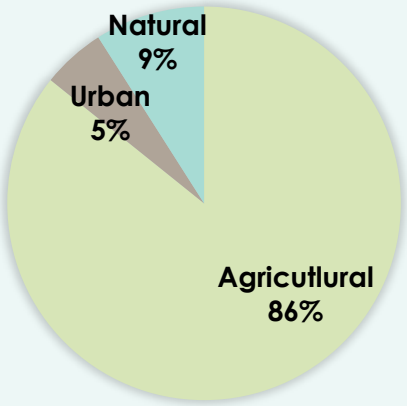


12,124 acres in the 100-year floodplain

779 acres of wetlands

3,095 estimated total population

Land Use:



Existing Point-Source Pollution:

28 Permitted CAFOs and Open Feed Lots

6 Permitted wastewater treatment facilities

Existing Management Practices:

97 buffer strips

5,286 grassed waterways

188 terraces

174 water and sediment control basins

221 pond dams

10 strip crop sites

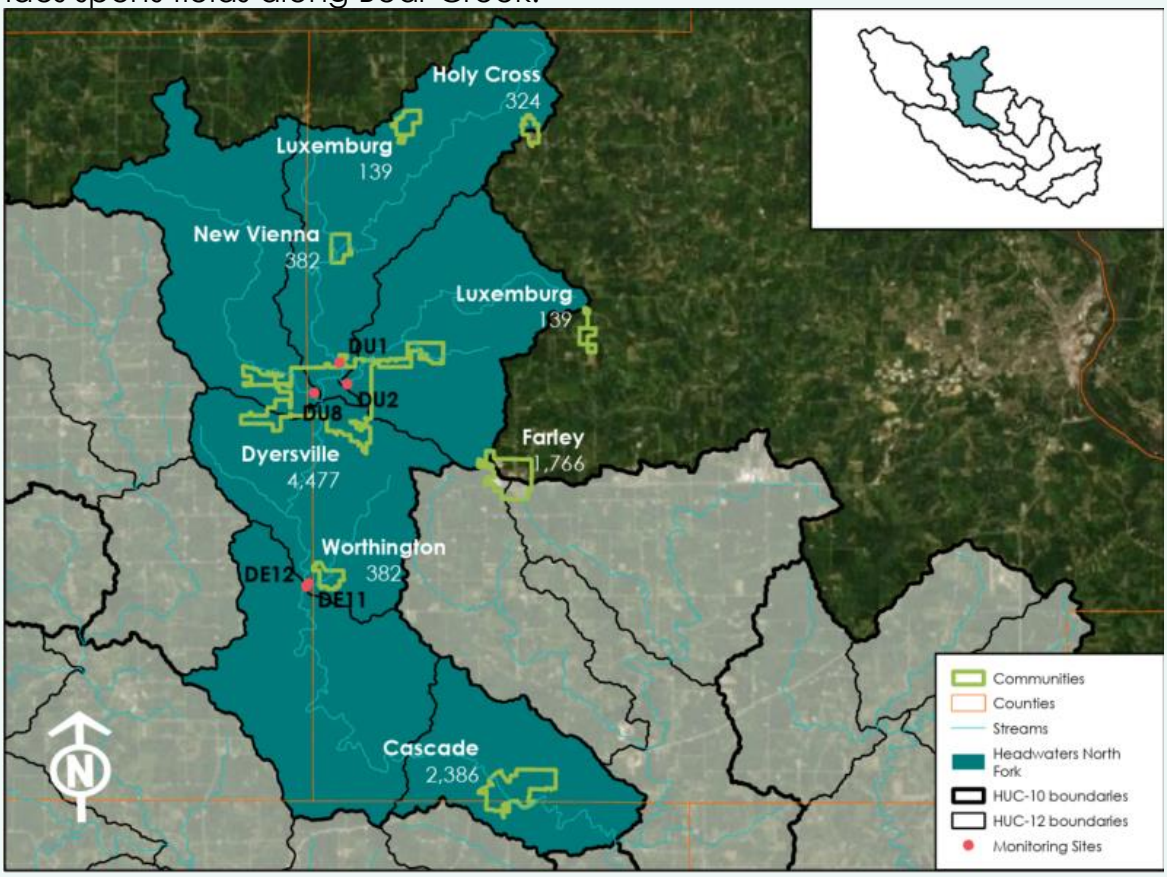
Water Quality Monitoring Results (2019-2021 average)

Sites	Chloride (mg/L)	Dissolved Phosphorous (mg/L)	E. Coli Bacteria (CFU/100ml)	Nitrate (mg/L)	Sulfate (mg/L)	Turbidity (NTUs)
JA7	15.31	0.26	4,755.11	3.44	21.61	24.00
JA8	16.48	0.39	3,493.47	5.36	21.41	83.00
Standard	5 to 250	1	235	10	500 to 2000	25

Standards are from the US EPA and IA DNR. Chloride and sulfate standards depend on the water hardness. E. Coli criteria listed is for waterbodies designated for swimming. Turbidity listed is the limit for each point source.

HUC-10 Profile: Headwaters North Fork

Headwaters North Fork is in the north portion of the Maquoketa River Watershed. It comprises 139,638 acres and six HUC-12s. This sub-watershed contains the City of Dyersville and the Cascade as well as all or part of six other smaller incorporated cities and four counties (Dubuque, Delaware, Jones, and Clayton). Notable features include the Heritage Trail, a 26-mile limestone path that connects to the City of Dubuque, and Dyersville Community Park, that provides sports fields along Bear Creek.



- This HUC-10 contains medium and high priority HUC-12's for flood risk.
- More urban area contributes to, and could be damaged by, flooding.

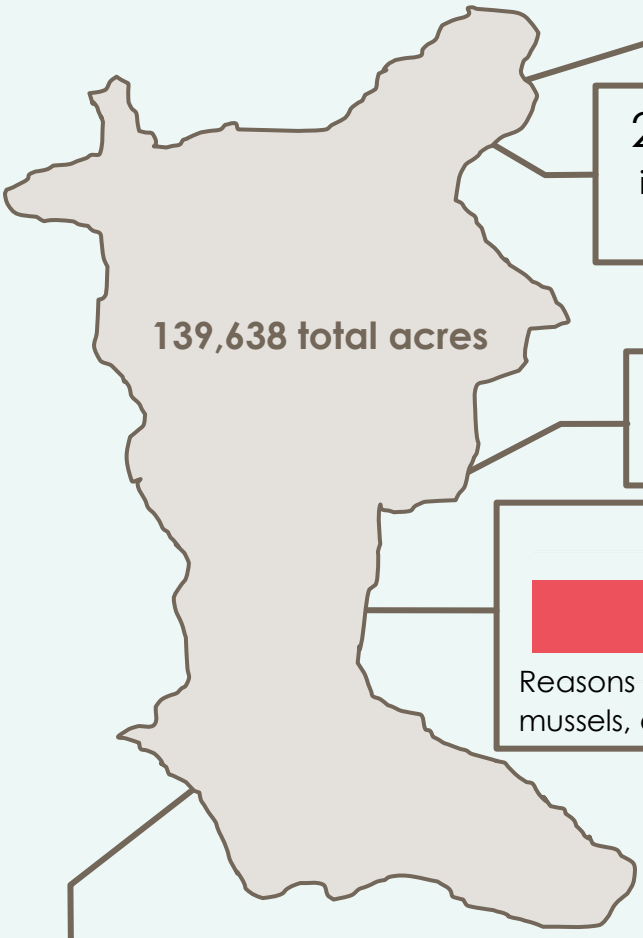
- Northern end is high priority for nitrate and phosphorous pollution.
- There are high monitored pollutants with few existing mitigation practices.

- This HUC-10 has the most high priority areas for recreation improvement.
- Few public lands and wetlands combined with many impaired streams restrict recreation opportunities.

What the heck is a HUC?

HUC (Hydrological Unit Code) is a number assigned to identify a sub-watershed. They range from 2 to 12 digits, with the entire Maquoketa River Watershed being a HUC-8.

MAQUOKETA RIVER WATERSHED Management Plan

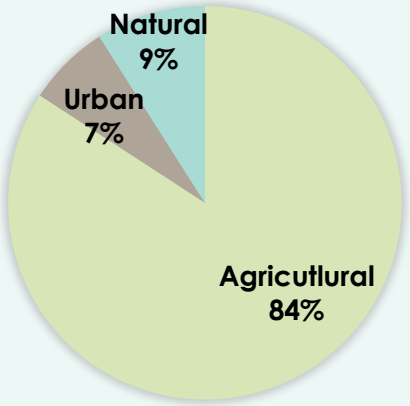


22,834 acres in the 100-year floodplain

938 acres of wetlands

10,402 estimated total population

Land Use:



Total Miles of Streams: 107.7

Impaired, 73.43	Unimpaired, 34.27

Reasons for impairment include fish kills, E. Coli, loss of native mussels, and low biological integrity.

Existing Point-Source Pollution:

97 Permitted CAFOs and Open Feed Lots

9 Permitted wastewater treatment facilities

Existing Management Practices:

97 buffer strips

4,780 grassed waterways

344 terraces

455 water and sediment control basins

109 pond dams

18 strip crop sites

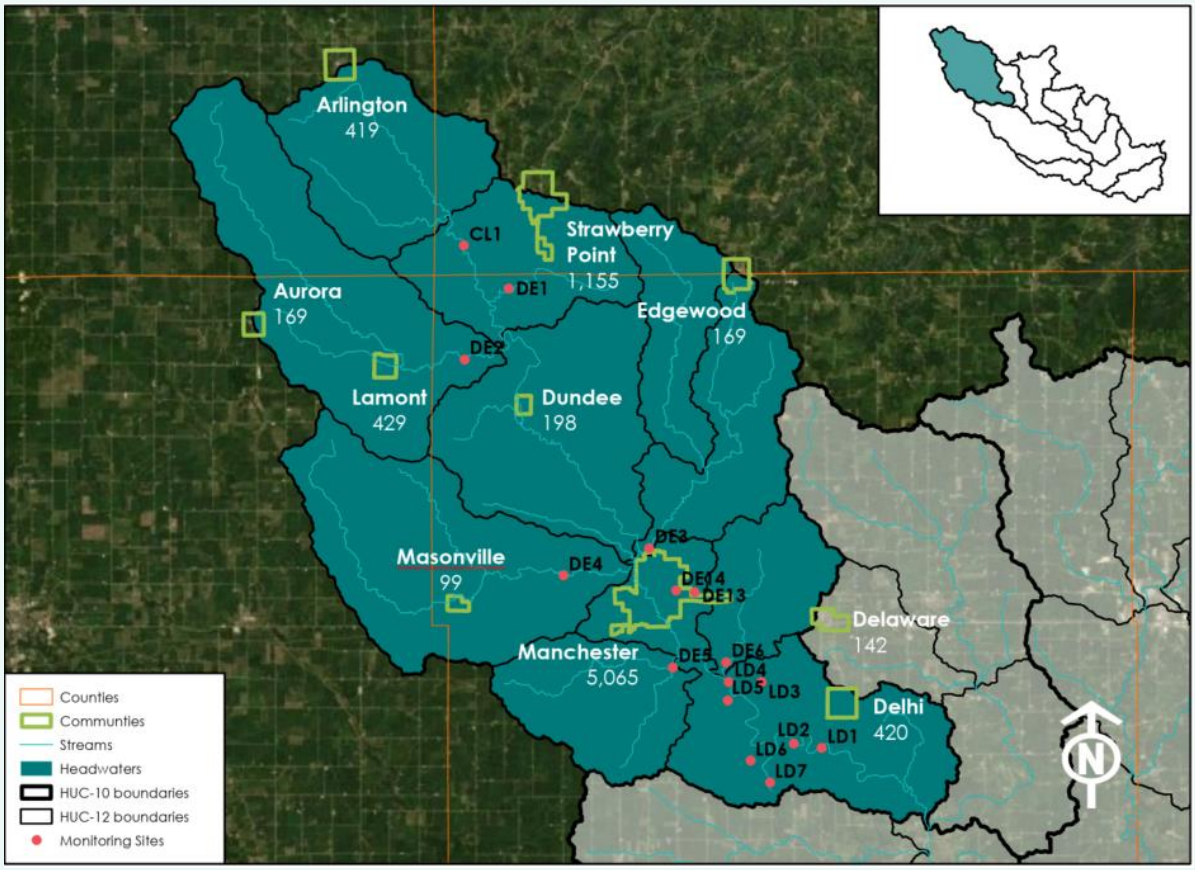
Water Quality Monitoring Results
(2019-2021 average)

Sites	Chloride (mg/L)	Dissolved Phosphorous (mg/L)	E. Coli Bacteria (CFU/100ml)	Nitrate (mg/L)	Sulfate (mg/L)	Turbidity (NTUs)
DE11	22.21	0.69	6,673.86	10.75	27.07	11.67
DE12	23.13	0.63	5,374.75	9.06	23.41	31.17
DU1	23.26	0.70	1,945.57	7.40	20.01	35.39
DU2	19.73	0.56	4,421.83	9.38	21.03	15.11
DU8	19.64	0.48	6,026.29	10.17	29.47	22.94
Standard	5 to 250	1	235	10	500 to 2000	25

Standards are from the US EPA and IA DNR. Chloride and sulfate standards depend on the water hardness. E. Coli criteria listed is for waterbodies designated for swimming. Turbidity listed is the limit for each point source.

HUC-10 Profile: Headwaters

Headwaters is the northern most HUC-10 in the Maquoketa River Watershed. It comprises 235,072 acres and ten HUC-12s. This sub-watershed contains the City of Manchester as well as all or part of nine other smaller incorporated cities and four counties (Fayette, Clayton, Buchanan, and Delaware). Notable features include Backbone State Park, a destination for camping, climbing, and fishing, as well as the man-made Whitewater Park in Manchester.



- This HUC-10 is largely medium-high priority for flooding.
- Larger cities like Manchester contribute to, and are at risk of, flooding.

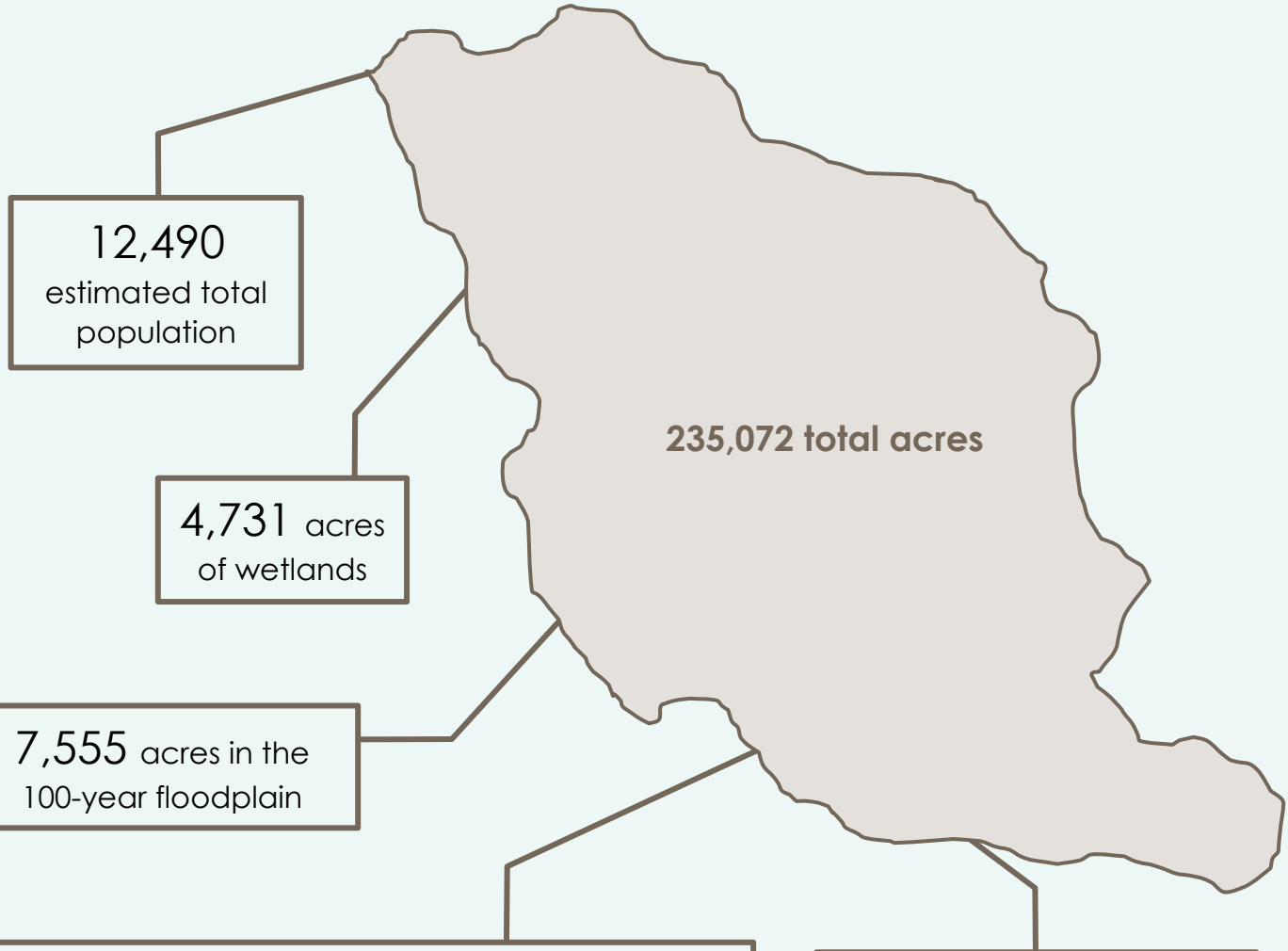
- Relatively high priority for nitrate and phosphorous pollution throughout the HUC-10.
- Many CAFOs are present in the northern portion.

- All HUC-12's have relatively good recreational opportunities.
- Several fish kill events in the southern portion restrict recreation opportunities.

What the heck is a HUC?

HUC (Hydrological Unit Code) is a number assigned to identify a sub-watershed. They range from 2 to 12 digits, with the entire Maquoketa River Watershed being a HUC-8.

MAQUOKETA RIVER WATERSHED Management Plan

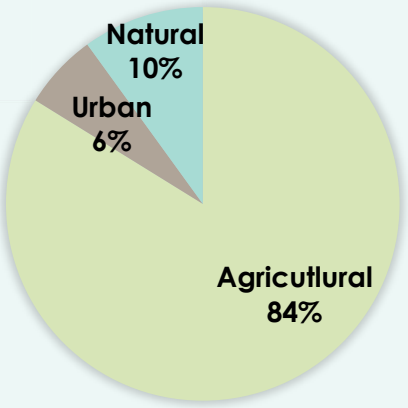


Total Miles of Streams: 207.8

Impaired, 67.86	Unimpaired, 139.94

Reasons for impairment include E. Coli, fish kills, loss of native mussels, and low aquatic macroinvertebrates.

Land Use:



Existing Management Practices:

79 buffer strips

4,470 grassed waterways

292 terraces

135 water and sediment control basins

73 pond dams

25 strip crop sites

Existing Point-Source Pollution:

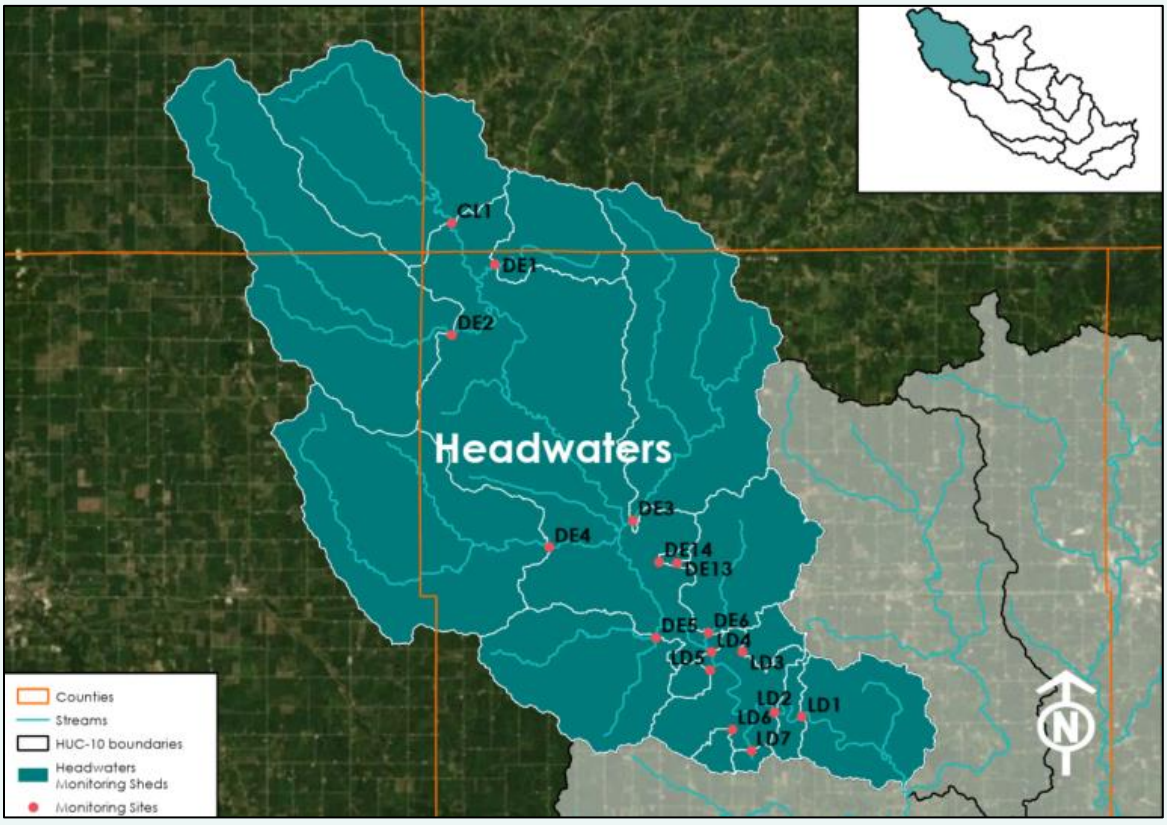
126 Permitted CAFOs and Open Feed Lots

21 Permitted wastewater treatment facilities

Water Quality Monitoring Results
(2019-2021 average)

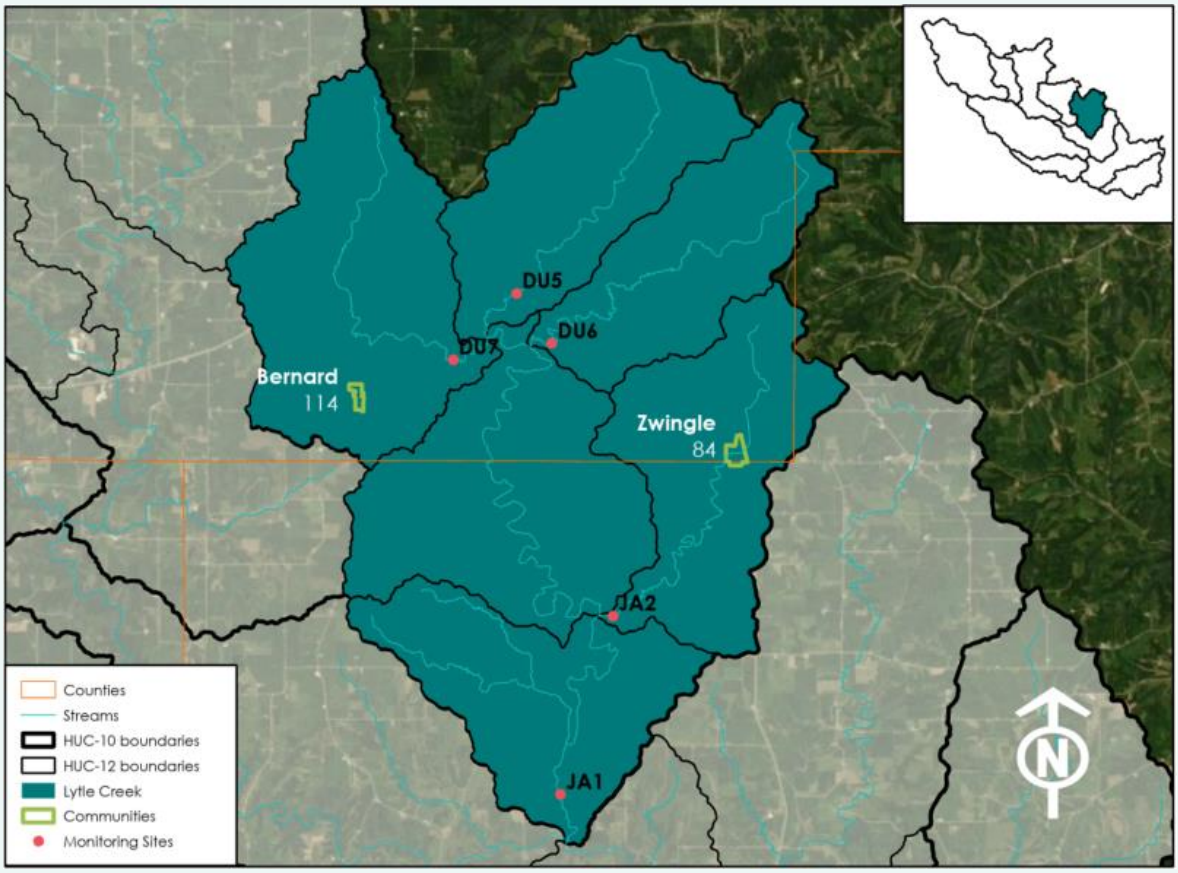
Sites	Chloride (mg/L)	Dissolved Phosphorous (mg/L)	E. Coli Bacteria (CFU/100ml)	Nitrate (mg/L)	Sulfate (mg/L)	Turbidity (NTUs)
CL1	13.56	0.21	2,090.75	9.16	15.36	5.33
DE1	21.26	0.31	1,645.50	10.59	21.64	3.25
DE2	13.49	0.17	1,398.11	6.58	21.60	6.22
DE3	17.32	0.27	2,452.00	10.64	18.21	14.44
DE4	14.82	0.23	871.33	8.11	17.37	9.56
DE5	17.51	0.15	2,038.78	9.71	18.32	7.56
DE6	16.74	0.18	1,133.78	12.87	16.92	4.00
DE13	34.42	0.27	1,427.50	5.47	19.47	3.00
DE14	28.57	0.26	1,985.50	7.68	24.38	3.00
LD1	18.18	0.07	204.50	4.51	19.28	8.67
LD2	18.23	0.17	563.50	4.67	19.52	18.00
LD3	17.08	0.17	7,126.00	7.75	27.43	12.67
LD4	17.16	0.22	730.00	5.92	17.70	11.00
LD5	20.25	0.18	3,478.50	9.31	18.10	6.00
LD6	29.23	0.78	2,535.50	7.33	19.87	4.33
LD7	16.00	0.17	840.33	8.99	20.64	5.00
Standard	5 to 250	1	235	10	500 to 2000	25

Standards are from the US EPA and IA DNR. Chloride and sulfate standards depend on the water hardness. E. Coli criteria listed is for waterbodies designated for swimming. Turbidity listed is the limit for each point source.



HUC-10 Profile: Lytle Creek

Lytle Creek is in the eastern, middle portion of the Maquoketa River Watershed. It comprises 73,821 acres and six HUC-12s. This sub-watershed contains two cities, Bernard and Zwingle, and is split between Dubuque and Jackson County. Notable features include LaSoya Wildlife Management Area and Leisure Lake campground.



- Relatively low flood risk throughout this HUC-10.
- Less population and urban areas that could be at risk from flooding.

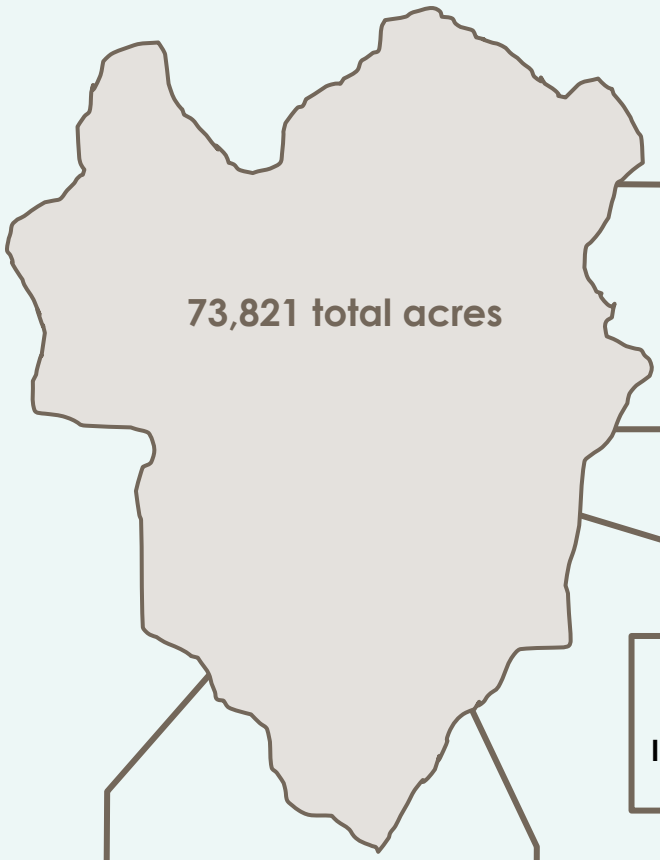
- Relatively low nitrate and phosphorous pollution risk throughout this HUC-10.

- All HUC-12's have relatively good recreational opportunities.
- Water quality issues

What the heck is a HUC?

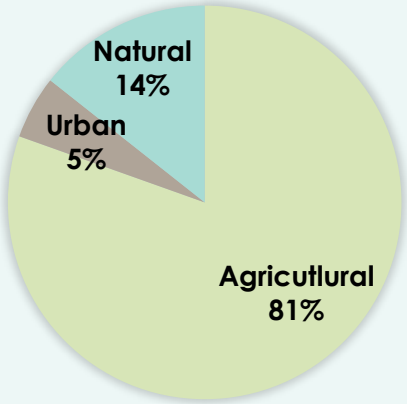
HUC (Hydrological Unit Code) is a number assigned to identify a sub-watershed. They range from 2 to 12 digits, with the entire Maquoketa River Watershed being a HUC-8.

MAQUOKETA RIVER WATERSHED Management Plan



1,910 estimated total population

Land Use:



Total Miles of Streams: 80.6

Impaired, 0

Unimpaired, 80.6

10,643 acres in the 100-year floodplain

368 acres of wetlands

Existing Point-Source Pollution:

13 Permitted CAFOs and Open Feed Lots

5 Permitted wastewater treatment facilities

Existing Management Practices:

100 buffer strips

3,902 grassed waterways

189 terraces

216 water and sediment control basins

224 pond dams

33 strip crop sites

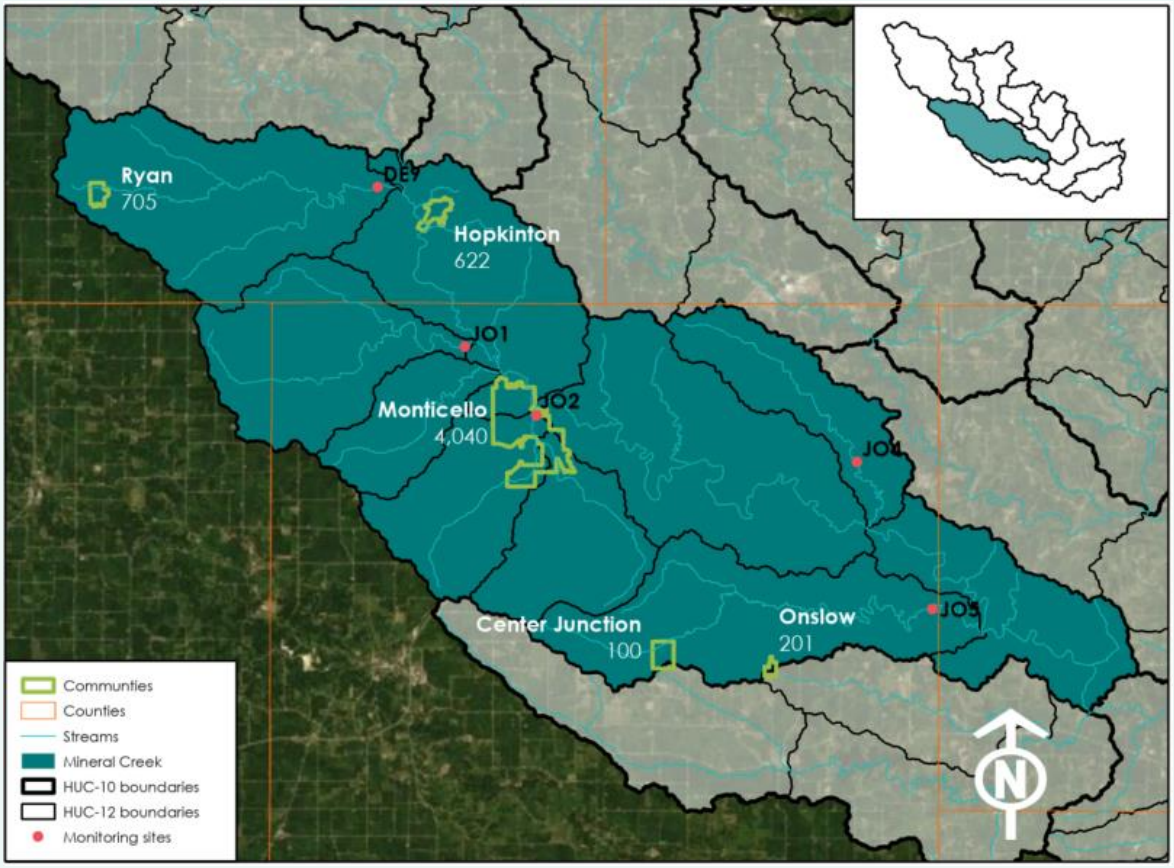
Water Quality Monitoring Results (2019-2021 average)

Sites	Chloride (mg/L)	Dissolved Phosphorous (mg/L)	E. Coli Bacteria (CFU/100ml)	Nitrate (mg/L)	Sulfate (mg/L)	Turbidity (NTUs)
DU5	20.54	0.46	1,954.60	7.51	12.87	29.22
DU6	17.86	0.38	3,044.71	7.76	13.32	15.28
DU7	22.26	0.46	5,315.17	9.86	17.72	28.50
JA1	16.98	0.39	4,049.88	6.49	14.87	40.78
JA2	20.21	0.42	3,053.50	5.74	13.76	24.00
Standard	5 to 250	1	235	10	500 to 2000	25

Standards are from the US EPA and IA DNR. Chloride and sulfate standards depend on the water hardness. E. Coli criteria listed is for waterbodies designated for swimming. Turbidity listed is the limit for each point source.

HUC-10 Profile: Mineral Creek

Mineral Creek is the southern, middle portion of the Maquoketa River Watershed. It comprises 236,588 acres and nine HUC-12s. This sub-watershed contains the City of Monticello as well as all or part of four other smaller incorporated cities and four counties (Delaware, Linn, Jackson, and Jones). Notable features include Pictured Rocks County Park, a regional destination for climbing and spelunking, and Indian Bluffs Wildlife Management Area.



- Northern end is high priority for flooding, while the southern end is low priority.
- Larger urban areas and public lands could be used to mitgate flood risk.

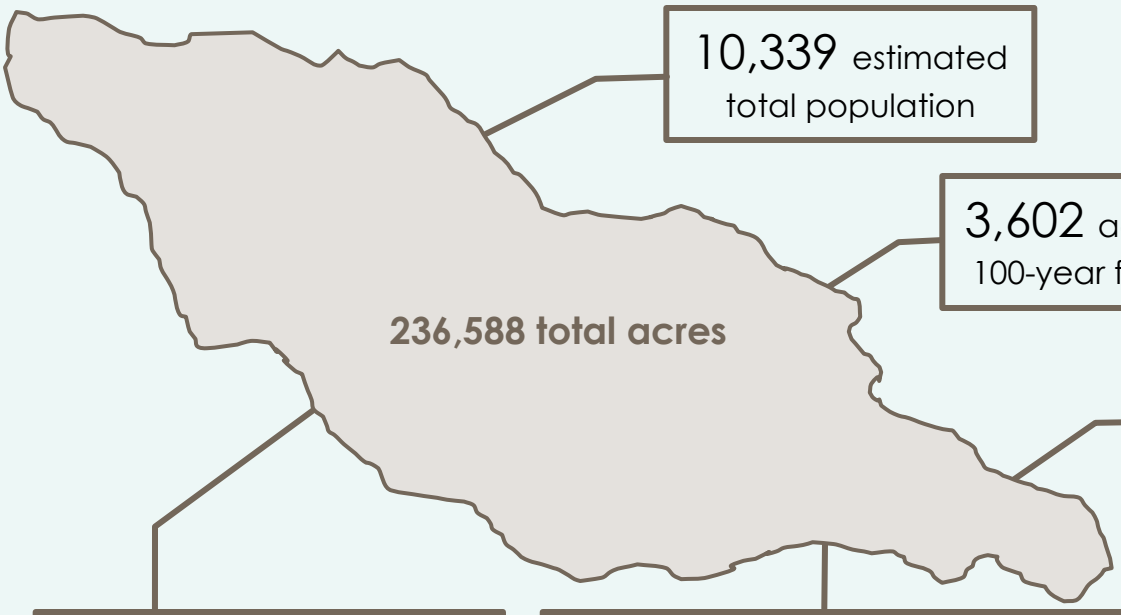
- Medium and high priority for nitrate pollution, due to pollutant sources and susceptible wells.
- Ranges from low to high priority for phosphorous, corresponding with runoff potential.

- Ranges from low to high priority for recreation improvements.
- Areas along the Maquoketa River have more wetland habitat but more impaired streams.

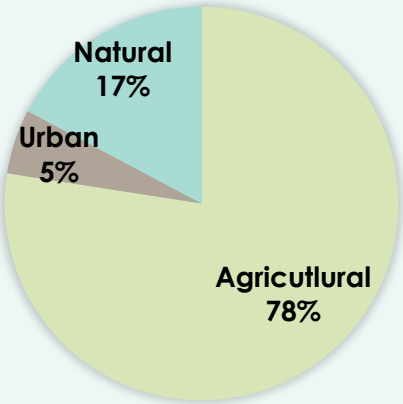
What the heck is a HUC?

HUC (Hydrological Unit Code) is a number assigned to identify a sub-watershed. They range from 2 to 12 digits, with the entire Maquoketa River Watershed being a HUC-8.

MAQUOKETA RIVER WATERSHED Management Plan



Land Use:



Total Miles of Streams: 237

Impaired, 76.3	Unimpaired, 160.7

Reasons for impairment include fish kills, loss of native mussels, E. Coli, and low aquatic macroinvertecbrates.

Existing Point-Source Pollution:

92 Permitted CAFOs and Open Feed Lots

8 Permitted wastewater treatment facilities

Existing Management Practices:

131 buffer strips

6,851 grassed waterways

786 terraces

1,518 water and sediment control basins

554 pond dams

25 strip crop sites

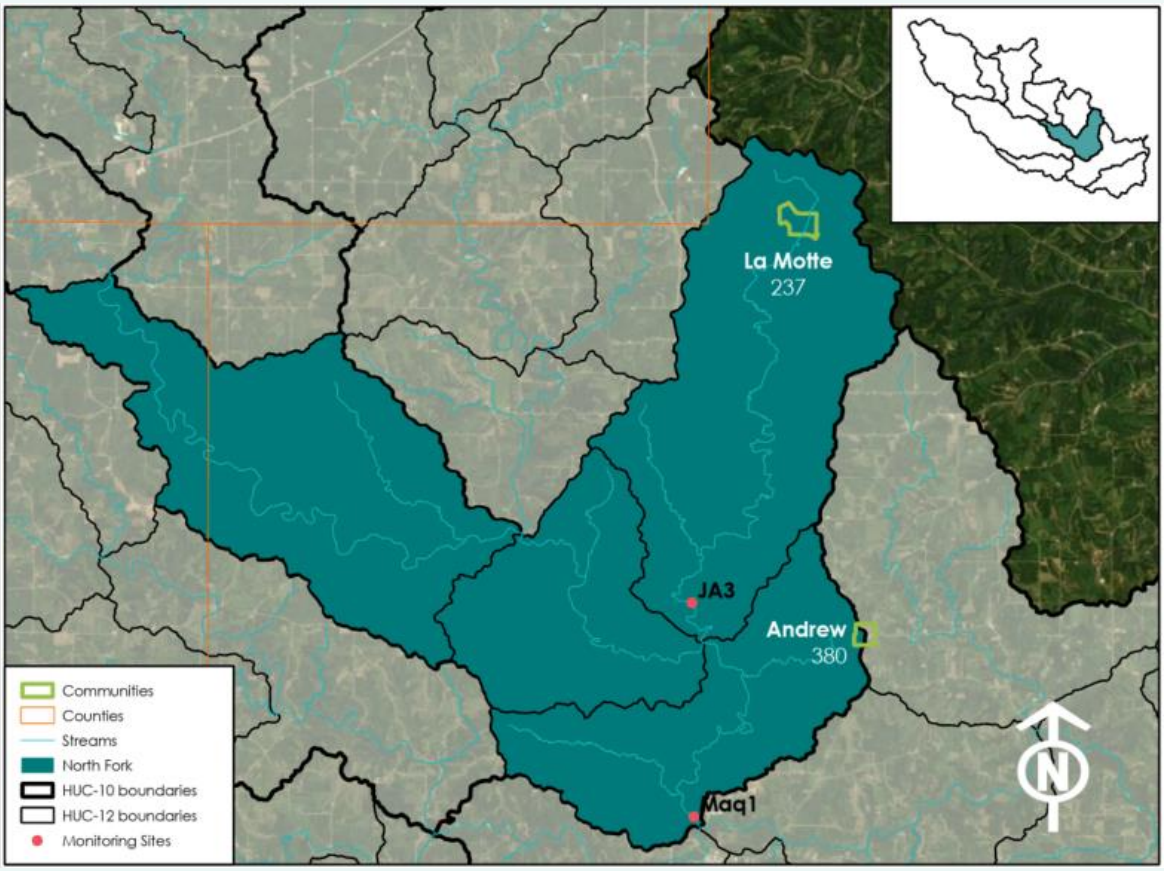
Water Quality Monitoring Results (2019-2021 average)

Sites	Chloride (mg/L)	Dissolved Phosphorous (mg/L)	E. Coli Bacteria (CFU/100ml)	Nitrate (mg/L)	Sulfate (mg/L)	Turbidity (NTUs)
DE9	16.20	0.33	4,178.63	10.55	18.41	20.56
JO1	14.66	0.23	2,454.89	7.83	19.20	15.83
JO2	18.68	0.18	2,588.67	5.55	16.18	12.44
JO4	14.34	0.51	1,461.33	6.44	21.17	36.11
JO5	13.66	0.22	2,096.78	4.53	15.42	37.61
Standard	5 to 250	1	235	10	500 to 2000	25

Standards are from the US EPA and IA DNR. Chloride and sulfate standards depend on the water hardness. E. Coli criteria listed is for waterbodies designated for swimming. Turbidity listed is the limit for each point source.

HUC-10 Profile: North Fork

North Fork is in the southeast portion of the Maquoketa River Watershed. It comprises 91,689 acres and four HUC-12s. This sub-watershed contains two cities, La Motte and Andrew and crosses two counties, Jackson and Jones. Notable features include Ozark Wildlife Area, a destination for hunting, fishing, and wildlife viewing, and Cottonville Conservation Area, which features 40-acres of timber and prairie restoration.



- Relatively low flood risk throughout this HUC-10.
- Less urban area means less contribution to, and risk from, flooding.

- Relatively low nirate and phosphorous pollution throughout this HUC-10.

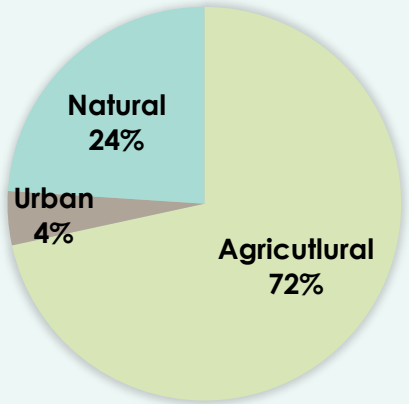
- Two of four HUC-12's are high priority for recreation improvement.
- Few wetland habitats and public lands throughout.

What the heck is a HUC?

HUC (Hydrological Unit Code) is a number assigned to identify a sub-watershed. They range from 2 to 12 digits, with the entire Maquoketa River Watershed being a HUC-8.

MAQUOKETA RIVER WATERSHED Management Plan

Land Use:



Total Miles of Streams: 92

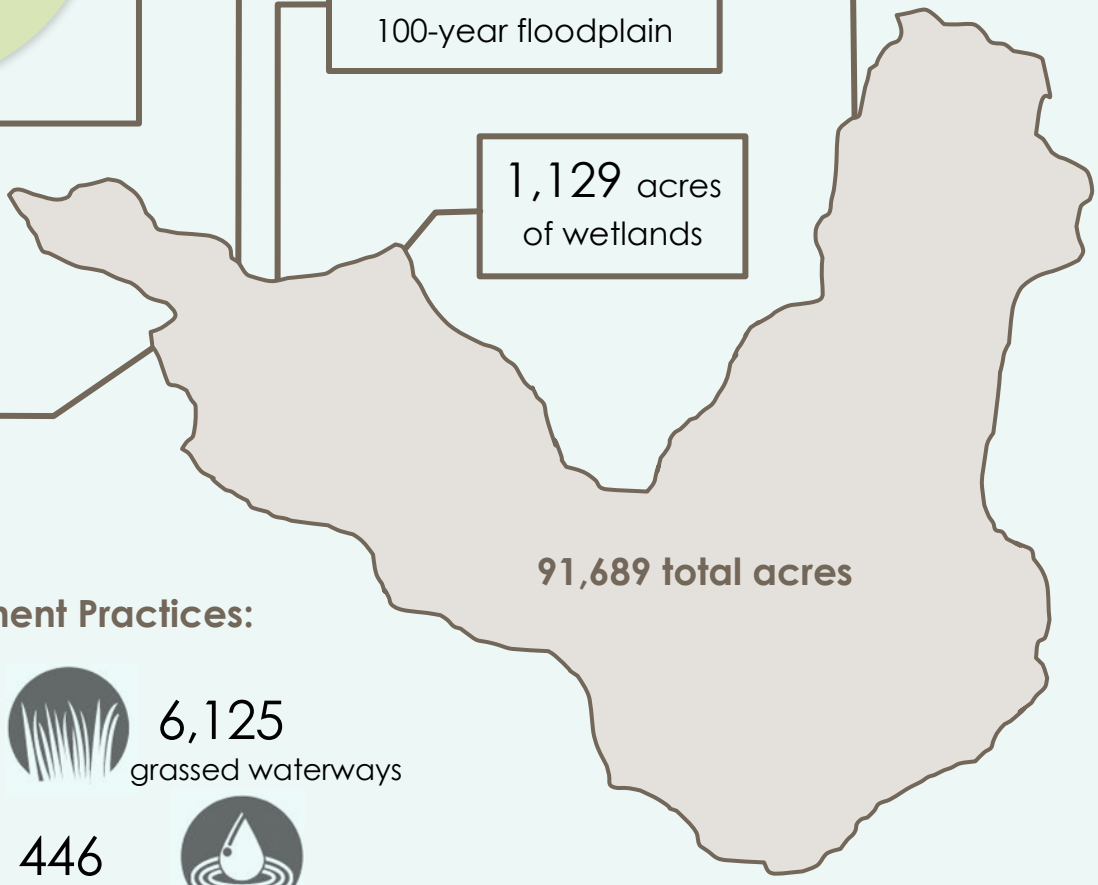
Impaired, 34.04	Unimpaired, 57.96

Reasons for impairment include fish kills, E. Coli, and low aquatic macroinvertebrates.

20,189 acres in the 100-year floodplain

1,129 acres of wetlands

2,062 estimated total population



Existing Management Practices:

108 buffer strips

6,125 grassed waterways

299 terraces

446 water and sediment control basins

537 pond dams

18 strip crop sites

Existing Point-Source Pollution:

19 Permitted CAFOs and Open Feed Lots

2 Permitted wastewater treatment facilities

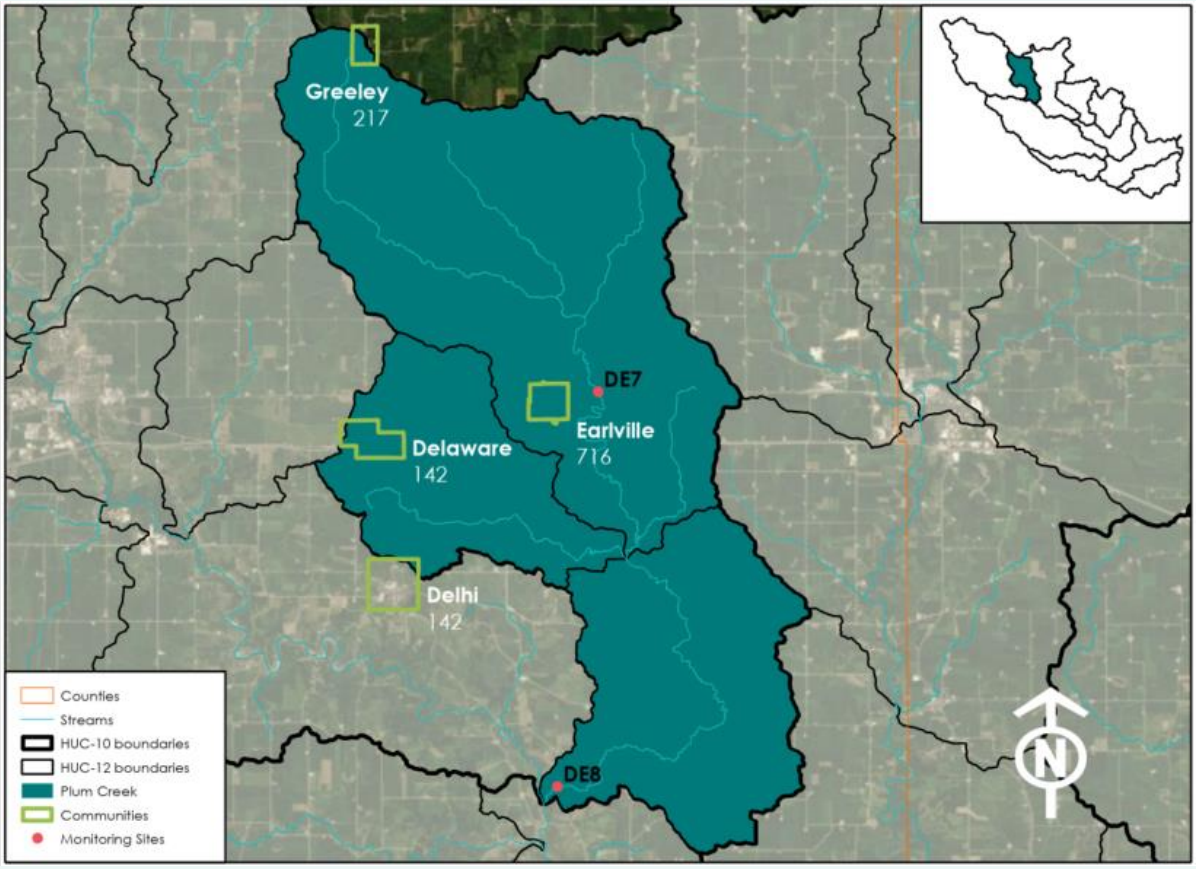
Water Quality Monitoring Results
(2019-2021 average)

Sites	Chloride (mg/L)	Dissolved Phosphorous (mg/L)	E. Coli Bacteria (CFU/100ml)	Nitrate (mg/L)	Sulfate (mg/L)	Turbidity (NTUs)
JA3	14.62	0.24	937.25	5.79	13.35	30.06
Maq1	17.61	0.27	3,986.50	4.88	18.49	86.33
Standard	5 to 250	1	235	10	500 to 2000	25

Standards are from the US EPA and IA DNR. Chloride and sulfate standards depend on the water hardness. E. Coli criteria listed is for waterbodies designated for swimming. Turbidity listed is the limit for each point source.

HUC-10 Profile: Plum Creek

Plum Creek is in the northern portion of the Maquoketa River Watershed. It comprises 57,104 acres and three HUC-12s. This sub-watershed contains four cities and lies entirely within Delaware County. Notable features include Brayton Memorial Forest, a 307-acre forest managed by Iowa State University, and Plum Creek County Park, located just south of the City of Earlville.



- Two of the three HUC-12's are high priority for flood risk.
- Public recreation areas could be used for flood mitigation.

- The northeastern HUC-12 is high priority for both nitrate and phosphorous pollution.
- Less public land and implemented management practices are there for mitigation.

- All HUC-12's are medium and high priority for recreation improvement.
- High proportion of streams in this area are impaired.

What the heck is a HUC?

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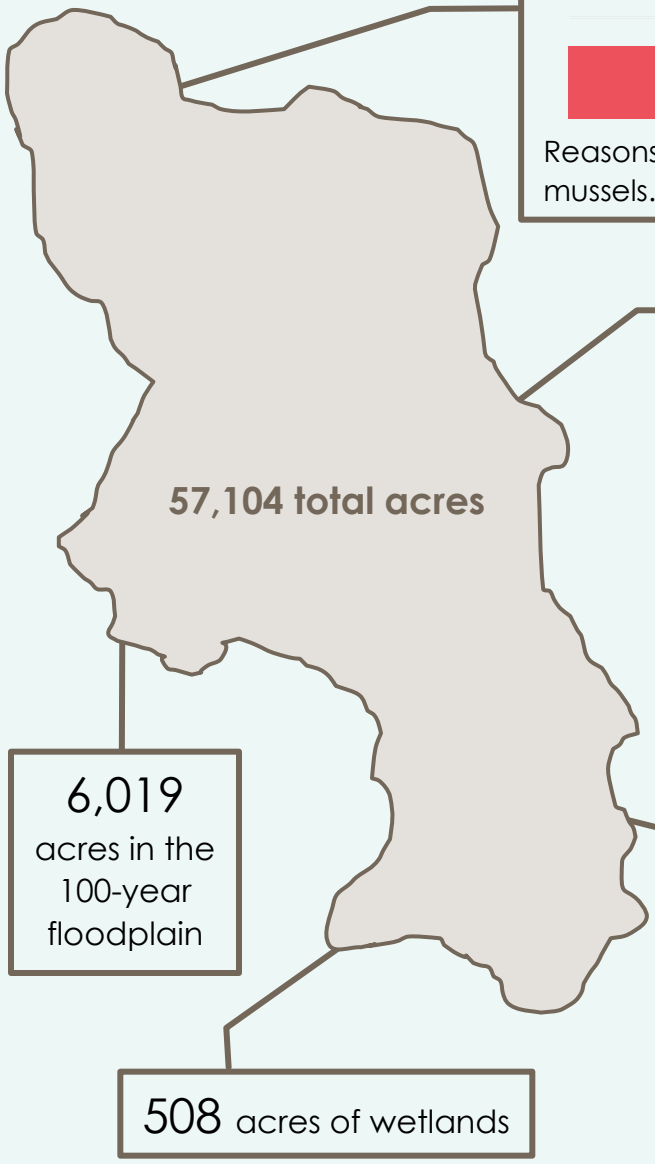
MAQUOKETA RIVER WATERSHED Management Plan

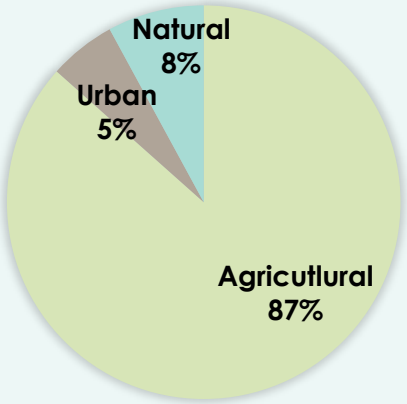


Total Miles of Streams: 55.6

Impaired, 31.73	Unimpaired, 23.87

Reasons for impairment include fish kills and loss of native mussels.

Land Use:



6,019 acres in the 100-year floodplain

2,320 estimated total population

508 acres of wetlands

Existing Point-Source Pollution:

35 Permitted CAFOs and Open Feed Lots

3 Permitted wastewater treatment facilities

Existing Management Practices:

21 buffer strips

1,235 grassed waterways

121 terraces

62 water and sediment control basins

10 pond dams

4 strip crop sites

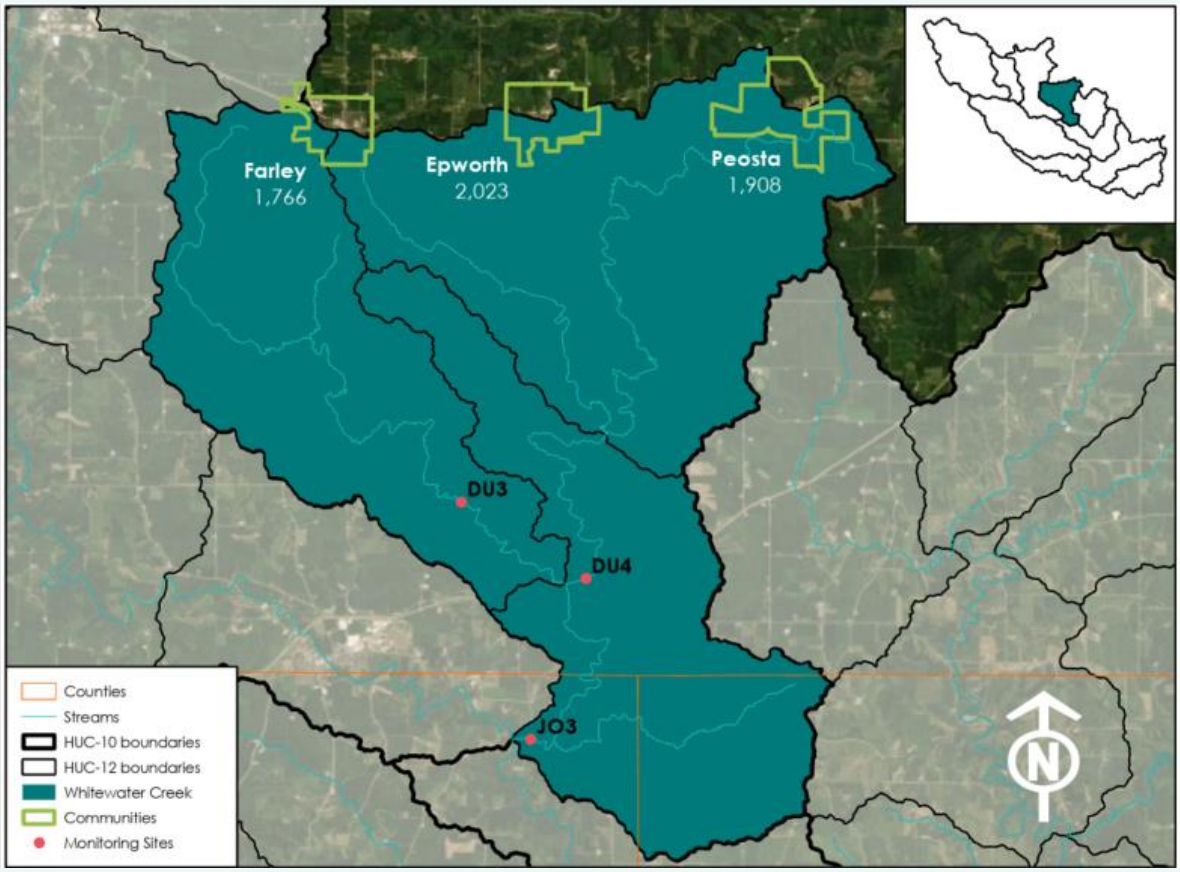
Water Quality Monitoring Results
(2019-2021 average)

Sites	Chloride (mg/L)	Dissolved Phosphorous (mg/L)	E. Coli Bacteria (CFU/100ml)	Nitrate (mg/L)	Sulfate (mg/L)	Turbidity (NTUs)
DE7	15.90	0.29	3,423.20	12.02	24.01	15.44
DE8	15.80	0.42	5,676.67	9.89	23.30	34.44
Standard	5 to 250	1	235	10	500 to 2000	25

Standards are from the US EPA and IA DNR. Chloride and sulfate standards depend on the water hardness. E. Coli criteria listed is for waterbodies designated for swimming. Turbidity listed is the limit for each point source.

HUC-10 Profile: Whitewater Creek

Whitewater Creek is in the northern, middle portion of the Maquoketa River Watershed. It comprises 72,372 acres and three HUC-12s. This sub-watershed contains three cities: Farley, Epworth, and Peosta, as well as parts of three counties (Dubuque, Jackson, and Jones). Notable features include Whitewater Canyon Wildlife Area, a destination for hunting and hiking, and the Heritage Trail, a 26-mile limestone path.



- Ranges from low to high flooding priority.
- High priority near the cities where there is more urban area and public land.

- One HUC-12 is high priority for phosphorous and soil runoff, due to topography.
- Medium priority throughout for nitrate pollution, due to limited mitigation possibilities.

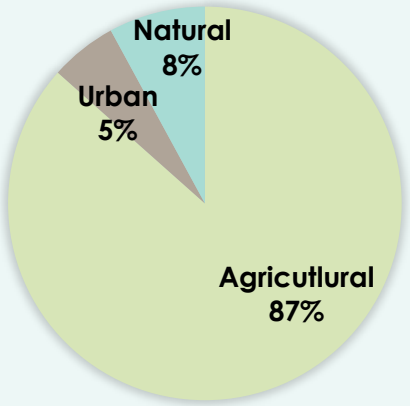
- Two of thee HUC-12's are high priority for recreation improvement.
- Impaired streams and few public lands for mitigation restrict recreational opportunities.

What the heck is a HUC?

HUC (Hydrological Unit Code) is a number assigned to identify a sub-watershed. They range from 2 to 12 digits, with the entire Maquoketa River Watershed being a HUC-8.

MAQUOKETA RIVER WATERSHED Management Plan

Land Use:



72,372 total acres

Total Miles of Streams: 73.1

Impaired, 36.63	Unimpaired, 36.47

Reasons for impairment include fish kills, E. Coli, and loss of native mussels.

5,519 estimated total population

387 acres of wetlands

5,630 acres in the 100-year floodplain

Existing Management Practices:

85 buffer strips

3,580 grassed waterways

333 terraces

333 water and sediment control basins

152 pond dams

13 strip crop sites

Existing Point-Source Pollution:

34 Permitted CAFOs and Open Feed Lots

2 Permitted wastewater treatment facilities

Water Quality Monitoring Results
(2019-2021 average)

Sites	Chloride (mg/L)	Dissolved Phosphorous (mg/L)	E. Coli Bacteria (CFU/100ml)	Nitrate (mg/L)	Sulfate (mg/L)	Turbidity (NTUs)
DU3	18.28	0.86	1,495.00	8.74	18.99	45.94
DU4	23.17	0.51	1,490.40	6.07	18.03	67.61
JO3	18.88	0.55	891.00	6.48	17.17	89.50
Standard	5 to 250	1	235	10	500 to 2000	25

Standards are from the US EPA and IA DNR. Chloride and sulfate standards depend on the water hardness. E. Coli criteria listed is for waterbodies designated for swimming. Turbidity listed is the limit for each point source.

Planning Process

This plan followed best practices for watershed action plan development from US EPA and other WMAs in Iowa (see Appendix D). The process included: engagement with key stakeholder groups; working with Maquoketa River WMA partners; collecting and analyzing data; and writing recommendations for conservation projects and plan evaluation. Figure 7 below shows the steps and timeline of the planning process for the MRW Management Plan Phase II.

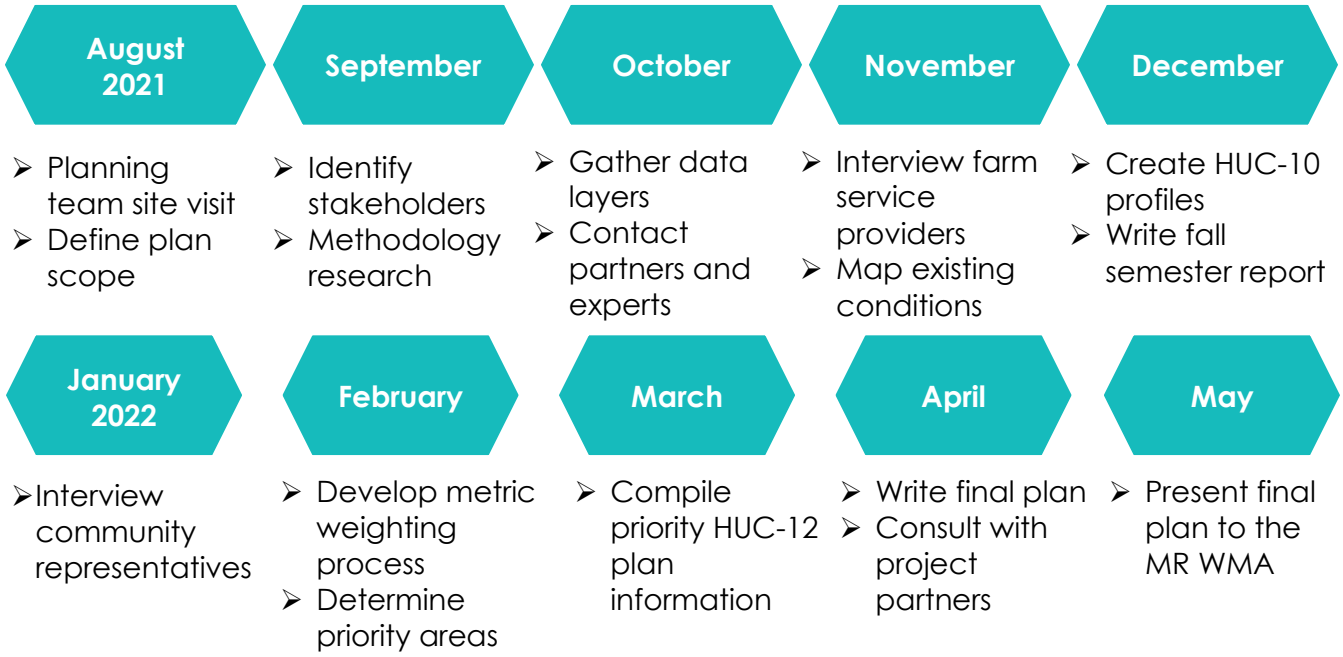


Figure 7: Timeline for writing Phase II of the Maquoketa River Watershed Management Plan. (authors)

Phase II Community Engagement

Talking with a small subset of stakeholder groups helps guide recommendations towards projects that are project politically feasible, meaning that people are willing to provide the time, land, and resources necessary to implement a management practice. The planning team specified two groups to conduct semi-structured interviews with:

- **City representatives** from all 41 incorporated cities within the MRW, who described conservation project benefits and barriers within urban areas.
- **Farm service providers**, who spot general trends in what persuades farmers to adopt, or deters them from, conservation practices.

One-on-one interviews with members of each group were conducted either in person, over the phone, or via Zoom from November 2021 to January 2022, then manually assessed for themes within the group. Common responses from six farm service providers, including staff from ISU Extension, NRCS, IDALS, and SWCDs, and staff from 14 of the 41 cities informed key issues and project implementation recommendations. A full list of questions used to guide interviews with members of each stakeholder group can be found in Appendix B.

Key Themes from Community Representatives

"We want to try to focus on [the river] and get people to use it more and then when they're in town, stop and visit our downtown." – Cascade representative

Interest in projects that benefit recreation and economic development

Interviewed communities place an emphasis on projects that benefit recreation and economic development. For example, existing projects with Whitewater Park in Manchester, Bear Creek Stream restoration in Dyersville, and Kitty Creek walking path in Monticello show that communities find value in recreational components to water management projects. A value-added component of projects with recreation is tourism, which add more money in the local economy.

Abundant water-related assets

Communities identified many water-related assets surrounding recreation including fishing, canoeing, and hiking/walking trails. Communities views these assets as activities for local residents and attractions for tourists. Most communities hope to build on water-related assets and believe residents and community leaders see the importance as well.

Extensive water management projects are underway

Communities are working on extensive water management projects. One notable example in the Bear Creek restoration in Dyersville, which is on Phase II of restoration work. Manchester, Monticello, Maquoketa, and Cascade are also working on various water-related projects.

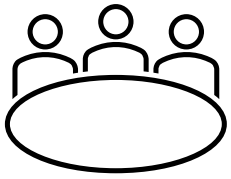
Widespread support for WMA activities

Regardless of community size or perceived issues, communities show widespread support for WMA activities. While some smaller communities did not the applicability of watershed project in their community, interviewees still supported WMA efforts and understood the importance for the watershed.

Understanding impacts to other communities

A key issue for WMA's is helping communities understand that watershed issues are not isolated to a particular location and their actions impact outcomes in neighboring communities. Communities interviewed generally understood the interconnectedness of issues across the watershed. A few communities even mentioned some issues related to flooding being out of their control.

"We need to be able to have those regional conversations to see how we can manage water as it comes into town and manage water as it leaves town." - Manchester representative



Uneven participation in WMA activities

Almost all communities mentioned having a member of the WMA Board, but level of involvement varied widely. Some communities appear held back by the lack of water-related issues perceived in their community, while other communities more affected by issues expressed higher levels of involvement.

Willing to collaborate with the WMA and surrounding jurisdictions to implement projects
The planning team asked interviewees to identify projects that would be of interest and applicable to their community. Each community received a list of specified projects to select. Table 1 shows the results of what project each community representative interviewed responded their city would like to implement.

Cities Interested by Type of Project	Pond, wetland, or small lakes	Rain garden projects	Rain barrel program	Permeable paver program	School stormwater runoff program	Native turf project	Bio-swale project	Downtown rain-scape	Stormwater policy/ordinance	Business rain-scape incentives	Stream restoration	Tree planting
Dyersville	X	X					X				X	X
Manchester	X	X		X	X	X	X		X		X	X
Maquoketa	X											X
Monticello	X	X		X			X	X			X	X
Preston	X			X					X			X

Table 1: City representative responses about completed and planned conservation projects. (authors)

Sub-Watershed Prioritization

In order to understand which areas should be a focus on for limited resources, the planning team first examined current conditions in the watershed through various metrics. Based on research of peer WMA plans, MRW technical committee guidance, and stakeholder input for both Phase I goals and Phase II implementation, the planning team collected 17 data layers to use as metrics. These metrics were grouped under four issue categories: **flooding risk**, **nitrate pollution**, **phosphorous and soil loss**, and **diminished recreation**. All issue categories directly connect to the goals and objectives identified by Phase I:

- flood risk mitigation and water quality improvement were identified as major goals of the watershed planning process by the Phase I stakeholder survey and Phase II stakeholder interviews
- diminished recreation was included as an issue category because of the emphasis on recreation within the MRW in the Phase I stakeholder survey and from Phase II interviews with city representatives

The planning team then prioritized sub-watersheds, at the HUC-12 level, by assigning importance to each metric based on a survey of the MRW technical committee members. For each of the four issues, metrics can be classified as either a cause of the issue, an effect of the issue, or increasing feasibility to mitigate the issue (see Table 2 below for justifications of these classifications and the assigned weight). After combining the weighted metrics, the HUC-12s were ranked for priority in each issue and overall. The full WMA Board agreed with the resulting priority sub-watersheds at their February 22, 2022 meeting.

Metric	Weight	Justification for including
Flooding risk (40%)		
Percent of area that is impervious surfaces	14%	Cause: proxy for areas that contribute more to flooding
Acres of public conservation and recreation land	20%	Impact: estimates potential flood damage to public resources
Total parcel value in the FHA	7%	Impact: estimates potential flood damage to private property
Total crop value in the FHA	16%	Impact: estimates potential flood damage to private property
Total population in the FHA	18%	Impact: proxy for people who will be affected the most by flooding
Number of existing management practices	25%	Mitigation: proxy for areas that are already willing to implement projects
Nitrate Pollution (30%)		
Tons per acre of soil runoff	10%	Cause: estimates magnitude of non-point sources of nitrogen
Number of CAFOs and water treatment facilities	23%	Cause: identifies point sources of nitrogen
Average monitored nitrate concentrations	25%	Impact: identifies most recent measured nitrate levels
Number of susceptible active wells	30%	Impact: proxy for public cost of treatment to avoid human exposure to nitrates
Number of existing management practices	12%	Mitigation: proxy for areas already willing to implement projects
Phosphorous and Soil Loss (20%)		
Tons per acre of soil runoff	22%	Cause: estimates magnitude of non-point sources of phosphorous, which bonds with soil particles as they enter waterways
Number of CAFOs and water treatment facilities	25%	Cause: identifies point sources of phosphorous
Percent of acreage in hydrographic group D soils	13%	Cause: proxy for soil loss based on soil type erosion and water solubility characteristics
Average monitored phosphorous concentrations	13%	Impact: identifies most recent measured phosphorous levels
Average monitored turbidity	11%	Impact: proxy for sedimentation levels in waterways
Number of existing management practices	16%	Mitigation: proxy for areas already willing to implement projects

Diminished Recreation (10%)		
Miles of streams impaired by E. Coli	27%	Impact: proxy for magnitude of swimming and boating impairment
Miles of streams impaired by fish kills	35%	Impact: proxy for magnitude of swimming and fishing impairment
Miles of streams impaired by native mussel loss	13%	Impact: proxy for magnitude of habitat quality impairment
Acres of wetlands	5%	Mitigation: estimates magnitude of existing wetland habitat for wildlife
Acres of public conservation and recreation land	20%	Mitigation: identifies areas open to the public for recreation

Table 2: Metrics, justifications, and weights for MRW HUC-12 prioritization. (authors)

Lastly, the planning team presented recommendations for priority areas following steps described in the US EPA Handbook for Watershed Planning. These watershed-wide and HUC-12 specific recommendations included: input from stakeholder interview results; WMA staff comments; a GIS analysis of possible and existing conservation practices; and the goals and objectives of Phase I.

Sub-watershed Analysis

Flooding Risk

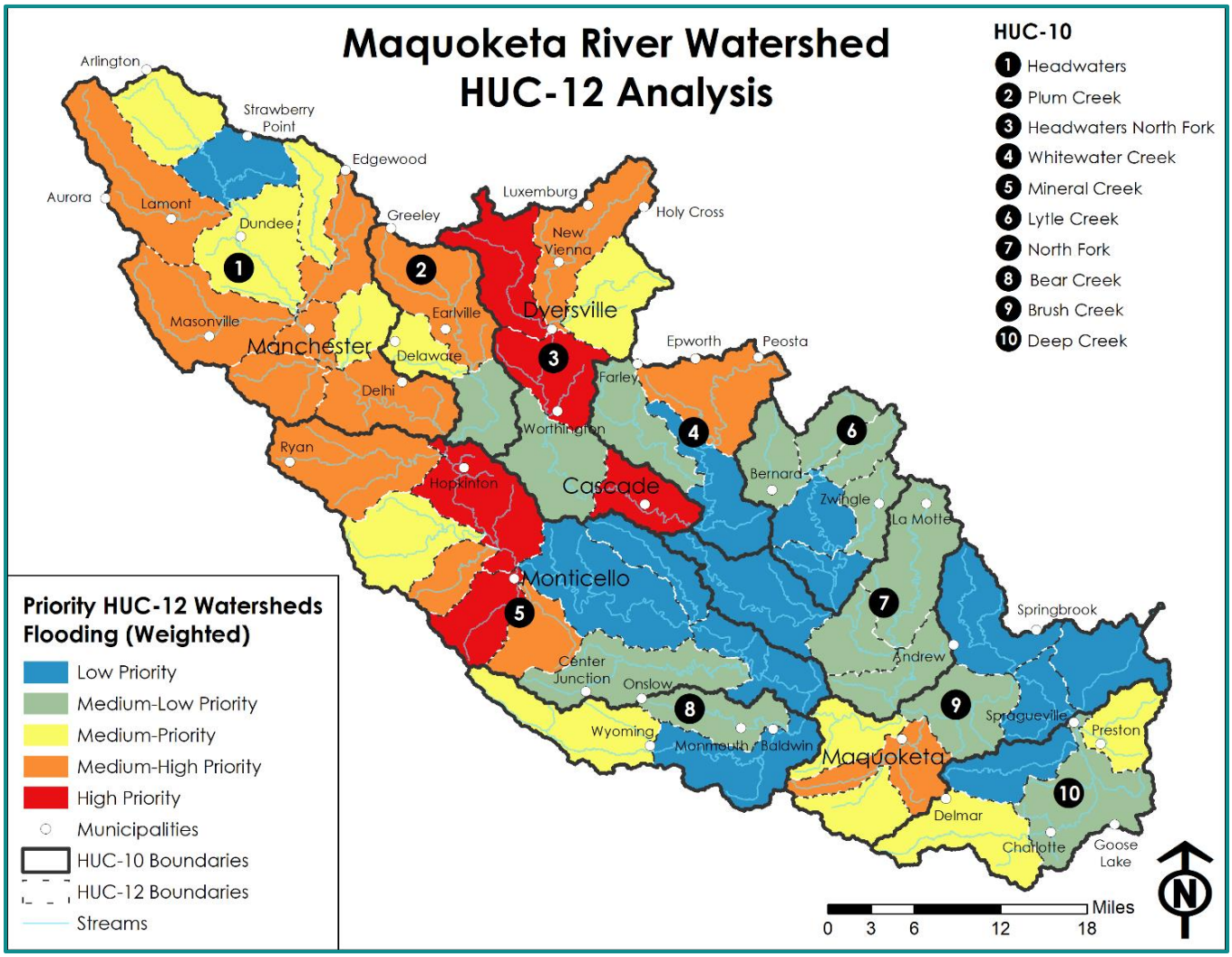


Figure 8: Weighted ranking of HUC-12s for flood mitigation priority. (authors)

Flood events are increasingly common in the MRW. A recent 2021 report from the IPCC shows that Iowa is already experiencing increased heavy precipitation due to climate change.[ii] A larger increase in these events is observed in Eastern Iowa, where the MRW is located, compared to Western Iowa.[iii] According to the IFC, Iowa faces more severe effects from flooding than other states. From 1988 to 2016, all nine counties in MRW received between 9 to 17 flood-related presidential disasters declarations.[iv]

To better understand which areas of the Maquoketa River Watershed should be prioritized regarding flooding, the planning team conducted a GIS analysis of existing conditions for multiple variables. These variables, examined individually in Appendix A, include the percentage of land covered by impervious surfaces, acres of public land used for conservation and recreation, parcel value in the FHA, crop value in the FHA, population in the FHA, and the presence of existing BMPs. Figure 8 shows the ranking of each HUC-12 within the MRW for flood risk.

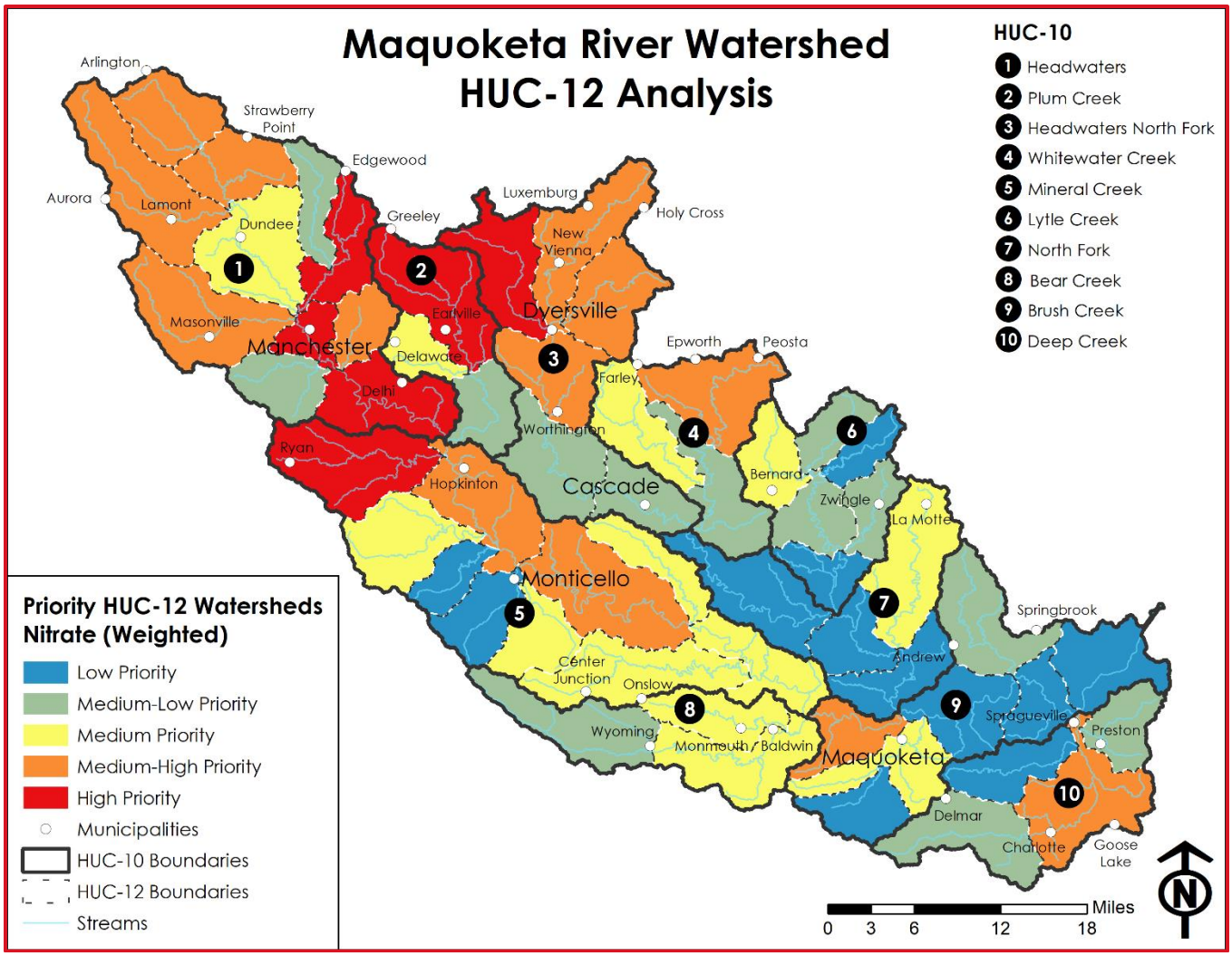


Figure 9: Weighted ranking of HUC-12s for nitrate reduction priority. (authors)

Nitrate is a naturally occurring compound that can be found in both surface and groundwater. It is an essential plant nutrient, but excessive levels of nitrate can result in significant water quality issues. There are typically no adverse effects on human health when naturally occurring, but health concerns arise when nitrate levels in drinking water exceed 10 mg/L. Above this level, public water supplies must implement costly mitigation measures to meet US EPA criteria. Elevated levels of nitrate are often the result of improper well construction, overuse of fertilizers, human and animal waste, septic systems, and more. Consuming water with elevated levels of nitrate is especially dangerous to the health of infants and pregnant women, as it can cause blue baby syndrome.[v] Due to this, communities need to spend extra money to treat their water supply to get nitrate levels under acceptable standards.

Given that the predominant land use in the MRW is agriculture, a plethora of potential nitrate sources exist, including runoff from fertilized fields and CAFOs. Water quality testing has revealed that nitrate is a consistent water quality issue within the MRW. These nitrate levels also have significant downstream effects, such as the nitrate loads

discharged from the mouth of the Mississippi River, which has been identified as a primary cause of the seasonal oxygen depleted zone in the Gulf of Mexico.[vi]

To better understand which areas of the Maquoketa River Watershed should be prioritized regarding nitrate pollution, the planning team conducted a GIS analysis of existing conditions for multiple variables. These variables, examined individually in Appendix A, include the amount of soil erosion, the number of CAFOs and water treatment facilities, monitored nitrate concentrations, the number of susceptible active wells, and the presence of existing BMPs. Figure 9 shows the ranking of each HUC-12 within the MRW for nitrate pollution.

Phosphorous and Soil Loss

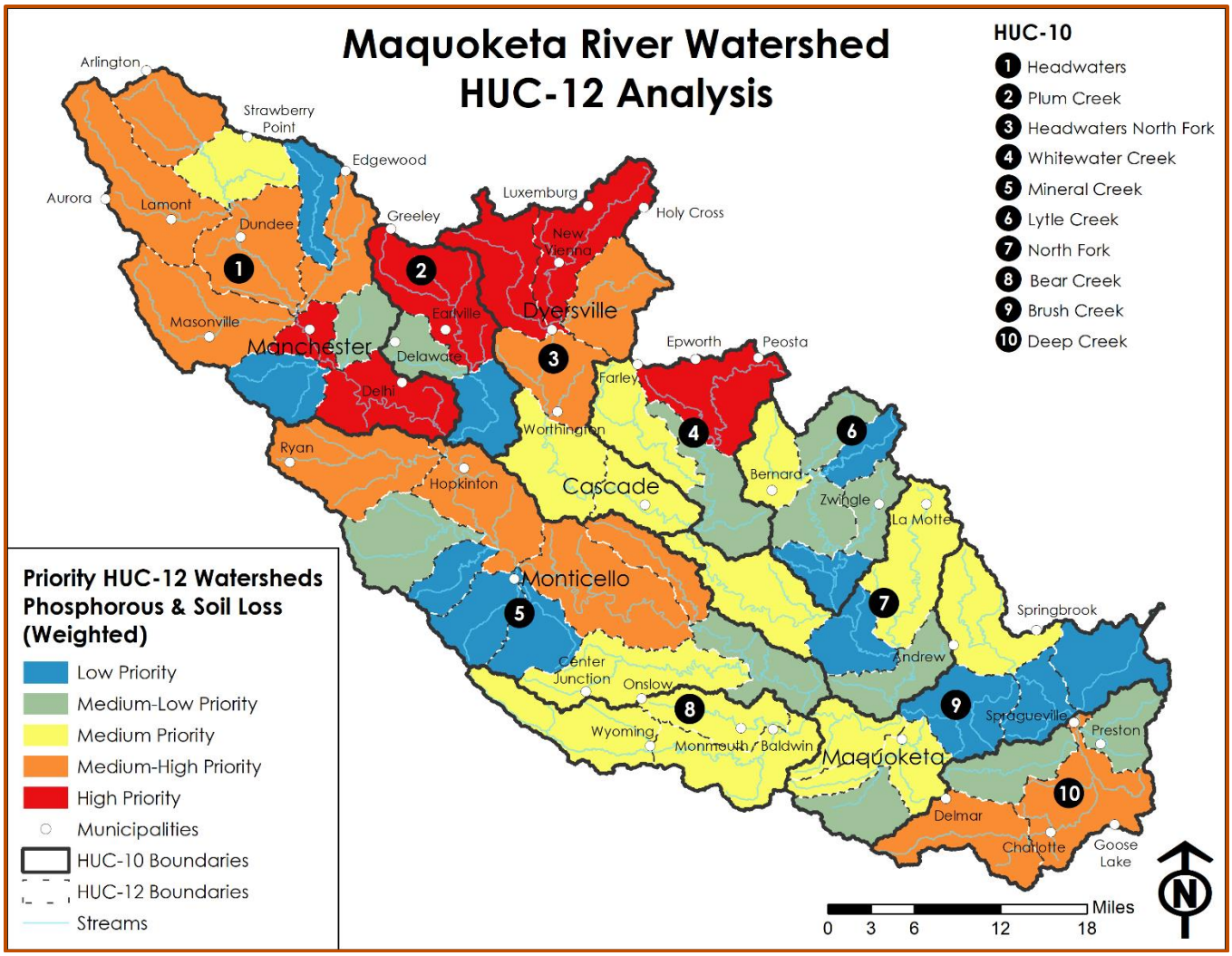


Figure 10: Weighted ranking of HUC-12s for phosphorous and soil loss mitigation priority. (authors)

Phosphorous, like nitrogen, is an essential nutrient for plants, animals, and humans. Under natural conditions, its presence in water is typically scarce. Due to human activities though, phosphorous loading into freshwater systems can occur. When there is too much in the water, phosphorous can cause eutrophication, meaning the environment becomes overly enriched with nutrients, leading to an increase in the amount of plant and algae growth. The consequences of eutrophication include algal blooms, low levels of dissolved oxygen, fish kills, turbidity, and shifts in plant and animal populations in surface waters.[vii]

Due to the tendency of phosphorous to attach to soil particles, it is important that soil loss is viewed in conjunction with phosphorous loading.[viii] Common sources of phosphorous include the chemical fertilizers and animal manure used to grow crops, wastewater treatment facilities, urban runoff, and fossil fuels. The implementation of agricultural practices that mitigate soil loss and limit the overapplication of nutrients are key to reducing the negative impacts associated with phosphorous within the watershed.

To better understand which areas of the MRW should be prioritized regarding phosphorous and soil loss, the planning team conducted a GIS analysis of existing conditions for multiple variables. These variables, examined individually in Appendix A, include the amount of soil erosion, the percentage of land covered by hydrographic group D soils, the number of CAFOs and water treatment facilities, monitored phosphorous concentrations, monitored turbidity levels, and the presence of existing BMPs. Figure 10 shows the ranking of each HUC-12 within the MRW for phosphorous pollution and soil loss risk.

Diminished Recreation

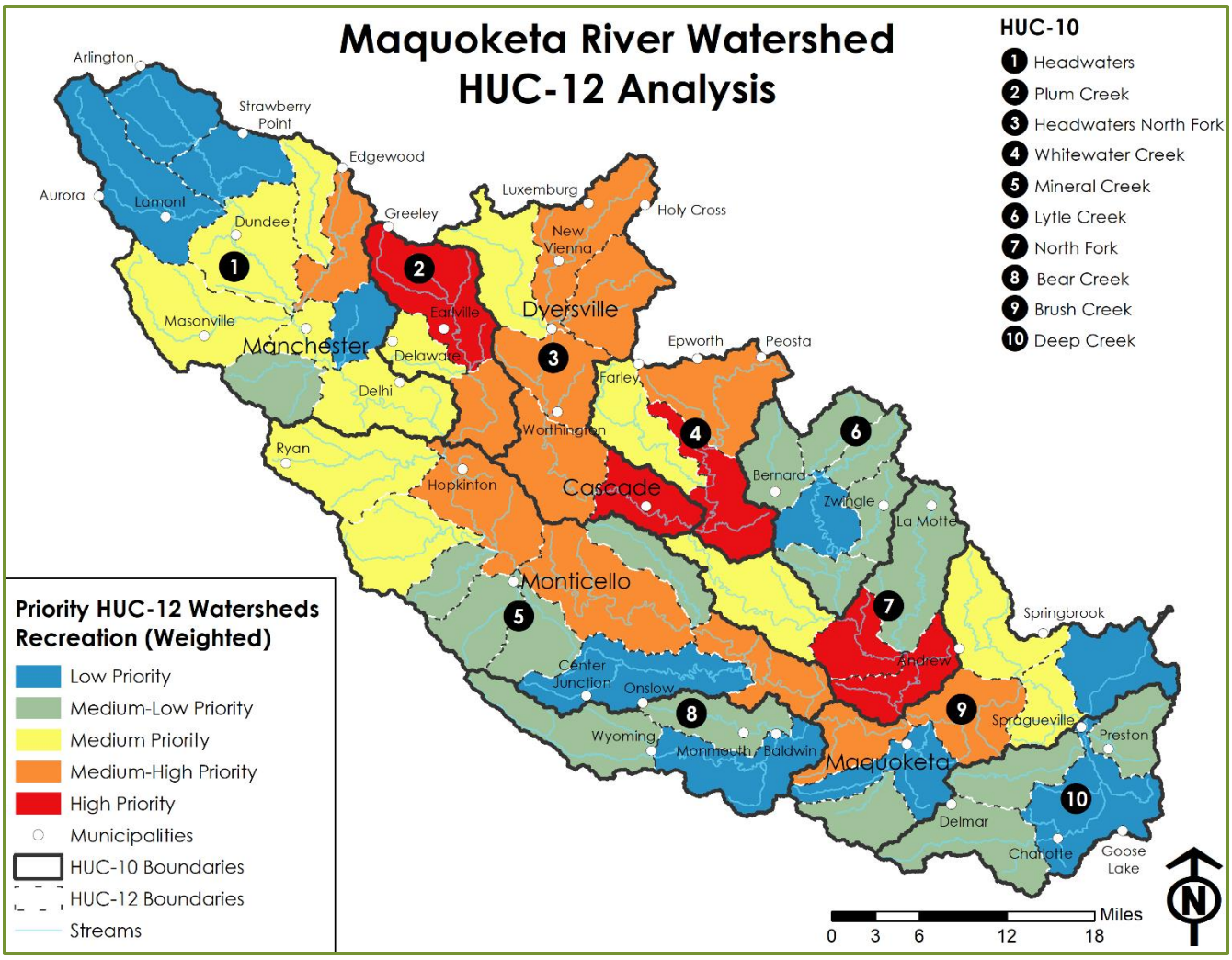


Figure 11: Weighted ranking of HUC-12s for improved recreation priority. (authors)

Recreational opportunities are abundant in the MRW, with people enjoying year-round activities such as boating, fishing, hunting, cross country skiing, and camping. Water quality issues, in the form of nutrient and sediment loading, can result in closure of recreational uses. The level of impairment determines the uses that are allowed in each waterbody in the MRW, so reducing the amount of pollutants will maximize recreational opportunities. It is vital that people who reside within the watershed take the necessary steps to improve water quality and mitigate the impacts of flooding to ensure ample outdoor opportunities remain available to future generations.

To better understand which areas of the MRW should be prioritized regarding diminished recreation, the planning team conducted a GIS analysis of existing conditions for multiple variables. These variables, examined individually in Appendix A, include streams impaired by E. coli, streams impaired by fish kill events, streams impaired by native mussel loss, acres of wetlands, and public land being used for conservation and recreation. Figure 11 shows the ranking of each HUC-12 within the MRW for diminished recreation.

Overall Ranking

Following detailed sub-watershed analysis of 17 metrics to measure flood risk, nitrate pollution, phosphorous and soil loss, and diminished recreation, the planning team looked at all issues together. Using weights assigned by a survey of the MR Technical Committee, the 56 MRW HUC-12s were ranked in order of importance of addressing water concerns. Weighted analysis revealed that flooding was the most important issue to address, followed by nitrates, phosphorous and soil loss, and finally recreational opportunities. Figure 12 below shows the priority level of HUC-12s across the watershed for all issues combined.

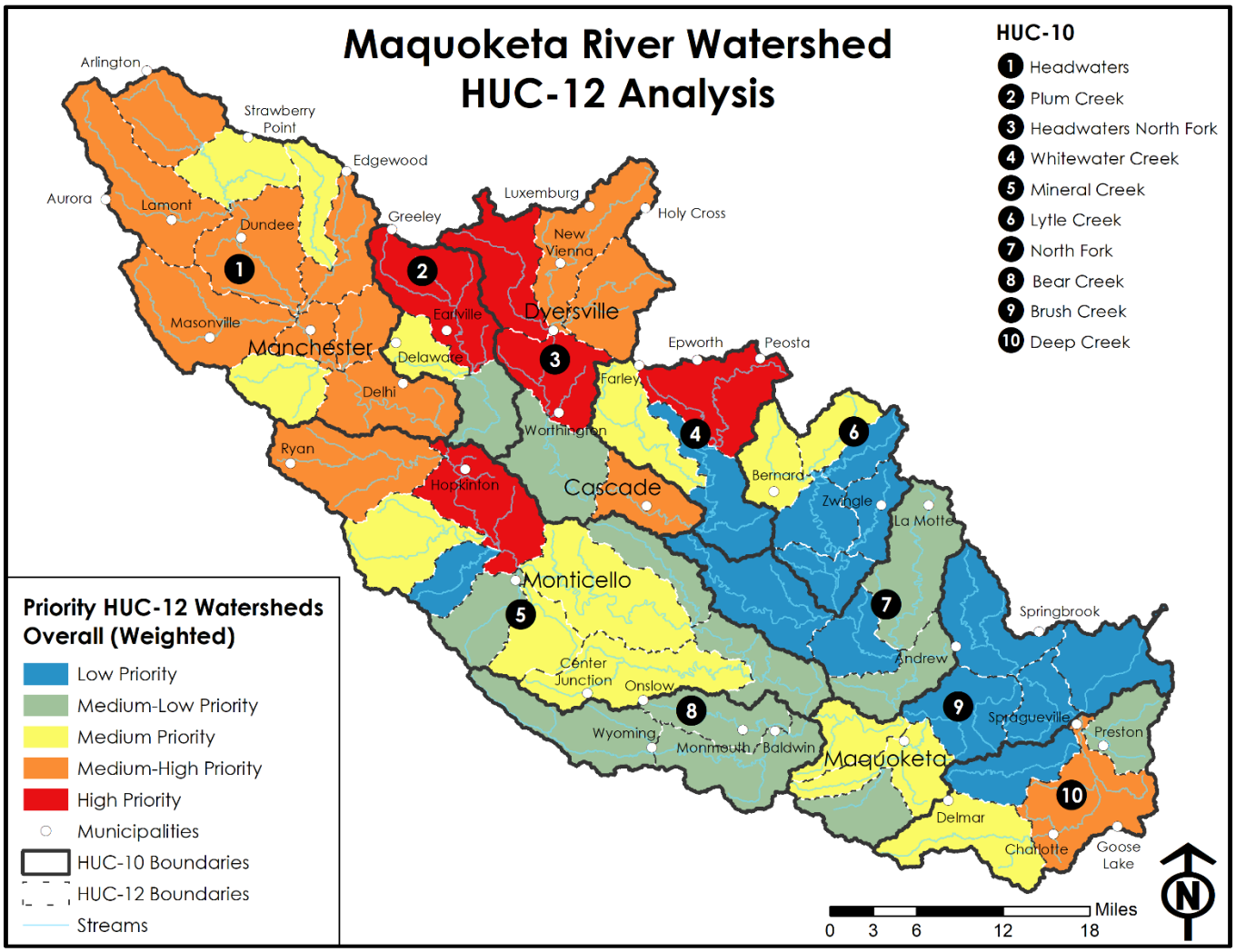


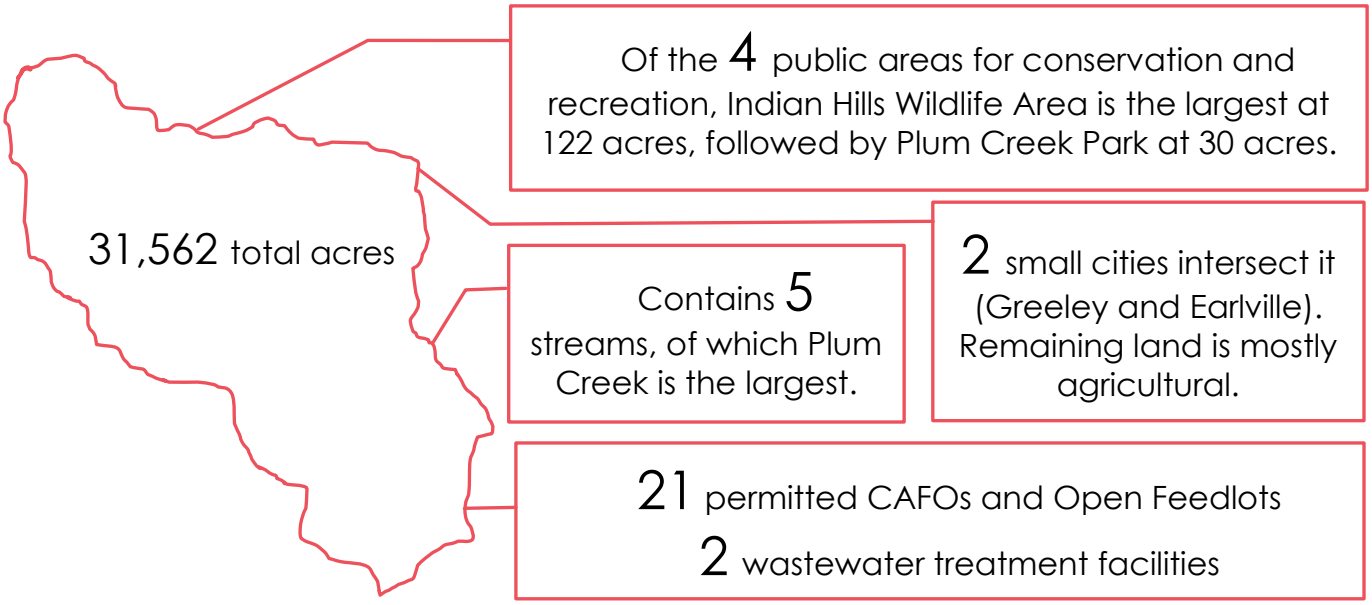
Figure 12: Map showing the combined priority level of HUC-12s within the MRW. (authors)

Priority HUC-12 Plans

Headwaters Plum Creek (070600060102)

Why Headwaters Plum Creek?

The **Headwaters Plum Creek** HUC-12 is in the upper part of the Maquoketa River Watershed, within the Plum Creek HUC-10. Out of the 56 HUC-12 sub-watersheds in the MRW, Headwaters Plum Creek is the highest priority, based on the combined scores from the sub-watershed analysis. For each of the four key issues, this sub-watershed ranked 7th in flooding risk, tied for 2nd in nitrate pollution, 5th in phosphorous and soil runoff, and 5th in diminished recreation.

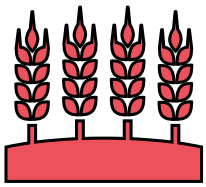


Since it affects all four key issues, the number of existing BMPs is one of the most influential variables that the planning team used for HUC-12 priority ranking. This sub-watershed is in the bottom third of all HUC-12s in terms of the number of existing BMPs. In regard to flooding, total crop value in the FHA, which estimates potential flood damage, is the second highest in this HUC-12, while total parcel value in the FHA and total population in the FHA are in the top 25% and top 20% of all HUC-12s, respectively.

With 23 potential point sources of water pollution, the effects of CAFOs and open feedlots is evident. For monitored pollutant concentrations and target reductions, see Table 3. Since both of the monitoring sites with drainage areas in this HUC-12 tested over the US EPA standard of 10 mg/L for nitrates. It is likely that these pollutant sources detract from recreational opportunities as well; there are over 20 miles of streams impaired due to fish kill events and loss of native mussels. However, the WMA can work with local communities to improve the conditions which ranked Headwaters Plum Creek as the #1 priority HUC-12.

Water Quality Monitoring Results: Headwaters Plum Creek (2019-2021 average)						
Sites	**Chloride (mg/L)**	**Dissolved Phosphorous (mg/L)**	**E. Coli Bacteria (CFU/100ml)**	**Nitrate (mg/L)**	**Sulfate (mg/L)**	**Turbidity (NTUs)**
DE7	15.90	0.29	3,423.20	12.02	24.01	15.44
DE8	15.80	0.42	5,676.67	9.89	23.30	34.44
Targets	5 to 250	1	235	10	500 to 2000	25
Targets are based on standards from the US EPA and IA DNR. Chloride and sulfate standards depend on the water hardness. E. Coli target listed is the standard for waterbodies designated for swimming. Turbidity listed is the EPA limit for each individual point source.						

Table 3: Water quality monitoring results for sites within Headwaters Plum Creek. (MR WMA)



What agricultural conservation practices can be implemented and what is already present?

Implementation of various BMPs is key step to addressing the four key issues that the plan focuses on. To look at the potential for implementing conservation practices, the planning team used the Agricultural Conservation Planning Framework (ACPF). ACPF is a set of GIS tools that leverage high resolution data to support watershed planning by identifying high-risk areas and potential solutions. In the context of this plan, ACPF was used to determine specific locations within the Headwaters Plum Creek HUC-12 sub-watershed that different conservation practices could be implemented, as shown in Figure 13 below. A GIS analysis conducted by ISU, called the IA BMP Mapping Project, created an inventory of existing BMPs across Iowa. ACPF results indicating which practices could be suitable in this sub-watershed and the practices already implemented according to the IA BMP Mapping Project are compared in Table 4.

Management Practice	Suggested by ACPF	Found on the IA BMP Mapping Project
Bioreactors	1	Not analyzed
Grassed waterways	1,674 (286 miles)	584 (194 miles)
Ponds	56	5 pond dams
WASCOBs	1 (0.06 miles)	17 (0.75 miles)
Terraces	Not analyzed	26
Contour buffer strips	Not analyzed	6 (462 acres)
Stream bank stiff stemmed grasses	135 acres	Not analyzed
Stream bank stabilization	335 acres	Not analyzed

Table 4: Comparing ACPF results of suggested management practices for Headwaters Plum Creek to existing management practices identified by the IA BMP Mapping Project. (authors)

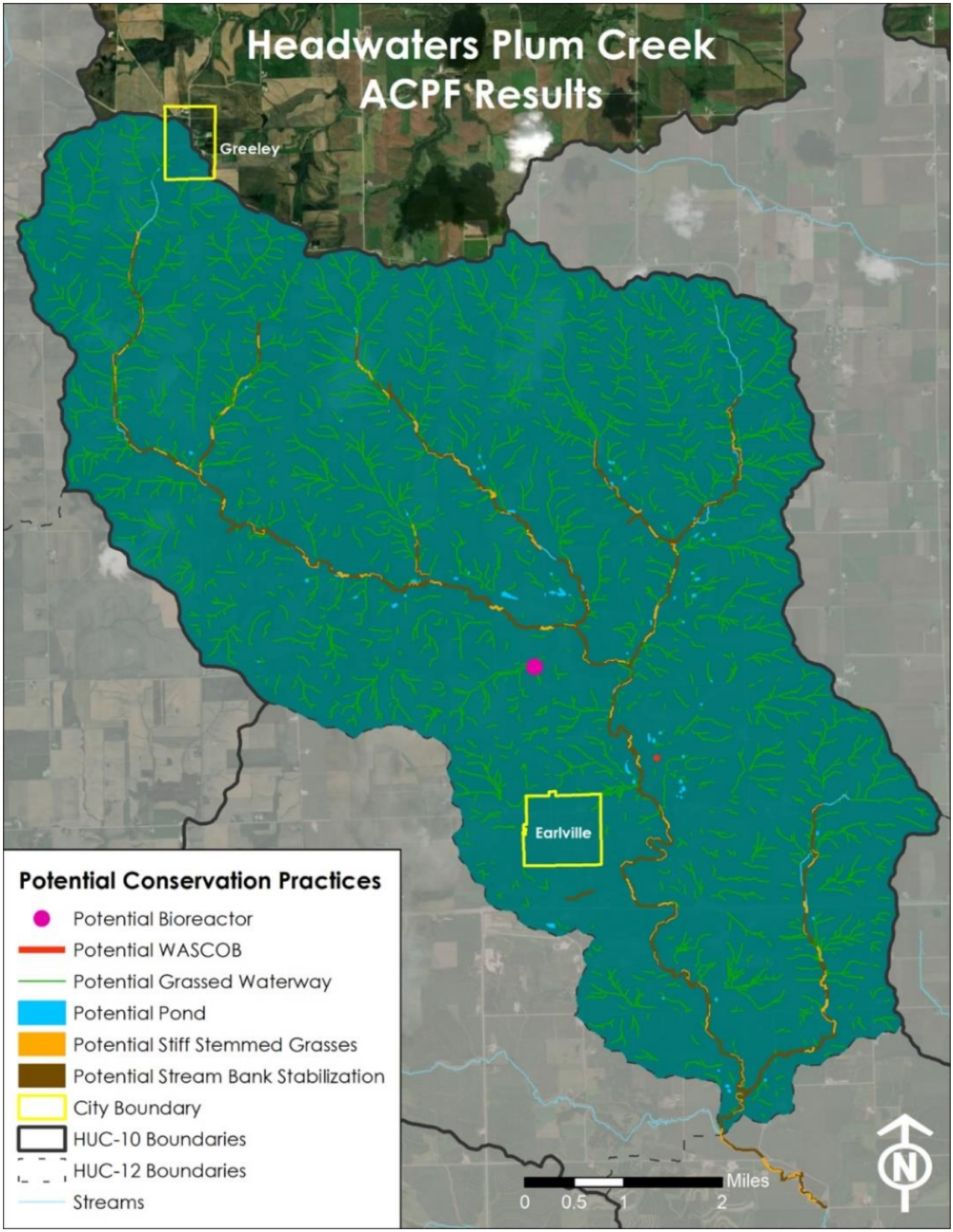
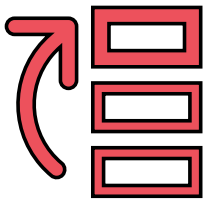


Figure 13: Results from the Agricultural Conservation Planning Framework showing potential project sites within Headwaters Plum Creek sub-watershed. (authors)

What can urban areas implement?

Cities within this HUC-12 can help improve flood risk, water quality, and recreational opportunities. The planning team did not interview either of the two cities that intersect this HUC-12 for this plan, but as part of the WMAs efforts to continual watershed-wide planning, both Earlville and Greeley should be involved in future WMA efforts. Future outreach can begin with a basic interview to determine existing water assets and issues, watershed planning and implementation, and city interest in future projects. The planning team has developed guided interview questions, in Appendix B, and a checklist of potential projects that can be filled out by communities to help determine feasible projects.

What are the goals for Headwaters Plum Creek?



The MRW Management Plan Phase I provides goals, objectives, strategies, and actions for the entire watershed. This section applies specific objectives from Phase I that are relevant to sub-watershed planning and prioritizes the objectives based on data from the sub-watershed analysis. Note that Phase I objectives which would not apply at the HUC-12 scale are not listed. The corresponding strategies and actions for each objective can be found in Phase I.

Table 5 illustrates prioritizing watershed management efforts in Headwaters Plum Creek. The table is ordered by objective number and includes corresponding metrics used to determine the priority level as low, medium, or high.

Goals & Objectives	Priority	Indicators
Goal 1: Improve water quality through techniques for nutrient management, erosion reduction, and increased infiltration		
1.1: Engage with the agricultural community to encourage techniques that increase field infiltration and reduce soil erosion	MEDIUM	➢ ACPF ➢ RUSLE
1.2: Engage with agricultural community to reduce and maximize efficiency of agricultural nutrient application	HIGH	➢ Monitored Nitrate ➢ Monitored E.coli ➢ CAFOs
1.3: Encourage practices that slow the flow of urban stormwater to increase infiltration and reduce erosion	LOW	➢ Community size ➢ Impervious surfaces
1.4: Encourage the use of bacteria management to reduce E. Coli and other bacteria levels	HIGH	➢ Impaired streams ➢ Monitored E.coli
1.5: Encourage and increase the implementation of wetlands to filter water pollutants	HIGH	➢ Acres of wetlands ➢ ACPF
1.6: Continue to document and report water quality indicators	HIGH	➢ Water quality monitoring data (all indicators)
Goal 2: Improve watershed flood management		
2.3: Increase awareness related to water quantity and strengthen connections between land use management practices and flooding.	HIGH	➢ Impervious surfaces ➢ Urban area ➢ Population in FHA ➢ Land value in FHA ➢ Crop value in FHA

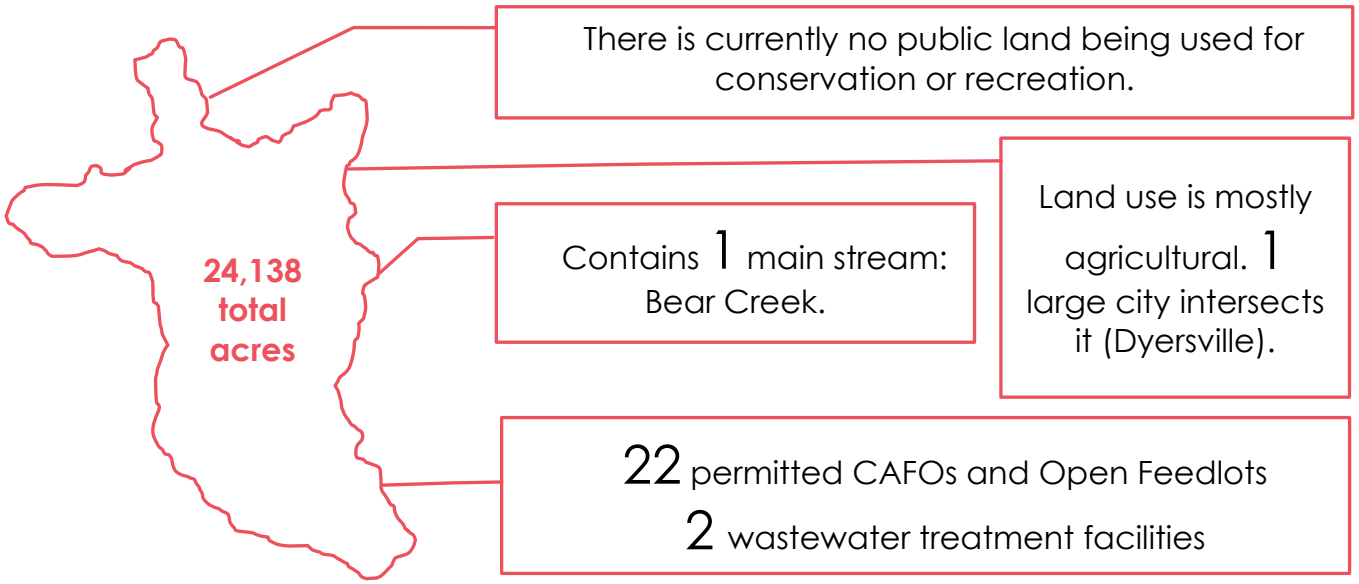
Goal 3: Increase watershed awareness among stakeholders		
3.1: Educate the local residents to make individual efforts and connections with the watershed.	MEDIUM	➢ Acres of Public land used for conservation and recreation
Goal 4: Preserve, protect, and improve ecologically sensitive habitats and ecosystems in the watershed		
4.1: Prioritize natural resource sites in the watershed for preservation, protection, and restoration	HIGH	➢ Acres of Public land used for conservation and recreation
4.2: Protect streambanks, shorelines, and buffer areas within the watershed	HIGH	➢ Land value in FHA ➢ Crop value in FHA ➢ RUSLE
4.3: Restore wetlands and riparian areas in the watershed	HIGH	➢ ACPF
4.4: Improve habitat conditions for native flora, fauna, and marine lives in the watershed	HIGH	➢ Impaired streams
4.5: Restore floodplain connectivity within the watershed	MEDIUM	➢ Land value in FHA
4.6: Protect source water sites in the watershed	LOW	➢ CAFOs ➢ ACPF ➢ Wells susceptible to contamination
Goal 5: Establish the WMA as a trusted community resource		
5.2: Connect communities with resources specific to the watershed	HIGH	➢ Community membership
5.3: Recognize and identify vulnerable populations in the watershed that may be affected by poor water quality and flooding	MEDIUM	➢ Population in FHA ➢ Wells susceptible to contamination

Table 5: Prioritizing objectives from Phase I to Headwaters Plum Creek. (authors)

Bear Creek (070600060602)

Why Bear Creek?

The **Bear Creek** HUC-12 is in the upper part of the Maquoketa River Watershed, within the Headwaters North Fork HUC-10. Out of the 56 HUC-12 sub-watersheds in the MRW, Bear Creek is the second highest priority, based on the combined scores from the sub-watershed analysis. For each of the four key issues, this sub-watershed ranked 3rd in flooding risk, tied for 2nd in nitrate pollution, was 2nd in phosphorous and soil runoff, and tied for 18th in diminished recreation.

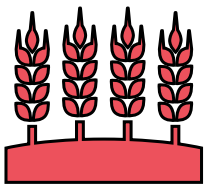


This sub-watershed is in the bottom quarter of all HUC-12s in terms of the number of existing BMPs, one of the most influential variables since it affects all four key issues. For estimates of potential flood damage, total parcel value in the FHA and total population in the FHA in Bear Creek are the second highest and fourth highest of all HUC-12s, respectively. Additionally, total crop value in the FHA is in the top 25% of all HUC-12s.

With 24 potential point sources of water pollution, the effects of CAFOs and open feedlots are evident in some monitored pollutant concentrations (see Table 6). The one monitoring site with a drainage area in this HUC-12 tested over the EPA standard of 10 mg/L for nitrates and well over the 235 CFU/100ml for E. Coli. Additionally, there are 7.76 miles of streams impaired due to fish kill events. The WMA can work with local communities to improve the conditions which ranked Bear Creek as the #2 priority HUC-12 in the MRW.

Water Quality Monitoring Results: Bear Creek (2019-2021 average)						
Sites	**Chloride (mg/L)**	**Dissolved Phosphorous (mg/L)**	**E. Coli Bacteria (CFU/100ml)**	**Nitrate (mg/L)**	**Sulfate (mg/L)**	**Turbidity (NTUs)**
DU8	19.64	0.48	6,026.29	10.17	29.47	22.94
Targets	5 to 250	1	235	10	500 to 2000	25
Targets are based on standards from the US EPA and IA DNR. Chloride and sulfate standards depend on the water hardness. E. Coli target listed is the standard for waterbodies designated for swimming. Turbidity listed is the EPA limit for each individual point source.						

Table 6: Water quality monitoring results for sites within Bear Creek. (MR WMA)



What agricultural conservation practices can be implemented and what is already present?

Implementation of various BMPs will aid in addressing the four key issues that the plan focuses on. The planning team utilized ACPF, a tool from the USDA, to determine specific locations within the Bear Creek HUC-12 sub-watershed that different conservation practices could be implemented (see Figure 14). These are compared to existing BMPs, as compiled in a GIS analysis conducted by ISU called the IA BMP Mapping Project, in Table 7, which residents and the WMA can use to approximate remaining conservation project potential and identify appropriate sites.

Management Practice	Suggested by ACPF	Found on the IA BMP Mapping Project
Bioreactors	0	Not analyzed
Grassed waterways	2,034 (563 miles)	467 (160 miles)
Ponds	34	2 pond dams
WASCOBs	0	52 (3.65 miles)
Terraces	Not analyzed	31
Contour buffer strips	Not analyzed	7 (406 acres)
Stream bank stiff stemmed grasses	99 acres	Not analyzed
Stream bank stabilization	193 acres	Not analyzed

Table 7: Comparing ACPF results of suggested management practices for Bear Creek to existing management practices identified by the IA BMP Mapping Project. (authors)

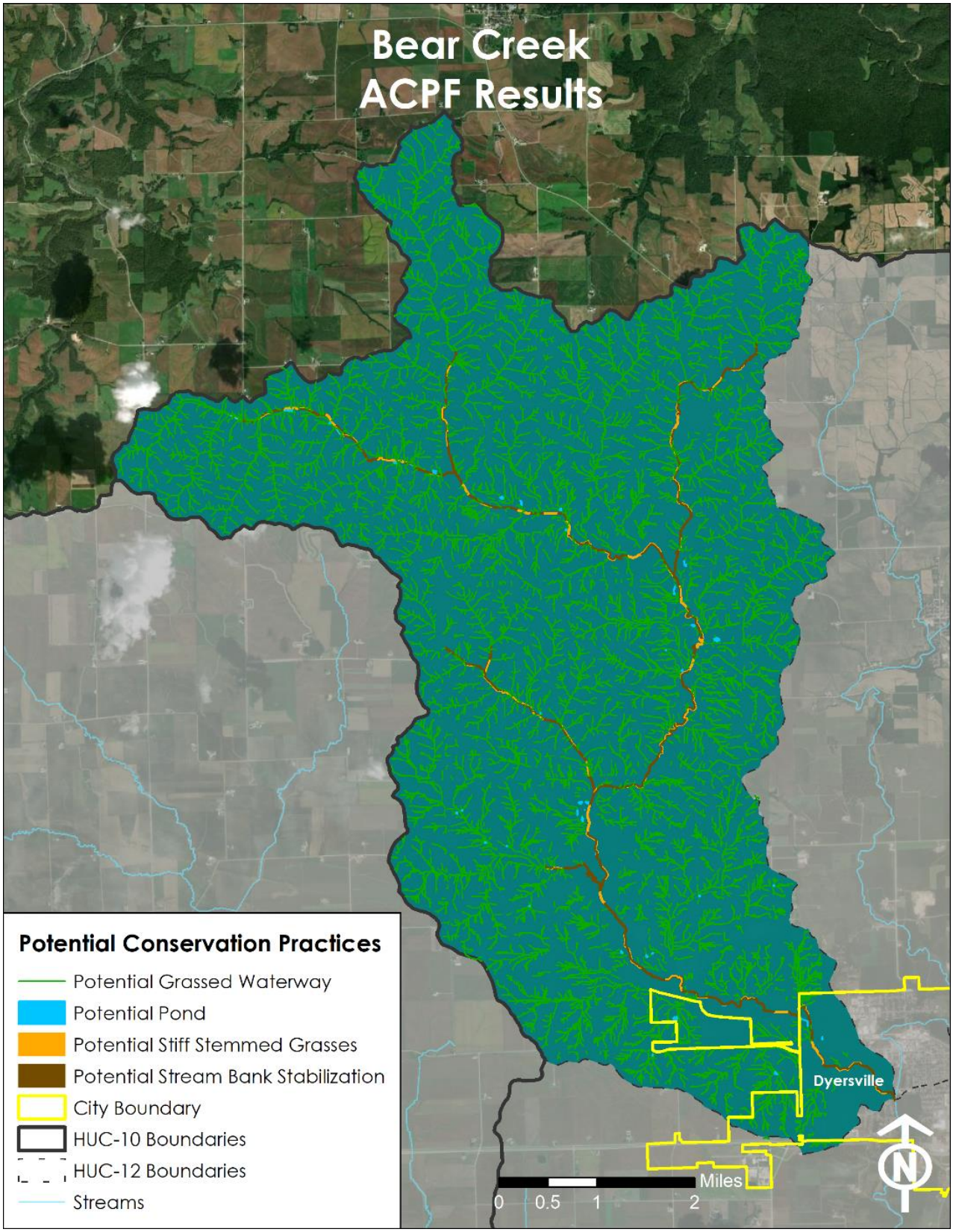


Figure 14: Results from the Agricultural Conservation Planning Framework showing potential project sites within Bear Creek sub-watershed. (authors)

What can urban areas implement?

The only city partially in this HUC-12 is Dyersville. In an interview that the planning team conducted, a city leader indicated that they have already undertaken extensive water management projects. Therefore, the WMAs role with urban projects in Bear Creek should be focused on supporting projects rather than general outreach. While the 1st phase of stream restoration projects are complete in Dyersville, the WMA can further support projects aligned with community's Field of Dreams Watershed Plan. Dyersville noted interest in watershed projects of ponds/wetland areas, rain gardens, bioswales, stream restoration, and tree plantings. The City also expressed interest in any projects that promote river recreation, such as the existing multi-use path along Bear Creek.

Besides being at the forefront of urban watershed planning, Dyersville also provides the WMA with an excellent example showing other communities how to engage with urban waterways. Watershed projects in Dyersville are not only viewed as positives for flood mitigation and water quality, but also recreation and economic development. During the stakeholder interview, the city representative noted that both city residents and people from outlying areas drive to Bear Creek just to walk along the stream. The WMA should continue to support Dyersville in expanding such amenities and use it as an example for other communities.

What are the goals for Bear Creek?

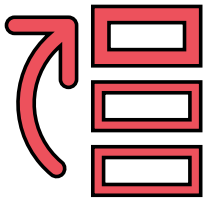


Table 8 illustrates prioritizing objectives from Phase I that are relevant to sub-watershed planning in Bear Creek. The corresponding strategies and actions for each objective can be found in Phase I. The table is ordered by objective number and includes corresponding metrics used to determine the priority level as low, medium, or high.

Goals & Objectives	Priority	Indicators
Goal 1: Improve water quality through techniques for nutrient management, erosion reduction, and increased infiltration		
1.1: Engage with the agricultural community to encourage techniques that increase field infiltration and reduce soil erosion	HIGH	➢ ACPF ➢ RUSLE
1.2: Engage with agricultural community to reduce and maximize efficiency of agricultural nutrient application	HIGH	➢ Monitored Nitrate ➢ Monitored E.coli ➢ CAFOs
1.3: Encourage practices that slow the flow of urban stormwater to increase infiltration and reduce erosion	MEDIUM	➢ Community size ➢ Impervious surfaces
1.4: Encourage the use of bacteria management to reduce E. Coli and other bacteria levels	HIGH	➢ Impaired streams ➢ Monitored E.coli
1.5: Encourage and increase the implementation of wetlands to filter water pollutants	HIGH	➢ Acres of wetlands ➢ ACPF
1.6: Continue to document and report water quality indicators	HIGH	➢ Water quality monitoring data (all indicators)

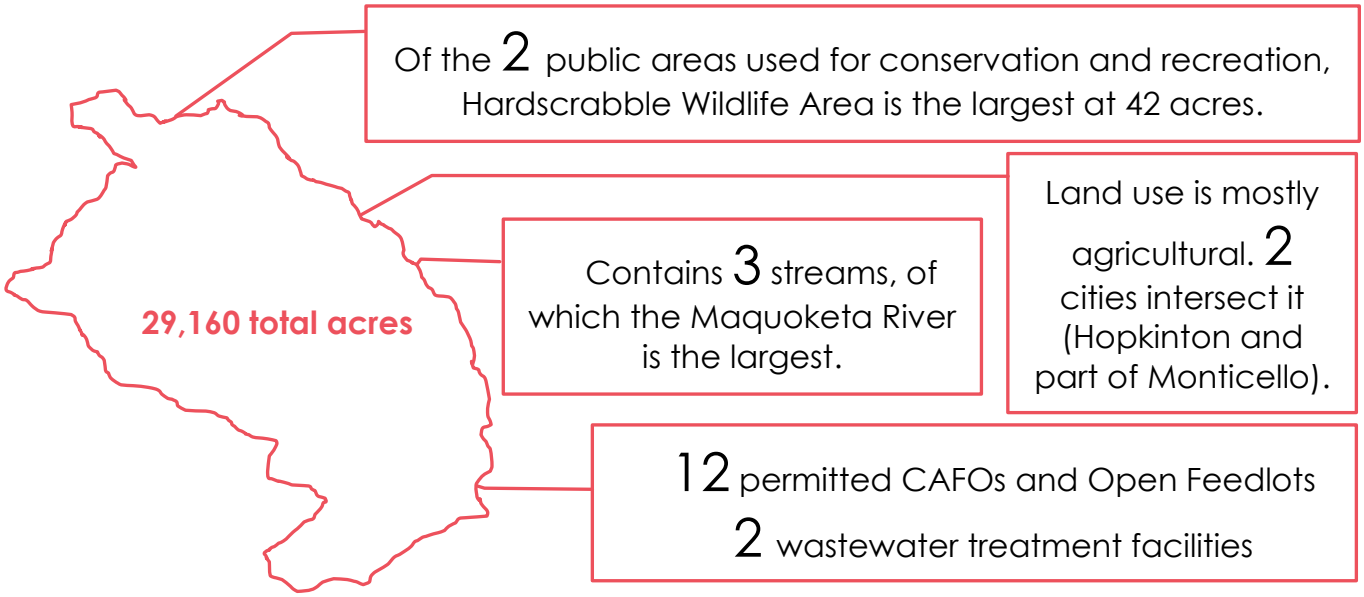
Goal 2: Improve watershed flood management		
2.3: Increase awareness related to water quantity and strengthen connections between land use management practices and flooding.	HIGH	➢ Impervious surfaces ➢ Urban area ➢ Population in FHA ➢ Land value in FHA ➢ Crop value in FHA
Goal 3: Increase watershed awareness among stakeholders		
3.1: Educate the local residents to make individual efforts and connections with the watershed.	HIGH	➢ Acres of Public land used for conservation and recreation
Goal 4: Preserve, protect, and improve ecologically sensitive habitats and ecosystems in the watershed		
4.1: Prioritize natural resource sites in the watershed for preservation, protection, and restoration	HIGH	➢ Acres of Public land used for conservation and recreation
4.2: Protect streambanks, shorelines, and buffer areas within the watershed	HIGH	➢ Land value in FHA ➢ Crop value in FHA ➢ RUSLE
4.3: Restore wetlands and riparian areas in the watershed	HIGH	➢ ACPF
4.4: Improve habitat conditions for native flora, fauna, and marine lives in the watershed	LOW	➢ Impaired streams
4.5: Restore floodplain connectivity within the watershed	MEDIUM	➢ Land value in FHA
4.6: Protect source water sites in the watershed	HIGH	➢ CAFOs ➢ ACPF ➢ Wells susceptible to contamination
Goal 5: Establish the WMA as a trusted community resource		
5.2: Connect communities with resources specific to the watershed	LOW	➢ Community membership
5.3: Recognize and identify vulnerable populations in the watershed that may be affected by poor water quality and flooding	MEDIUM	➢ Population in FHA ➢ Wells susceptible to contamination

Table 8: Prioritizing objectives from Phase I to Bear Creek. (authors)

Cline Creek (070600060406)

Why Cline Creek?

The **Cline Creek** HUC-12 is in the middle part of the Maquoketa River Watershed, within the Mineral Creek HUC-10. Cline Creek is the third highest priority, based on the combined scores from the sub-watershed analysis. For each of the four key issues, this sub-watershed ranked 5th in flooding risk, 5th in nitrate pollution, 13th in phosphorous and soil runoff, and tied for 8th in diminished recreation.



This sub-watershed is in the bottom half of all HUC-12s in terms of the number of existing BMPs, a measure of progress towards all four key issues. In regard to flooding, total crop value in the FHA and total parcel value, which estimate potential flood damage, is in the middle of all 56 HUC-12s while population in the FHA is in the top 15%. Bear Creek has the third highest number of public wells highly susceptible to water pollution.

For monitored pollutant concentrations and target reductions, see Table 9. The one monitoring site in this HUC-12 has high turbidity, which may detract from recreational opportunities. Additionally, there are over 13 miles of streams impaired for recreation, the second highest amount of all HUC-12s, due to E. coli, loss of native mussels, and low aquatic macroinvertebrate biotic integrity.

Water Quality Monitoring Results
(2019-2021 average)

Sites	Chloride (mg/L)	Dissolved Phosphorous (mg/L)	E. Coli Bacteria (CFU/100ml)	Nitrate (mg/L)	Sulfate (mg/L)	Turbidity (NTUs)
Maq1	15	0.07	41	3.6	19.1	25
Targets	5 to 250	1	235	10	500 to 2000	25

Targets are based on standards from the US EPA and IA DNR. Chloride and sulfate standards depend on the water hardness. E. Coli target listed is the standard for waterbodies designated for swimming. Turbidity listed is the EPA limit for each individual point source.

Table 9: Water quality monitoring results for sites within Cline Creek. (MR WMA)

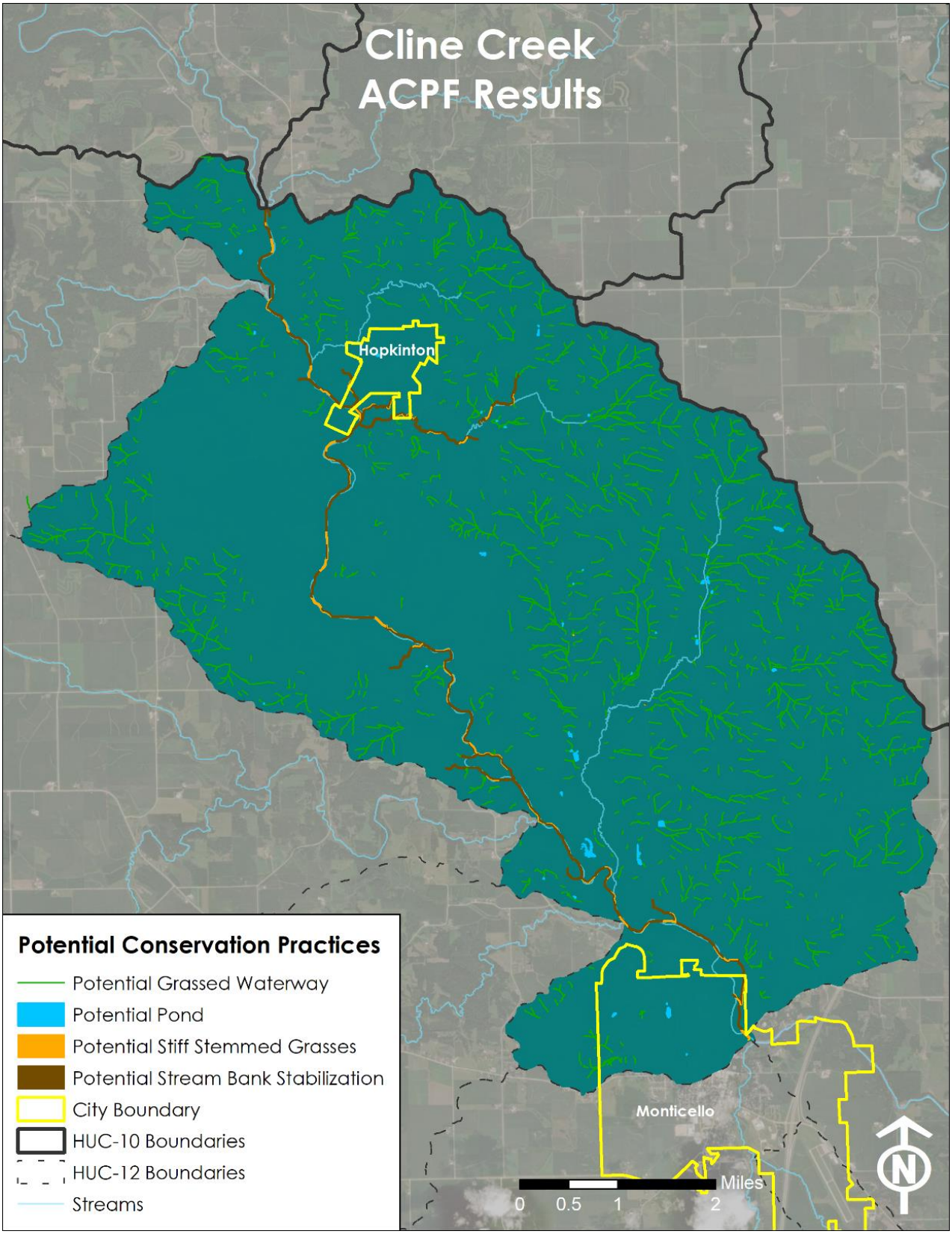


Figure 15: Results from the Agricultural Conservation Planning Framework showing potential project sites within Cline Creek sub-watershed. (authors)

What agricultural conservation practices can be implemented and what is already present?

Implementation of various BMPs will aid in addressing the four key issues that the plan focuses on. The planning team utilized ACPF, a tool from the USDA, to determine specific locations within the Cline Creek HUC-12 sub-watershed that different conservation practices could be implemented (see Figure 15). These are compared to existing BMPs, as compiled in a GIS analysis conducted by ISU called the IA BMP Mapping Project, in Table 10, which residents and the WMA can use to approximate remaining conservation project potential and identify appropriate sites.

Management Practice	Suggested by ACPF	Found on the IA BMP Mapping Project
Bioreactors	0	Not analyzed
Grassed waterways	1,102 (163 miles)	410 (108 miles)
Ponds	37	49 pond dams
WASCOBs	0	76 (4 miles)
Terraces	Not analyzed	91
Contour buffer strips	Not analyzed	21 (1,135 acres)
Stream bank stiff stemmed grasses	57 acres	Not analyzed
Stream bank stabilization	183 acres	Not analyzed

Table 10: Comparing ACPF results of suggested management practices for Cline Creek to existing management practices identified by the IA BMP Mapping Project. (authors)

What can urban areas implement?

This HUC-12 contains the northern portion of the City of Monticello and the entire City of Hopkinton. The planning team interviewed a city leader from Monticello for this plan but did not interview anyone from Hopkinton. The WMA should work to engage Hopkinton in future efforts. Future outreach can begin with a basic interview to determine existing water assets and issues, watershed planning and implementation, and city interest in future projects. The planning team developed guided interview questions, in Appendix B, and a checklist of potential projects that can be filled out by communities to help determine feasible projects.

Monticello is already engaged in extensive watershed management projects. For example, the City used funding to buy land and demolish buildings along Kitty Creek to reduce impacts from flooding. This project also involved the addition of a multi-use path along the creek. The City and the WMA are also in the planning phase of a wetland and prairie restoration project, as of May 2022. For future projects, the city leader noted Monticello is interested in pond/wetlands, rain gardens, permeable paver programs, bioswales, rain-scaping, stream restoration, and tree planting. The WMA should continue to support current projects with the City and seek out future projects.

What are the goals for Cline Creek?

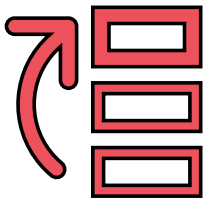


Table 11 illustrates prioritizing objectives from Phase I that are relevant to sub-watershed planning in Cline Creek. The corresponding strategies and actions for each objective can be found in Phase I. The table is ordered by objective number and includes corresponding metrics used to determine the priority level as low, medium, or high.

Goals & Objectives	Priority	Indicators
Goal 1: Improve water quality through techniques for nutrient management, erosion reduction, and increased infiltration		
1.1: Engage with the agricultural community to encourage techniques that increase field infiltration and reduce soil erosion	MEDIUM	➢ ACPF ➢ RUSLE
1.2: Engage with agricultural community to reduce and maximize efficiency of agricultural nutrient application	MEDIUM	➢ Monitored Nitrate ➢ Monitored E.coli ➢ CAFOs
1.3: Encourage practices that slow the flow of urban stormwater to increase infiltration and reduce erosion	HIGH	➢ Community size ➢ Impervious surfaces
1.4: Encourage the use of bacteria management to reduce E. Coli and other bacteria levels	MEDIUM	➢ Impaired streams ➢ Monitored E.coli
1.5: Encourage and increase the implementation of wetlands to filter water pollutants	LOW	➢ Acres of wetlands ➢ ACPF
1.6: Continue to document and report water quality indicators	HIGH	➢ Water quality monitoring data (all indicators)
Goal 2: Improve watershed flood management		
2.3: Increase awareness related to water quantity and strengthen connections between land use management practices and flooding.	HIGH	➢ Impervious surfaces ➢ Urban area ➢ Population in FHA ➢ Land value in FHA ➢ Crop value in FHA
Goal 3: Increase watershed awareness among stakeholders		
3.1: Educate the local residents to make individual efforts and connections with the watershed.	HIGH	➢ Acres of Public land used for conservation and recreation
Goal 4: Preserve, protect, and improve ecologically sensitive habitats and ecosystems in the watershed		
4.1: Prioritize natural resource sites in the watershed for preservation, protection, and restoration	HIGH	➢ Acres of Public land used for conservation and recreation
4.2: Protect streambanks, shorelines, and buffer areas within the watershed	MEDIUM	➢ Land value in FHA ➢ Crop value in FHA ➢ RUSLE
4.3: Restore wetlands and riparian areas in the watershed	LOW	➢ ACPF
4.4: Improve habitat conditions for native flora, fauna, and marine lives in the watershed	HIGH	➢ Impaired streams
4.5: Restore floodplain connectivity within the watershed	MEDIUM	➢ Land value in FHA

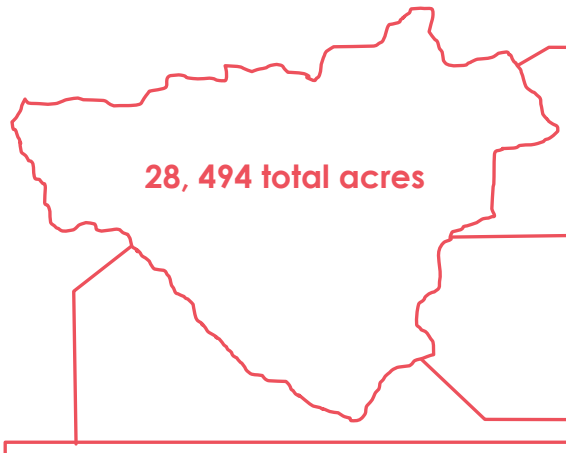
4.6: Protect source water sites in the watershed	MEDIUM	➢ CAFOs ➢ ACPF ➢ Wells susceptible to contamination
Goal 5: Establish the WMA as a trusted community resource		
5.2: Connect communities with resources specific to the watershed	MEDIUM	➢ Community membership
5.3: Recognize and identify vulnerable populations in the watershed that may be affected by poor water quality and flooding	MEDIUM	➢ Population in FHA ➢ Wells susceptible to contamination

Table 11: Prioritizing objectives from Phase I to Cline Creek. (authors)

Curran Creek (070600060501)

Why Curran Creek?

The **Curran Creek** HUC-12 is in the middle part of the Maquoketa River Watershed, within the Whitewater Creek HUC-10. Curran Creek is the 4th highest priority out of all 56 HUC-12s, based on the combined scores from the sub-watershed analysis. For each of the four key issues, this sub-watershed is tied for 11th in flooding risk, tied for 7th in nitrate pollution, is 4th in phosphorous and soil runoff, and 6th in diminished recreation.



Contains 2 streams, of which the Whitewater Creek is the largest.

The Whitewater Wildlife Area intersects the Curran Creek sub-watershed in two locations, totaling over 39 acres.

Land use is mostly agricultural.
3 small cities intersect it (Farley, Epworth, and Peosta).

11 permitted CAFOs and Open Feedlots
2 wastewater treatment facilities

This HUC-12 is in the top 15% of all 56 sub-watersheds in terms of existing BMPs, a metric influencing all four key issues, and the bottom 20% of publicly-owned land. In regard to flooding, estimates of potential flood damage are high, with Curran Creek containing the fourth highest total parcel value in the FHA, 5th highest percentage of impervious land cover, and top 25% for population in the FHA. For water quality, the impacts of soil runoff are evident, being the highest in tons per acre of runoff and 2nd highest in monitored turbidity.

Curran Creek HUC-12 has over 12 miles of streams impaired due to fish kill events, the fourth highest amount of all HUC-12s. Other monitored concentrations which may detract from recreational opportunities appear to be low (for monitored pollutant concentrations and target reductions, see Table 12). However, the WMA should work to implement more monitoring sites in this priority HUC-12 to better understand local conditions.

Water Quality Monitoring Results (2019-2021 average)						
Sites	**Chloride (mg/L)**	**Dissolved Phosphorous (mg/L)**	**E. Coli Bacteria (CFU/100ml)**	**Nitrate (mg/L)**	**Sulfate (mg/L)**	**Turbidity (NTUs)**
DU4	23.17	0.51	1,490	6.07	18.03	67.61
Targets	5 to 250	1	235	10	500 to 2000	25
Targets are based on standards from the US EPA and IA DNR. Chloride and sulfate standards depend on the water hardness. E. Coli target listed is the standard for waterbodies designated for swimming. Turbidity listed is the EPA limit for each individual point source.						

Table 12: Water quality monitoring results for sites within Curran Creek. (MR WMA)

What agricultural conservation practices can be implemented and what is already present?

Implementation of various BMPs will aid in addressing the four key issues that the plan focuses on. The planning team utilized ACPF, a tool from the USDA, to determine specific locations within the Curran Creek HUC-12 sub-watershed that different conservation practices could be implemented (see Figure 16). These are compared to existing BMPs, as compiled in a GIS analysis conducted by ISU called the IA BMP Mapping Project, in Table 13, which residents and the WMA can use to approximate remaining conservation project potential and identify appropriate sites.

Management Practice	Suggested by ACPF	Found on the IA BMP Mapping Project
Bioreactors	1	Not analyzed
Grassed waterways	1,625 (245 miles)	1,738 (348 miles)
Ponds	16	43 pond dams
WASCOBs	0	37 (1.49 miles)
Terraces	Not analyzed	73
Contour buffer strips	Not analyzed	29 (1,404 acres)
Stream bank stiff stemmed grasses	115 acres	Not analyzed
Stream bank stabilization	276 acres	Not analyzed

Table 13: Comparing ACPF results of suggested management practices for Curran Creek to existing management practices identified by the IA BMP Mapping Project. (authors)

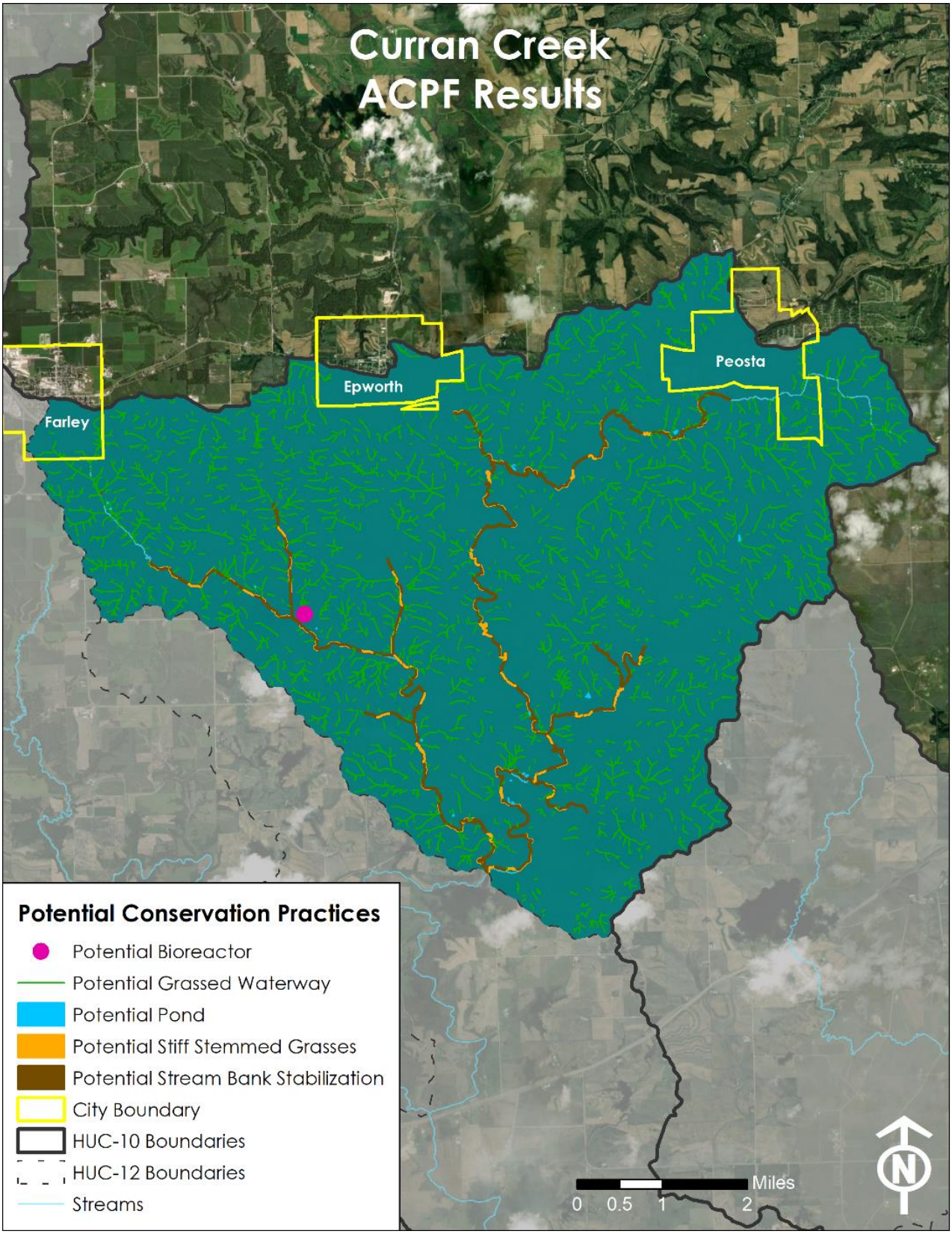


Figure 16: Results from the Agricultural Conservation Planning Framework showing potential project sites within Curran Creek sub-watershed. (authors)

What can urban areas implement?

This HUC-12 contains the southern portions of the City of Farley, the City of Epworth, and the City of Peosta. The planning team interviewed a city leader from Epworth for this plan but did not interview anyone from Farley or Peosta. The WMA should work to engage both communities in future efforts. Future outreach can begin with a basic interview to determine existing water assets and issues, watershed planning and implementation, and city interest in future projects. The planning team developed guided interview questions, in Appendix B, and a checklist of potential projects that can be filled out by communities to help determine feasible projects.

While Epworth does not contain many waterways, the city leader did mention some flooding-related issues along an unnamed creek that runs between residential development, Western Dubuque High School, and Highway 20. The City recognizes the importance of watershed planning and recently adopted a stormwater ordinance in 2011. The WMA should work with the City of Epworth to better understand flooding issues in the community and help with implementing projects to mitigate this issue.

What are the goals for Curran Creek?

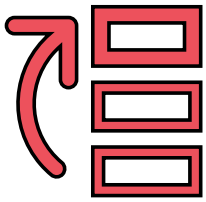


Table 14 illustrates prioritizing objectives from Phase I that are relevant to sub-watershed planning in Curran Creek. The corresponding strategies and actions for each objective can be found in Phase I. The table is ordered by objective number and includes corresponding metrics used to determine the priority level as low, medium, or high.

Goals & Objectives	Priority	Indicators
Goal 1: Improve water quality through techniques for nutrient management, erosion reduction, and increased infiltration		
1.1: Engage with the agricultural community to encourage techniques that increase field infiltration and reduce soil erosion	MEDIUM	➢ ACPF ➢ RUSLE
1.2: Engage with agricultural community to reduce and maximize efficiency of agricultural nutrient application	HIGH	➢ Monitored Nitrate ➢ Monitored E.coli ➢ CAFOs
1.3: Encourage practices that slow the flow of urban stormwater to increase infiltration and reduce erosion	HIGH	➢ Community size ➢ Impervious surfaces
1.4: Encourage the use of bacteria management to reduce E. Coli and other bacteria levels	HIGH	➢ Impaired streams ➢ Monitored E.coli
1.5: Encourage and increase the implementation of wetlands to filter water pollutants	HIGH	➢ Acres of wetlands ➢ ACPF
1.6: Continue to document and report water quality indicators	HIGH	➢ Water quality monitoring data (all indicators)
Goal 2: Improve watershed flood management		
2.3: Increase awareness related to water quantity and strengthen connections between land use management practices and flooding.	HIGH	➢ Impervious surfaces ➢ Urban area ➢ Population in FHA ➢ Land value in FHA ➢ Crop value in FHA

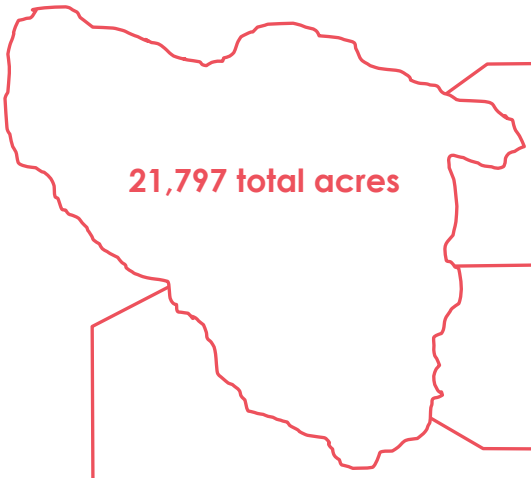
Goal 3: Increase watershed awareness among stakeholders		
3.1: Educate the local residents to make individual efforts and connections with the watershed.	HIGH	➢ Acres of Public land used for conservation and recreation
Goal 4: Preserve, protect, and improve ecologically sensitive habitats and ecosystems in the watershed		
4.1: Prioritize natural resource sites in the watershed for preservation, protection, and restoration	HIGH	➢ Acres of Public land used for conservation and recreation
4.2: Protect streambanks, shorelines, and buffer areas within the watershed	HIGH	➢ Land value in FHA ➢ Crop value in FHA ➢ RUSLE
4.3: Restore wetlands and riparian areas in the watershed	HIGH	➢ ACPF
4.4: Improve habitat conditions for native flora, fauna, and marine lives in the watershed	MEDIUM	➢ Impaired streams
4.5: Restore floodplain connectivity within the watershed	HIGH	➢ Land value in FHA
4.6: Protect source water sites in the watershed	MEDIUM	➢ CAFOs ➢ ACPF ➢ Wells susceptible to contamination
Goal 5: Establish the WMA as a trusted community resource		
5.2: Connect communities with resources specific to the watershed	HIGH	➢ Community membership
5.3: Recognize and identify vulnerable populations in the watershed that may be affected by poor water quality and flooding	MEDIUM	➢ Population in FHA ➢ Wells susceptible to contamination

Table 14: Prioritizing objectives from Phase I to Curran Creek. (authors)

Durion Creek (070600060604)

Why Durion Creek?

The **Durion Creek** HUC-12 is in the middle part of the Maquoketa River Watershed, within the Headwaters North Fork HUC-10. It ranks 5th highest priority, based on the combined scores from the sub-watershed analysis. For each of the four key issues, this sub-watershed ranked 2nd in flooding risk, tied for 11th in nitrate pollution, tied for 14th in phosphorous and soil runoff, and is 7th in diminished recreation.



Contains 3 streams, of which the North Fork Maquoketa River is the largest.

9 permitted CAFOs and Open Feedlots

2 wastewater treatment facilities

Land use is mostly agricultural. 2 cities intersect it (Dyersville and Worthington).

There is no public land being used for conservation or recreation.

Durion Creek does not rank highly for existing mitigation, being in the middle of all 56 HUC-12s for existing BMPs and wetlands, as well as containing no public conservation and recreational lands. In regard to potential damage from flooding, this HUC-12 has the 3rd highest population, and 6th highest parcel value, in the FHA, as well as the 6th highest amount of impervious surfaces. While there are few highly susceptible wells and no streams impaired due to fish kills, Durion Creek is in the top 10% of loss of native mussel impairment and top 25% for E. Coli impairment.

For monitored pollutant concentrations and target reductions, see Table 15. The impacts of the 11 permitted point source pollutants is evident in the high monitored E. Coli, turbidity, and phosphorous (which is the 3rd highest monitored concentration out of all sub-watersheds). These pollutant sources and stream impairments detract from recreational opportunities as well. The WMA can work with local communities to improve these metrics through both rural and urban conservation projects.

Water Quality Monitoring Results (2019-2021 average)						
Sites	**Chloride (mg/L)**	**Dissolved Phosphorous (mg/L)**	**E. Coli Bacteria (CFU/100ml)**	**Nitrate (mg/L)**	**Sulfate (mg/L)**	**Turbidity (NTUs)**
DE11	22.21	0.69	6,673.86	1.75	27.07	11.67
DE12	23.13	0.63	5,374.75	9.06	23.41	31.17
Targets	5 to 250	1	235	10	500 to 2000	25
Targets are based on standards from the US EPA and IA DNR. Chloride and sulfate standards depend on the water hardness. E. Coli target listed is the standard for waterbodies designated for swimming. Turbidity listed is the EPA limit for each individual point source.						

Table 15: Water quality monitoring results for sites within Durion Creek. (MR WMA)

What agricultural conservation practices can be implemented and what is already present?

Implementation of various BMPs will aid in addressing the four key issues that the plan focuses on. The planning team utilized ACPF, a tool from the USDA, to determine specific locations within the Durion Creek HUC-12 sub-watershed that different conservation practices could be implemented (see Figure 17). These are compared to existing BMPs, as compiled in a GIS analysis conducted by ISU called the IA BMP Mapping Project, in Table 16, which residents and the WMA can use to approximate remaining conservation project potential and identify appropriate sites.

Management Practice	Suggested by ACPF	Found on the IA BMP Mapping Project
Bioreactors	0	Not analyzed
Grassed waterways	1,007 (154 miles)	1513 (107 miles)
Ponds	23	9 pond dams
WASCOBs	1 (0.06 miles)	14 (0.53 miles)
Terraces	Not analyzed	12
Contour buffer strips	Not analyzed	10 (360 acres)
Stream bank stiff stemmed grasses	71 acres	Not analyzed
Stream bank stabilization	181 acres	Not analyzed

Table 16: Comparing ACPF results of suggested management practices for Durion Creek to existing management practices identified by the IA BMP Mapping Project. (authors)

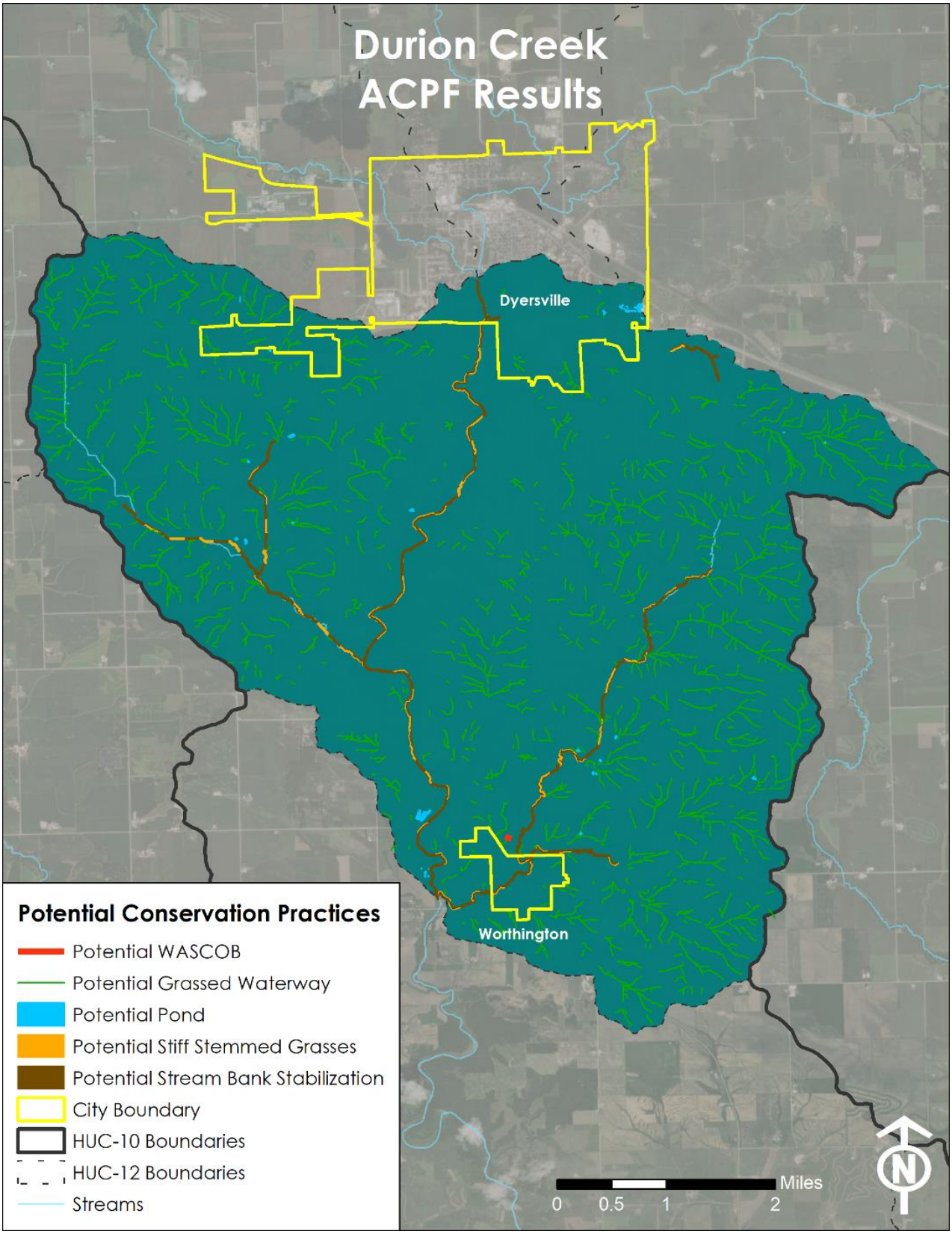


Figure 17: Results from the Agricultural Conservation Planning Framework showing potential project sites within Durion Creek sub-watershed. (authors)

What can urban areas implement?

This HUC-12 includes the southern portion of the City of Dyersville and the entire City of Worthington. The planning team interviewed city leaders from both Dyersville and Worthington for this plan. In Dyersville, the city representative indicated that they have already undertaken extensive water management projects. While the 1st phase of stream restoration projects are complete in Dyersville, the WMA can further support projects aligned with community's Field of Dreams Watershed Vision Plan. Dyersville noted interest in watershed projects of ponds/wetland areas, rain gardens, bioswales, stream restoration, and tree plantings. The City expressed interest in any projects that promote river recreation, such as the existing multi-use path along Bear Creek. During the interview, the city representative noted that both city residents and people from outlying areas drive to Bear Creek just to walk along the stream. The WMA should continue to support Dyersville in expanding such amenities and use it as an example for other communities.

In Worthington, the city representative noted some flooding issues that arise during heavy rain events, occurring in and north of the city, which result in larger quantities of water coming downstream. The city representative expressed in the stakeholder interview that keeping Durion Creek clean is an important goal. Worthington noted interest in having a walking trail along Durion Creek, . The WMA should continue to engage with Worthington and build on their interest in watershed management to implement future projects.

What are the goals for Durion Creek?

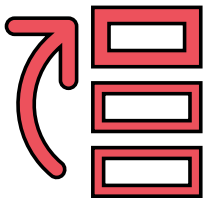


Table 17 illustrates prioritizing objectives from Phase I that are relevant to sub-watershed planning in Durion Creek. The corresponding strategies and actions for each objective can be found in Phase I. The table is ordered by objective number and includes corresponding metrics used to determine the priority level as low, medium, or high.

Goals & Objectives	Priority	Indicators
Goal 1: Improve water quality through techniques for nutrient management, erosion reduction, and increased infiltration		
1.1: Engage with the agricultural community to encourage techniques that increase field infiltration and reduce soil erosion	MEDIUM	➢ ACPF ➢ RUSLE
1.2: Engage with agricultural community to reduce and maximize efficiency of agricultural nutrient application	HIGH	➢ Monitored Nitrate ➢ Monitored E.coli ➢ CAFOs
1.3: Encourage practices that slow the flow of urban stormwater to increase infiltration and reduce erosion	HIGH	➢ Community size ➢ Impervious surfaces
1.4: Encourage the use of bacteria management to reduce E. Coli and other bacteria levels	HIGH	➢ Impaired streams ➢ Monitored E.coli
1.5: Encourage and increase the implementation of wetlands to filter water pollutants	HIGH	➢ Acres of wetlands ➢ ACPF
1.6: Continue to document and report water quality indicators	HIGH	➢ Water quality monitoring data (all indicators)

Goal 2: Improve watershed flood management		
2.3: Increase awareness related to water quantity and strengthen connections between land use management practices and flooding.	HIGH	➢ Impervious surfaces ➢ Urban area ➢ Population in FHA ➢ Land value in FHA ➢ Crop value in FHA
Goal 3: Increase watershed awareness among stakeholders		
3.1: Educate the local residents to make individual efforts and connections with the watershed.	HIGH	➢ Acres of Public land used for conservation and recreation
Goal 4: Preserve, protect, and improve ecologically sensitive habitats and ecosystems in the watershed		
4.1: Prioritize natural resource sites in the watershed for preservation, protection, and restoration	HIGH	➢ Acres of Public land used for conservation and recreation
4.2: Protect streambanks, shorelines, and buffer areas within the watershed	MEDIUM	➢ Land value in FHA ➢ Crop value in FHA ➢ RUSLE
4.3: Restore wetlands and riparian areas in the watershed	HIGH	➢ ACPF
4.4: Improve habitat conditions for native flora, fauna, and marine lives in the watershed	MEDIUM	➢ Impaired streams
4.5: Restore floodplain connectivity within the watershed	MEDIUM	➢ Land value in FHA
4.6: Protect source water sites in the watershed	MEDIUM	➢ CAFOs ➢ ACPF ➢ Wells susceptible to contamination
Goal 5: Establish the WMA as a trusted community resource		
5.2: Connect communities with resources specific to the watershed	MEDIUM	➢ Community membership
5.3: Recognize and identify vulnerable populations in the watershed that may be affected by poor water quality and flooding	MEDIUM	➢ Population in FHA ➢ Wells susceptible to contamination

Table 17: Prioritizing objectives from Phase I to Durion Creek. (authors)

Plan Implementation

Decision Making Criteria

The WMA should work with the MRW technical committee and local residents to determine cost-effective projects that will maximize flood mitigation, nitrate and phosphorous reduction, and recreational opportunities. The US EPA Handbook on Watershed Planning has outlined criteria which can be used to screen the possible management practice sites for actual project sites. Figure 18 below describes factors to consider when identifying which site should be selected for a management practice, including considerations unique to the MRW.

Strength of impact	Projects that address the key issues in the HUC-12, and have a high potentional for pollutant load or flooding reduction, should be prioritized. The WMA should consult with the MRW technical committee, NRCS staff, and the Iowa Flood Center to determine reductions.
Any co-benefits	While management projects are designed to improve one aspectof water resources, they may have co-benefits that address issues in this plan and beyond it. Projects that can improve the watershed in multple ways, such as reducing pollutnants, mitigating flooding, creating recreational amenities, improving wildlife habitat, increasing economic opportunity, and/or promoting equity should be given higher consideration.
Cost of project	After identifying the direct and indirect benefits, the cost of the potential project should be calculated. Costs to consider include access to the land, site design and engineering, installation, operation, and long-term maintenance for the practice. The WMA should work with the MRW technical committee, NRCS staff, Iowa Flood Center, and conservation funding sources to estimate a project's cost.
Negative impacts	While having unintended impacts should not automatically rule out a project, it should be noted that there will be trade-offs in each possible practice. For instance, a project that controls one pollutant may increase another. If the benefits outweight the consquences, or if consquences can be mitigated, the project should move forward.
Local concerns	Successful conservation projects require collaboration between the WMA, local governments, and residents. The WMA should consult impacted groups and design projects to address any concerns. Stakeholder interviews for this plan identified project implementation barriers, including city and farmer budget constraints, lack of technical expertise, and political support for conservation.

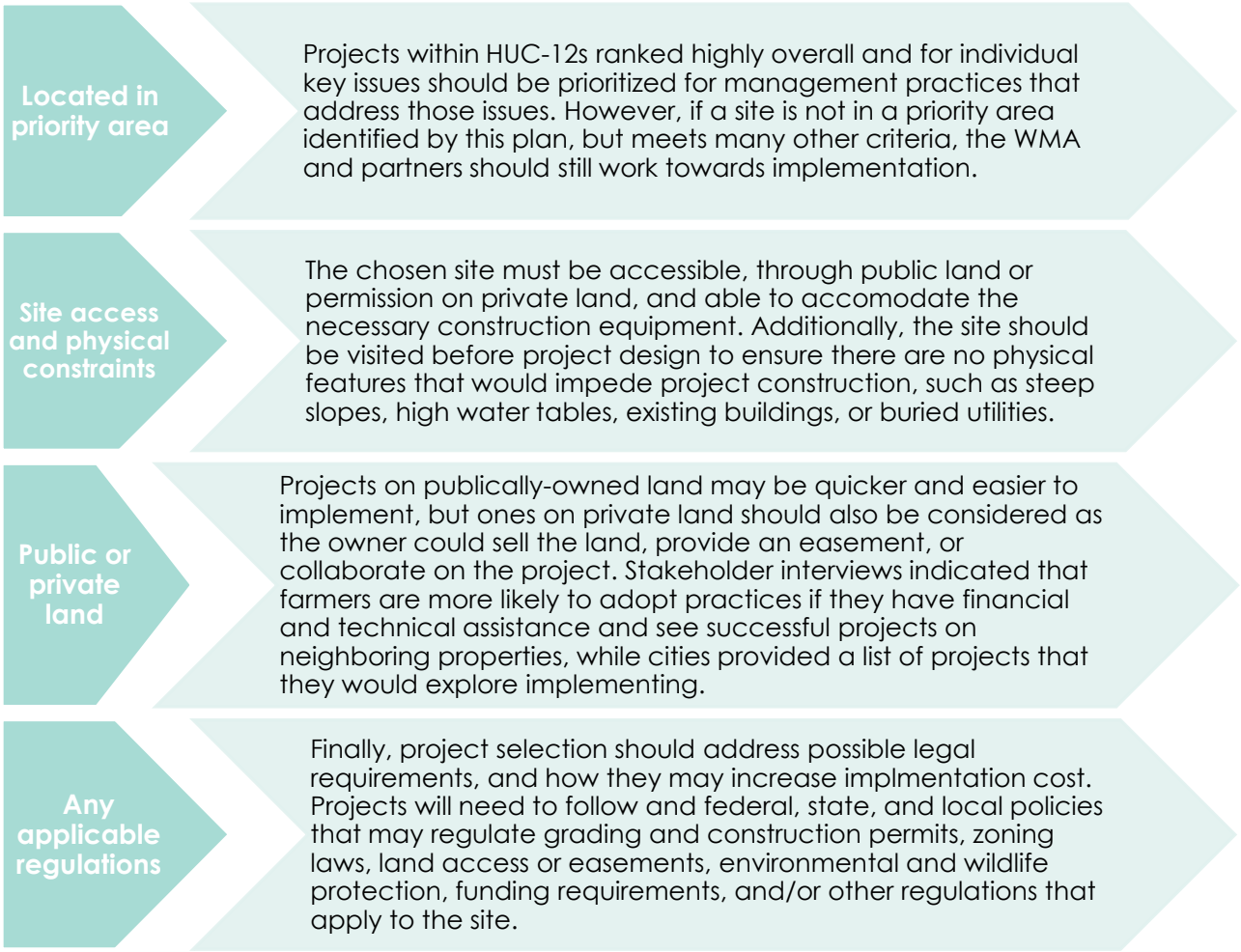


Figure 18: Screening criteria to select specific sites for conservation project implementation. (authors)

Project Funding Sources

As part of deciding which project to select, costs should be considered. However, costs may be offset by utilizing the potential cost-share and other conservation incentive programs listed below from local, state, and federal sources. Phase I of the MRW Management Plan outlined fundings sources specific to action steps related to key goals. The funding sources listed in Table 18 below includes some of the funding sources listed in Phase I along with new funding sources.

Program	Website	Description
Environmental Quality Incentives Program (EQIP)	https://bit.ly/3LKCr9D	EQIP provides agricultural producers financial and technical assistance to implement structural and management practices that optimize environmental benefits on working agricultural lands.
Regional Conservation Partnership Program (RCPP)	https://bit.ly/38mvxZM	RCPP promotes conservation practice activities among landowners and agricultural producers that address on-farm, watershed, and natural resource concerns.
Stormwater Program from the Iowa State Revolving Fund (SRF)	https://bit.ly/3NSX9G9	The Iowa SRF provides low-cost loans to public and private entities for projects focus on stormwater quantity and include a water quality benefit.
Iowa Department of Agriculture & Land Stewardship (IDALS) Urban Water Quality Initiative	https://bit.ly/3NQrMfB	IDALS Urban Water Quality Initiative supports conversation projects in urban areas, such as bioswales, native landscaping, permeable pavers, and wetlands, through cost-share funding.
Conservation Innovation Grants (CIG)	https://bit.ly/3JiPUUq	CIG supports funding supports non-federal entities and individuals in the development and adoption of innovative conservation approaches and requires a one to one funding match.
Wetland Program Development Grants (WPDGs)	https://bit.ly/3v31Jt1	WPDGs assists governments and public entities in building programs to increase the quantity and quality of wetlands through restoration and better management.
5 Star Wetland and Urban Waters Restoration Grants	https://bit.ly/36YI5X2	This grant provides modest funding for education and training through wetland and stream restoration by bringing together multiple stakeholders, such as students, landowners, and government agencies.
Clean Water State Revolving Fund (CWSRF)	https://bit.ly/3DRajyT	CWRSF provides communities financing for water quality infrastructure projects.
Conservation Stewardship Program	https://bit.ly/3jfPq70	This program helps agricultural producers with land management plans that focus on conservation practices.

Agricultural Conservation Easement Program (ACEP)	https://bit.ly/37nL8YC	ACEP provides easements to public and private landowners to limit non-agricultural uses on working lands, such as cropland and wetlands.
Water Infrastructure Fund (WIF)	https://bit.ly/3Kmbp8u	WIF provides funds for innovative water resource projects focused on water quality improvement and can include other benefits such as reducing excess nutrients, reducing flood risk, and providing significant economic benefits.
Resource Enhancement and Protection (REAP) program	https://bit.ly/3jdjC2U	REAP provides funding to soil and water conservation districts to address water quality protection from point and non-point pollution sources.
Watershed and Flood Prevention Operations (WFPO) Program	https://bit.ly/3DMe6gZ	WFPO provides funding and technical assistance for watershed projects up to 250,000 acres that include flood prevention, water quality improvements, and habitat enhancement.
Emergency Watershed Protection (EWP) Program	https://bit.ly/3Ji8lbO	EWP funds projects that protect infrastructure and land from flooding and soil erosion.

Table 18: Funding sources that are applicable in the MRW for projects to improve flood mitigation and water quality. (authors)

Next Steps

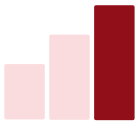
Based on results from the sub-watershed analysis and community engagement conducted in Phase II, the planning teams makes the following recommendations:

Follow sub-watershed plans for priority HUC-12s	The planning team developed five sub-watershed plans for priority HUC-12s based on the combined weighted scores for key issues. The WMA should follow the sub-watershed plans and decision-making criteria to choose specific projects and programs to implement.
Identify larger-scale site specific projects in priority HUC-12s	Priority HUC-12s in Phase II were determine based on technical data, but proposed interventions in sub-watershed plans focus on politically feasible agricultural practices and community-specific projects. Phase II does not address larger-scale watershed projects, but the US EPA Handbook for Watershed Planning provides guidance on how to identify specific management strategies and projects with assistance from technical experts, such as the IFC, ISU Extension, IDALS, and MR Technical Committee.
Develop sub-watershed plans for lower-priority HUC-12s	Sub-watershed planning allows for more specified decision-making for WMA activities and offers useful information to evaluate management efforts. Phase II included the development of five priority sub-watershed plans, which the WMA should replicate for non-priority HUC-12s as deemed necessary. The MR Technical Committee may be a possible partner to continue developing sub-watershed plans for lower-priority HUC-12s.
Continue support for projects and programs in lower-priority HUC-12s	While Phase II determined priority sub-watersheds for management efforts, the WMA should continue to support projects and programs in non-priority HUC-12s. Water management issues still exist in non-priority HUC-12s even if not as extreme as priority HUC-12s. Additionally, communities show widespread interest in water management activities, but not all communities are located in priority HUC-12s. The WMA should continue support for all projects and programs that align with Phase I Goals and Objectives, local interest, and improving key watershed issues.
Reassess key issues and variables used in the Sub-watershed Analysis every 5 years	The variables analyzed for key issues in the Sub-Watershed Analysis are dynamic. For example, streams have had impairments removed during the of writing Phase II. Over the next several years, it is likely that new CAFOs will be permitted, the number of implemented BMPs will change, and parcel value in the FHA will fluctuate based on new construction, removal of buildings, or land and building value appreciation. The WMA should reassess key issues and variables used in the Sub-watershed Analysis every 5 years to monitor changes occurring in the MRW. This reassessment allows the WMA to see if new priority sub-watersheds are emerging or if there are improvements in current priority sub-watersheds.

Prioritizing Phase I Management Objectives

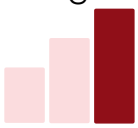
The results from the sub-watershed analysis and community engagement provide value not only priority sub-watersheds, but the entire MRW. This section prioritizes management objectives from Phase I based on technical and qualitative data analyzed in this plan and other relevant sources. The following list helps to prioritize watershed-wide management efforts. Goal and objectives outlined in Phase I are assigned corresponding priority levels the determining factors are explained.

Objective 1.1: Engage with the agricultural community to encourage techniques that increase field infiltration and reduce soil erosion.



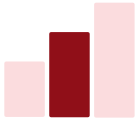
- Priority Level: HIGH
- Explanation: Based on a comparison between ACPF tool and the Iowa BMP mapping projects, grassed waterways in priority HUC-12s appear to be an underused conservation practice. The WMA should assess this practice watershed-wide along with other practices to find potential gaps in adoption.

Objective 1.2: Engage with agricultural community to reduce and maximize efficiency of agricultural nutrient application



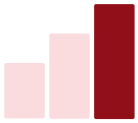
- Priority Level: HIGH
- Explanation: Nitrate and phosphorus are key issues identified in Phase II, which stem in part from nutrient application. Monitored nitrate and phosphorus in the MRW are routinely above statewide averages. Additionally, 7 of 45 monitoring sites average nitrate concentrations over the US EPA limit.

Objective 1.3: Encourage practices that slow the flow of urban stormwater to increase infiltration and reduce erosion.



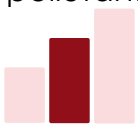
- Priority Level: MEDIUM
- Explanation: Some communities in the watershed show interest in urban projects, such as rain gardens, bio-swales, and stream restoration, that help increase infiltration and reduce erosion. The WMA should continue to assess interest for those projects in other communities and support communities that expressed interest in this planning phase.

Objective 1.4: Encourage the use of bacteria management to reduce E. Coli and other bacteria levels.



- Priority Level: HIGH
- Explanation: All monitoring sites in the MRW have average E. Coli concentrations above the US EPA limit. Additionally, many miles of streams are impaired due to fish kills from E. Coli and E. Coli concentration itself.

Objective 1.5: Encourage and increase the implementation of wetlands to filter water pollutants.



- Priority Level: MEDIUM
- Explanation: Wetland projects appear to be of interest to larger communities in the watershed. The WMA should support those communities interested in wetland projects and assess other communities' interest not covered by this plan. The ACPF tool also offer a module to determine potential wetland locations, which was not used for this plan.

Objective 1.6: Continue to document and report water quality indicators.

- Priority Level: HIGH
- Explanation: Water quality indicators provide important information to evaluate management efforts. Phase II used water quality monitoring data to help determine priority HUC-12s and will be used in the future for reassessment.

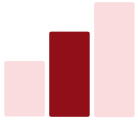
Objective 2.1: Advance the mission and goals of the WMA by fostering partnerships between agencies, organizations, and political entities regarding flood prevention and recovery.

- Priority Level: HIGH
- Explanation: The WMA technical committee ranked flooding risk as the highest key issue in prioritizing sub-watersheds for management efforts, which was endorsed by WMA leadership. The WMA should highly prioritize fostering partnership among stakeholders to address flooding risk.

Objective 2.2: Implement a comprehensive program of targeted activities designed to reduce flood risk and improve water quality in the Maquoketa River Watershed.

- Priority Level: HIGH
- Explanation: Phase II planning efforts prioritize sub-watersheds for management efforts. The WMA can further this planning effort by considering further analysis into site-specific areas for management projects within priority HUC-12s.

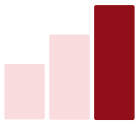
Objective 2.3: Increase awareness related to water quantity and strengthen connections between land use management practices and flooding.



- Priority Level: MEDIUM
- Explanation: Phase II analyzed data on impervious surfaces, which range from 4 to 12 percent of total area in HUC-12s. Four HUC-12s contain impervious surfaces representing greater than 10% of total area. The WMA should continue to monitor impervious surface levels.

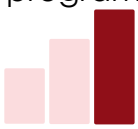
Goal 3 Increase watershed awareness and involvement among stakeholders

Objective 3.1: Educate the local residents to make individual efforts and connections with the watershed.



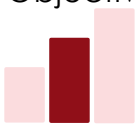
- Priority Level: HIGH
- Explanation: Respondents to a survey in Phase I show strong interest in non-agricultural conservation strategies implemented by individual landowners. The WMA should highly prioritize educating local residents on conservation efforts.

Objective 3.2: Ensure all stakeholders in the watershed are included in activities and programs.



- Priority Level: HIGH
- Explanation: Sub-watershed plans developed in Phase II focus on agricultural practices and community-specified projects. The success of these efforts will depend on the engagement of agricultural landowners and community leaders.

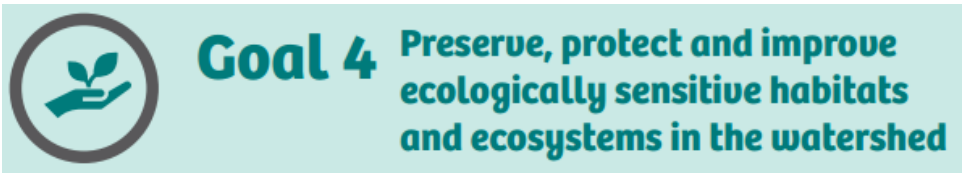
Objective 3.3: Expand WMA network within the watershed through outreach.



- Priority Level: MEDIUM
- Explanation: All communities interviewed in Phase II are aware of the WMA and widely support WMA activities. The WMA should consider continuing interviews with community leaders and other stakeholders.

Objective 3.4: Work to achieve an effective interagency cooperation with relevant authorities in the region.

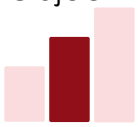
- Priority level: HIGH
- Explanation: Implementing sub-watershed plans developed in Phase II depends on strong relationships with communities, counties, Soil and Water Conservation Authorities and other stakeholders.



Objective 4.1: Prioritize natural resource sites in the watershed for preservation, protection, and restoration.

- Priority Level: HIGH
- Explanation: Sub-watershed plans in Phase II primarily focus on agricultural practices and community-specified projects. A further step in this effort is to identify specific projects within priority sub-watersheds.

Objective 4.2: Protect streambanks, shorelines, and buffer areas within the watershed.

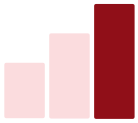


- Priority Level: MEDIUM
- Explanation: Phase II analyzed parcel value and crop value in the 100-year floodplain, which highlights potential human activities that erode streambanks. The WMA should assess other indicators, such inventorying stream restoration projects and identify activities along streams.

Objective 4.3: Restore wetlands and riparian areas in the watershed.

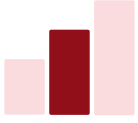
- Priority Level: HIGH
- Explanation: Wetland projects are of interest to larger communities in the watershed. Dyersville, Manchester, and Monticello all have extensive wetland restoration projects underway. The WMA should continue to support these projects and identify other areas where restoration is needed.

Objective 4.4: Improve habitat conditions for native flora, fauna, and marine lives in the watershed.



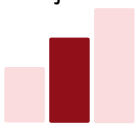
- Priority Level: HIGH
- Explanation: 31% of streams in the MRW are impaired with many impairments impacting aquatic life and habitat, such as fish kills, loss of native mussel species, and low aquatic macroinvertebrate. Additionally, Phase I summarized threatened and endangered animal and plant species in the watershed, which the WMA may further analyze to determine priority.

Objective 4.5: Restore floodplain connectivity within the watershed.



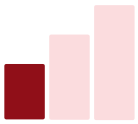
- Priority Level: MEDIUM
- Explanation: Phase II analyzed parcel value in the floodplain, which highlight potential infrastructure barriers in the floodplain. Projects such as Dyersville's Field of Dream Watershed Vision Plan should be used as an example to other communities that are interested in

Objective 4.6: Protect source water sites in the watershed.



- Priority Level: MEDIUM
- Explanation: Phase II analyzed locations of CAFOs and wastewater treatment facilities, which are important consideration regarding source water protection. A higher number of CAFOs are located in the northern portion of the watershed, although, the dataset is limited due to reporting requirements. The WMA should continue to monitor this dataset.

Objective 5.1: Make the WMA representative of the people and interests in the watershed.

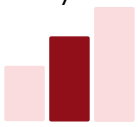


- Priority Level: LOW
- Explanation: Phase II identified key issues facing the watershed with input from WMA leadership, technical committee, and community members. The technical committee ranked key issues facing the watershed with the results being endorsed by WMA leadership. The WMA may continually reassess key issues in the watershed and their priority.

Objective 5.2: Connect communities with resources specific to the watershed.

- Priority Level: HIGH
- Explanation: Communities show widespread interest in WMA activities. While not all communities express need to implement water management projects, there is support for projects that mitigate flooding and improve water quality. The WMA should enhance this support with further engagement activities.

Objective 5.3: Recognize and identify vulnerable populations in the watershed that may be affected by poor water quality and flooding.



- Priority Level: MEDIUM
- Explanation: Phase II provides data on population living in the 100-year floodplain. The WMA may further this analysis by looking at other demographic of groups living in the 100-year floodplain

Plan Implementation Logic Model

By examining existing conditions, ranking sub-watersheds, creating priority HUC-12 plans, and delineating implementation steps and goals, this plan serves a call to action for residents of the Maquoketa River Watershed. The logic model below (Figure 19) summarizes who should carry out action steps which will improve the conditions of the watershed. These conditions should then be re-examined as the goals of this plan are met over the next 20 years. If WMA staff, Technical Committee, and service providers (such as ISU Extension, NRCS, and IDALS staff) work with farmers and cities to implement projects, long-term outcomes of improved flood mitigation, water quality, recreation, and collaboration can be achieved.

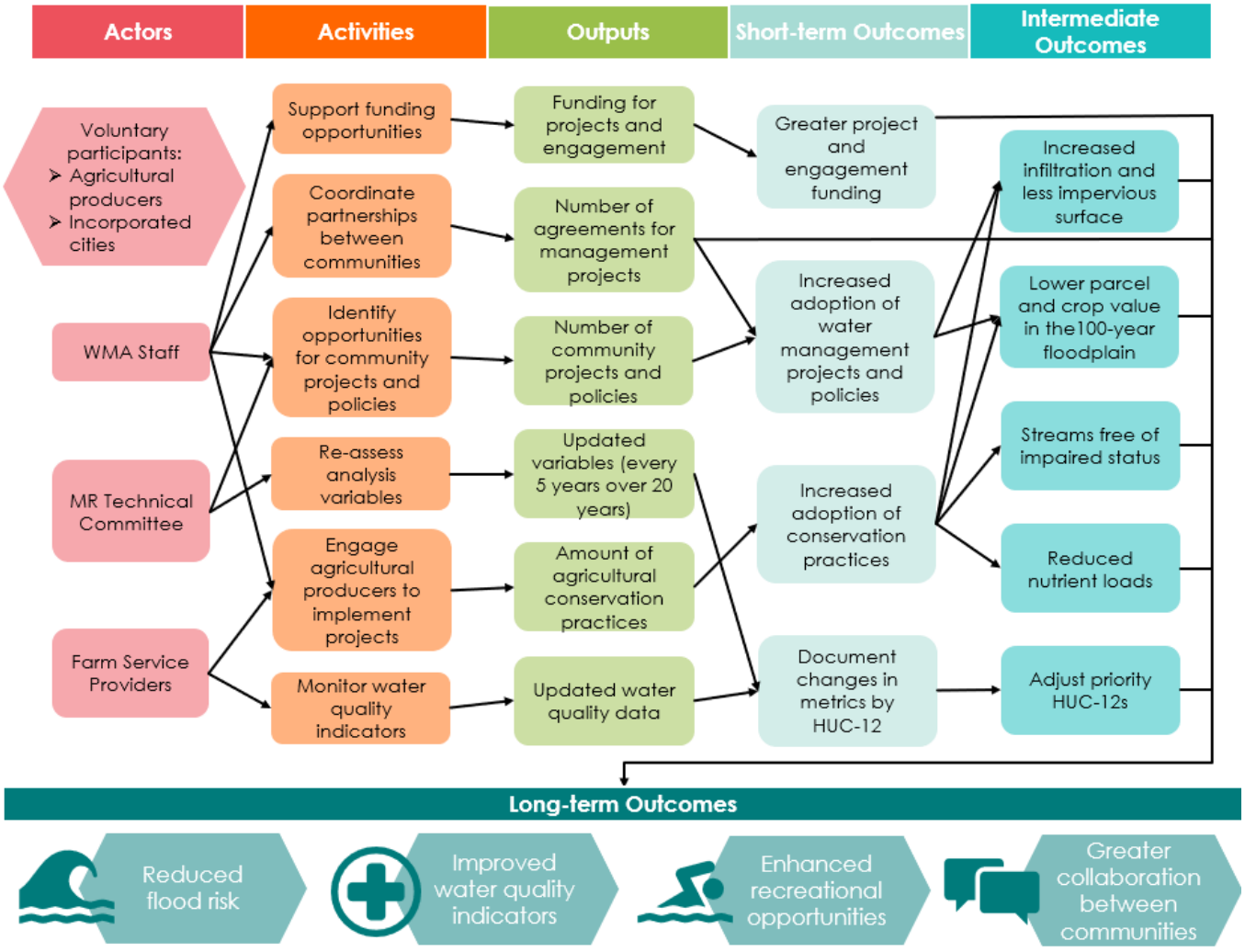


Figure 19: Logic model showing actors, activities, outputs, and short-, intermediate, and long-term outcomes of the MRW Management Plan Phase II: Sub-watershed Implementation. (authors)

Appendices

Appendix A: Individual Metric Maps

Acres of impervious surfaces

Impervious surfaces create higher amounts of stormwater runoff because when rain falls, the water is unable to infiltrate and subsequently runs off. Higher amounts of impervious surfaces are typically found in urban areas where there are more buildings and pavement, although compacted soils create a similar effect.[ix] When stormwater runs off impervious surfaces like parking lots or roads, flash flooding events and pollutant transport is possible. Figure 20 shows percent impervious surface by HUC-12. HUC-12s that contain the cities of Manchester and Maquoketa contain the highest percentage of impervious surfaces.

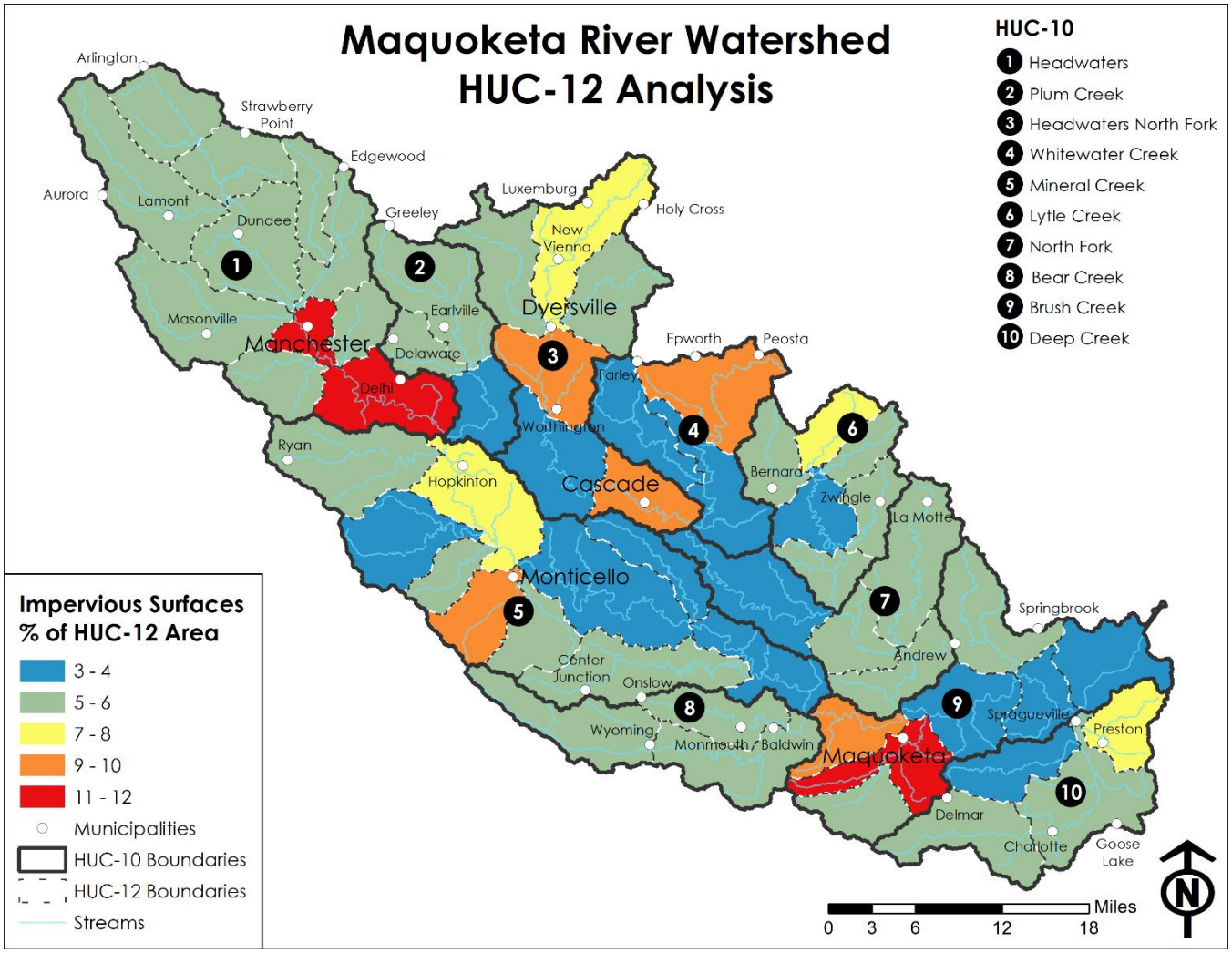


Figure 20: Map showing percent impervious surface by HUC-12. (LULC, map by authors)

Acres of public land used for conservation and recreation

Understanding the amount and distribution of public land between HUC-12s is important when identifying opportunities to implement projects. Public land ownership typically increases the likelihood of project implementation and reduces potential issues with accessing the project site.[x] Figure 21 shows the amount of public land used for conservation and recreation in acres by HUC-12. The two largest HUC-10s by size, Headwaters and Mineral Creek, also contain the most acres of public land. Headwater North Fork and Lytle Creek have the lowest amount of public land.

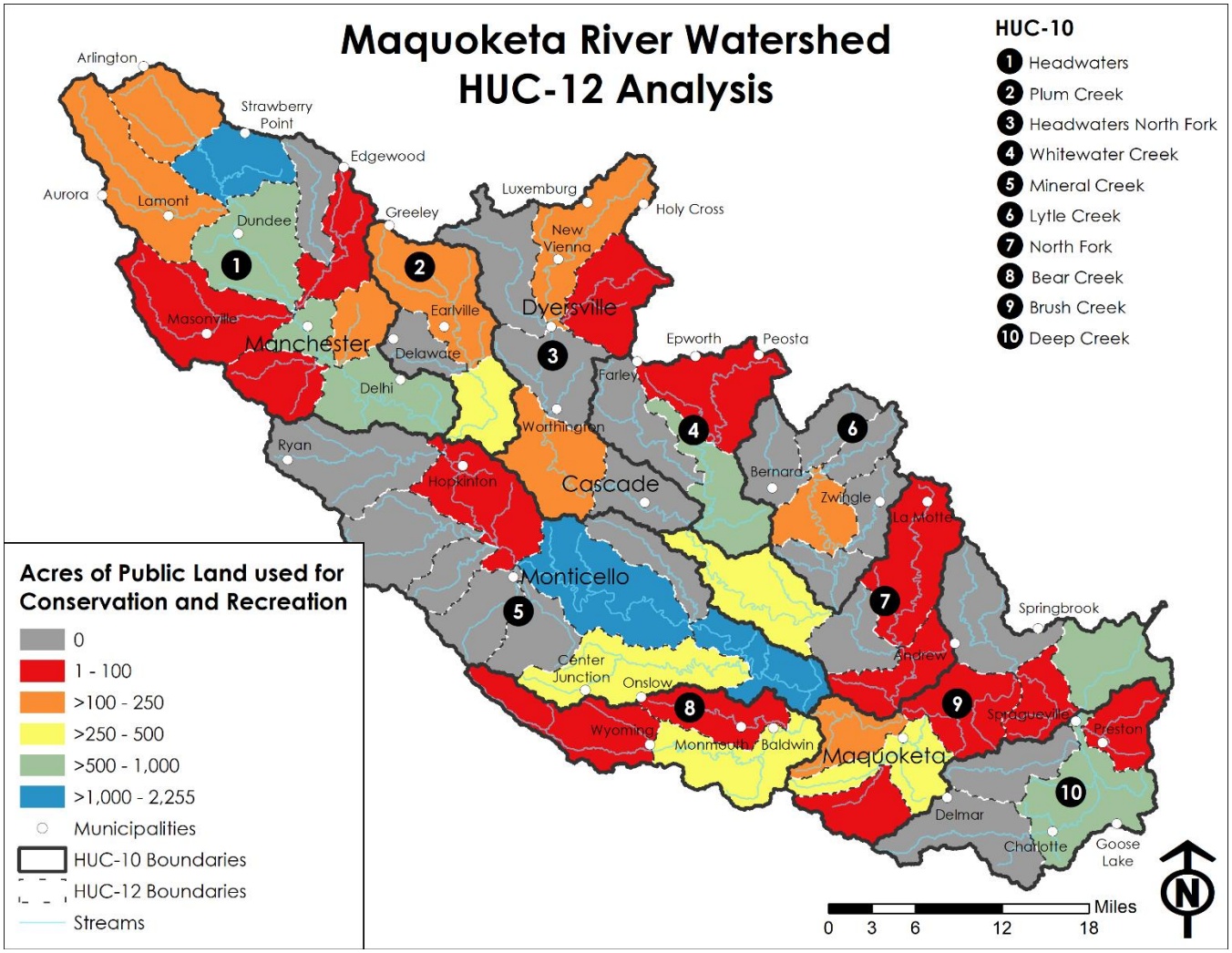


Figure 21: Map showing acres of public land by HUC-12. (map by authors)

Parcel value in the 100-year floodplain

Parcel value in the floodplain provides a proxy for areas most susceptible to economic loss from flood events. The planning team collected building and land value for each privately owned parcel in the MRW and overlayed the 100-year floodplain to calculate total parcel value in the floodplain. The values were then analyzed at the HUC-12 level to understand the spatial distribution across the entire watershed at finer scale. Figure 22 shows that HUC-12s with the greatest building value (shown in red) are primarily in the northern portion of the MRW, where the cities of Manchester and Dyersville are located.

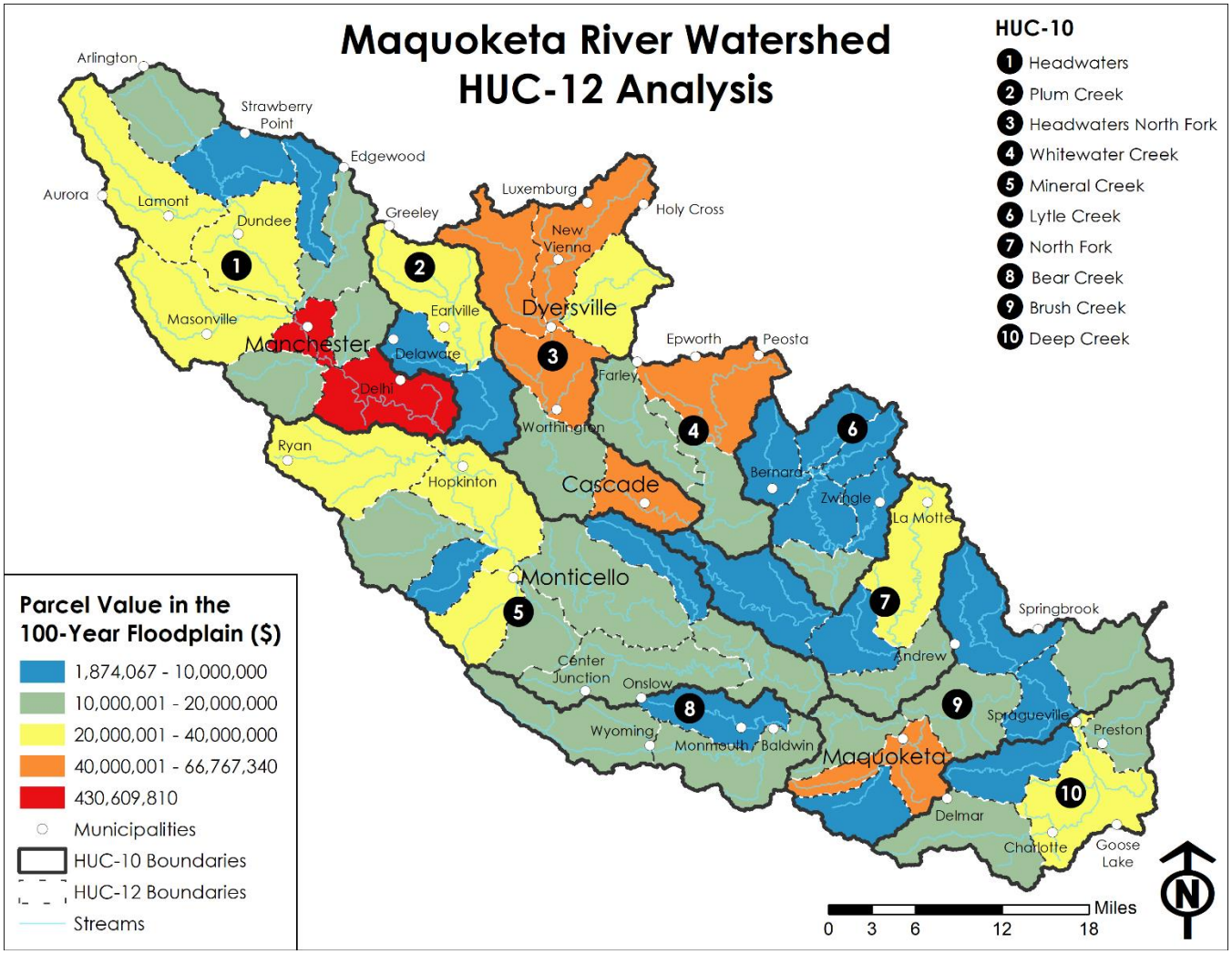


Figure 22: Map showing parcel values in the FHA by HUC-12. (County assessor data, map by authors)

Crop value in the 100-year floodplain

With farmers often using all farmable land to maximize their yields, crops often encroach upon bodies of water. The purpose of this variable is to provide an estimate for potential crop losses due to flooding events. ACPF field data, based on the National Agricultural Statistics Service (NASS) Cropland Data Layer, were used to calculate the acreage of corn and soybeans in the FHA in 2017, 2018, and 2019. Average yields for each crop type during each of those years was multiplied by the dataset to calculate average yields per acre. The yield data was then multiplied by the respective crop prices for each of those years to calculate the total value of crops over a 3-year period. This was then averaged to provide the final dataset which shows the crop value in the 100-year floodplain as shown in Figure 23. Headwaters, Plum Creek, Mineral Creek, Bear Creek, and Deep Creek HUC-10s all see areas with high amounts of crop value located within the 100-year floodplain, while Lytle Creek has relatively little.

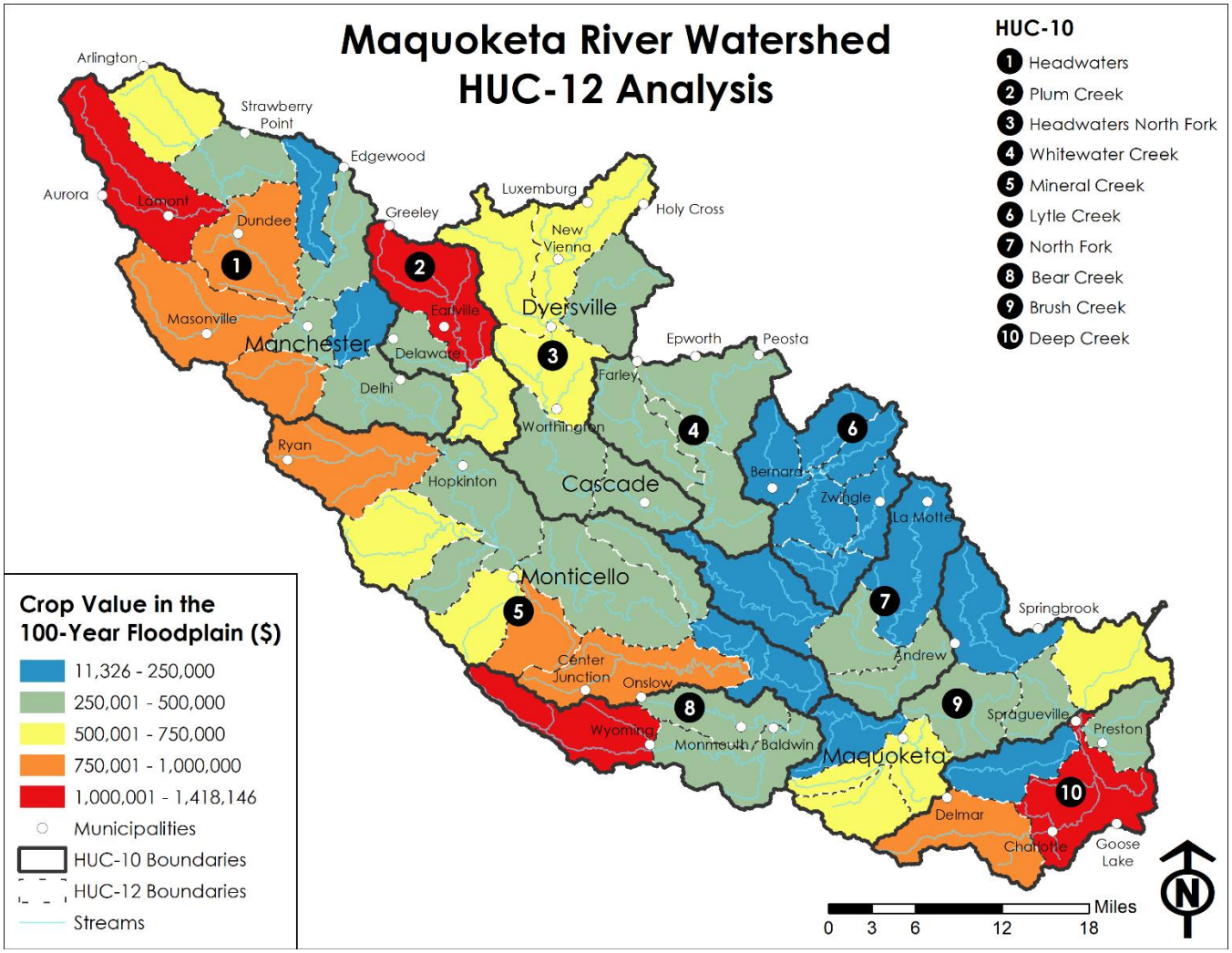


Figure 23: Map showing crop value in the FHA by HUC-12. (NASS, map by authors)

Number of people residing in the 100-year floodplain

Like building value in the floodplain, people residing in the 100-year floodplain provides a proxy for social impacts of flood events. The planning team calculated this variable by using census blocks that intersect with the 100-year floodplain, and then aggregating population from the census blocks to HUC-12s. Figure 24 shows greater population living in the floodplain in the northern portion of the watershed.

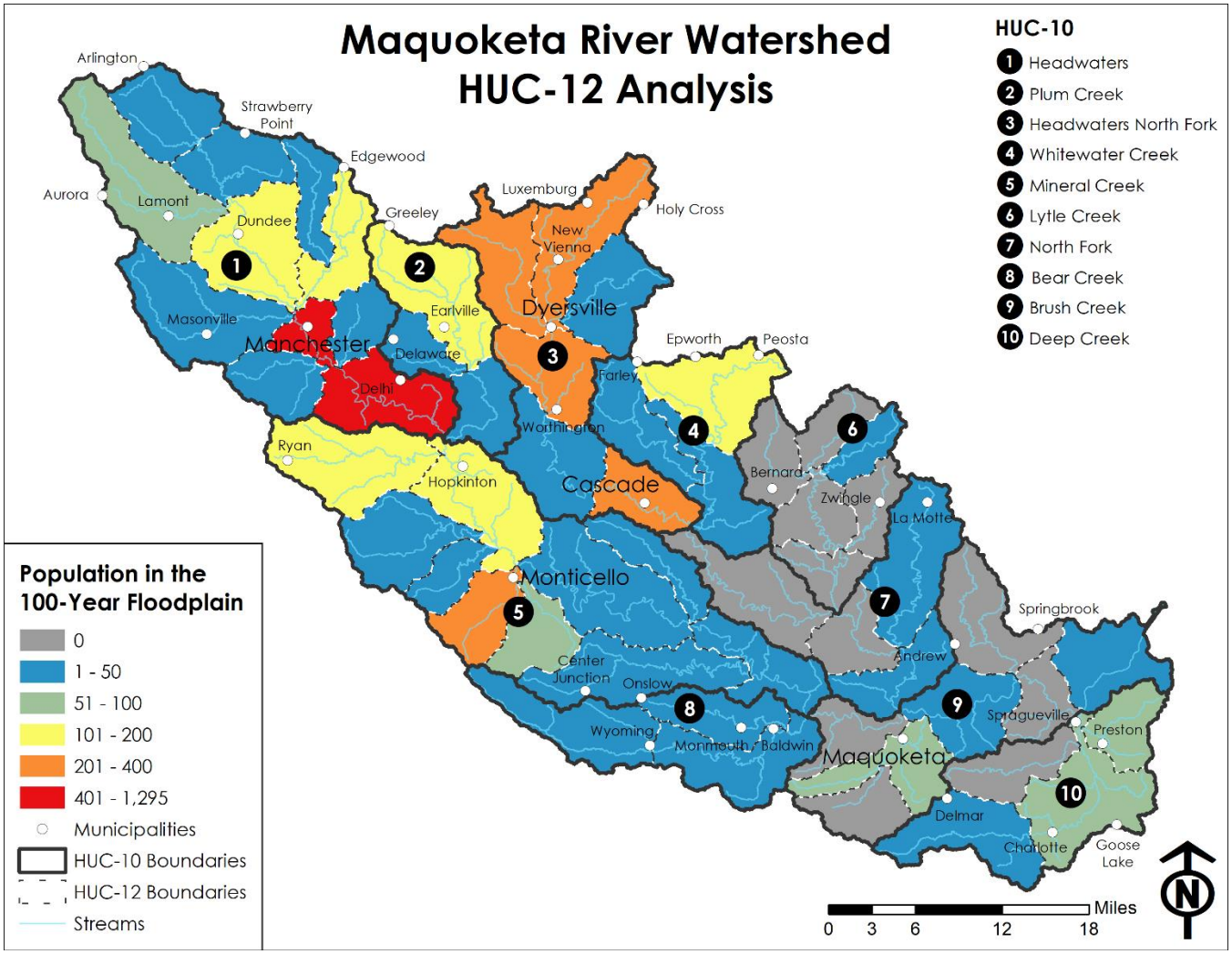


Figure 24: Map showing population in the FHA by HUC-12. (US Census, map by authors)

Existing best management practices (BMP)

Best management practices were mapped at the HUC-12 level for the entire state of Iowa in 2007-2010 by analyzing various LiDAR products and aerial imagery. A sample of HUC-12s was then chosen to create an inventory of BMPs present in the 1980s and 2016. The dataset created by the planning team used BMPs present in 2016 if the HUC-12 was included in the additional inventory mapping, while 2010 data were used for the HUC-12s that were not included in the additional inventory mapping. Figure 25 shows the number of buffer strips, grassed waterways, pond dams, strip cropping sites, terraces, and water and sediment control basins present in 2016.

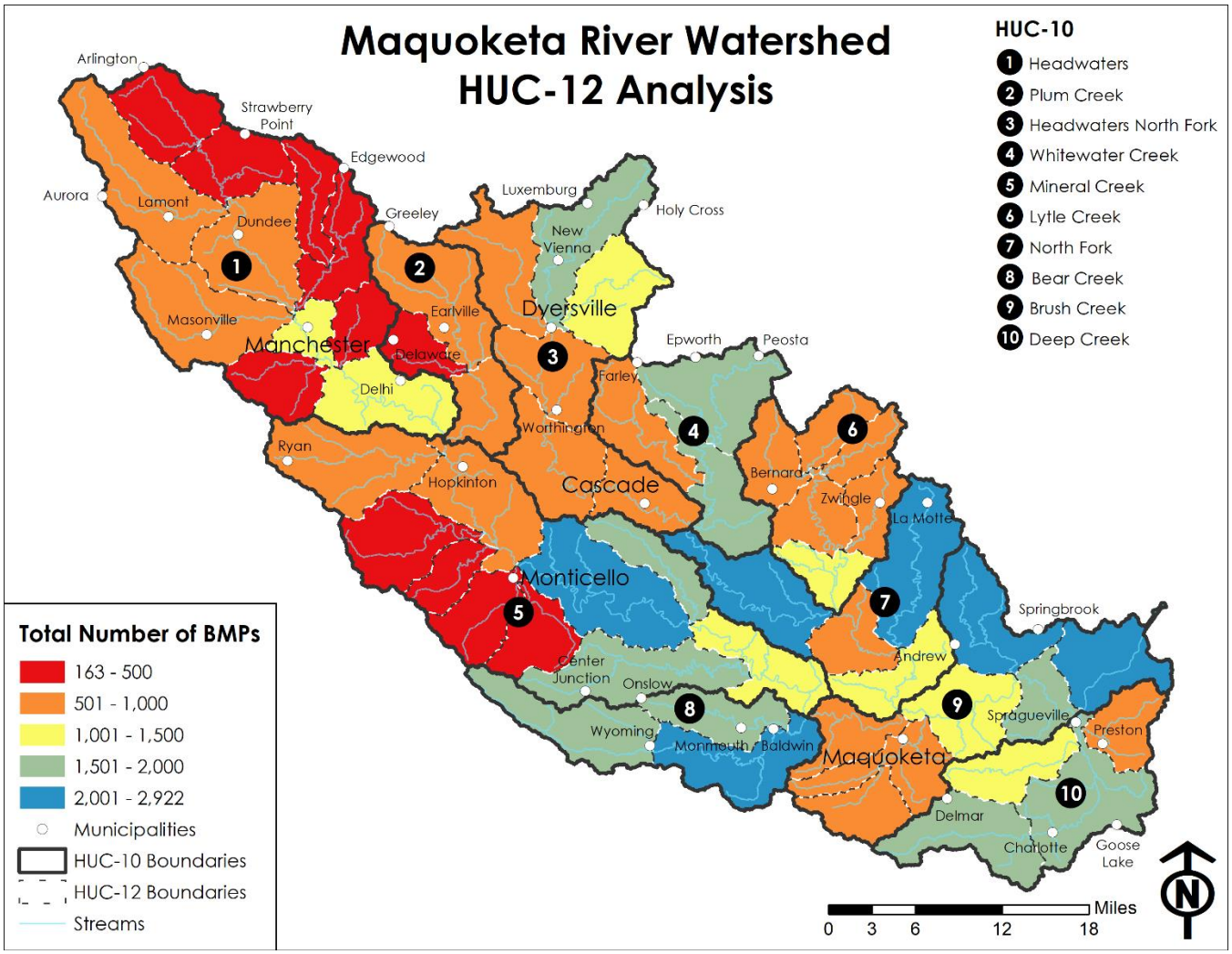


Figure 25: Map showing total number of existing agricultural best management practices by HUC-12. (IA BMP Mapping Project, map by authors)

Soil runoff (tons per acre)

Aside from the reducing soil productive, soil erosion can result in deteriorating water quality conditions. Nitrogen can be transported into waterbodies through surface water runoff and soil erosion. When high levels of nitrogen are present, eutrophication can occur, resulting in algal growth and lower levels of dissolved oxygen levels. This in turn results in increased turbidity, fish kills, and shifts in flora and fauna populations. Figure 26 shows the different levels of soil erosion in tons per year throughout the watershed, derived from the Revised Universal Soil Loss Equation (RUSLE). Bear Creek, Deep Creek, North Fork, Whitewater Creek, and Headwaters North Fork HUC-10s all contain HUC-12 sub-watersheds with high levels of soil loss.

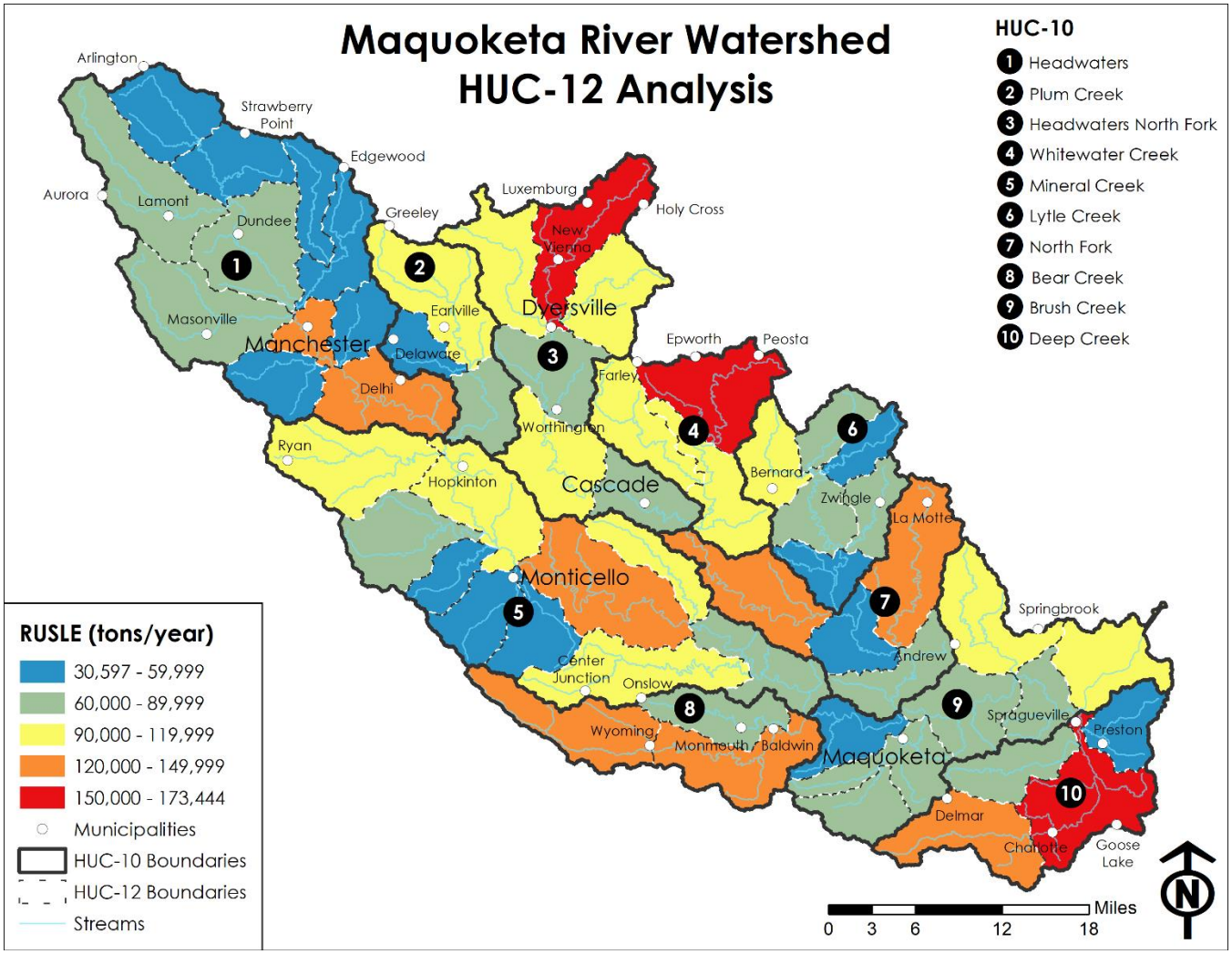


Figure 26: Map showing soil runoff risk by HUC-12. (RUSLE, map by authors)

Number of CAFOs and Water Treatment Facilities

Point source locations such as Confined Animal Feeding Operations and wastewater treatment facilities have the potential to add nutrients such as nitrogen and phosphorous to water sources. Since only facilities over a certain size are tracked by the IA DNR, these data are a proxy for water pollution from animals. Figure 27 shows the variation in animal agriculture operations across the MRW. HUC-12s in the Upper Maquoketa have generally higher numbers of CAFOs and Open Feed Lots than the Lower Maquoketa.

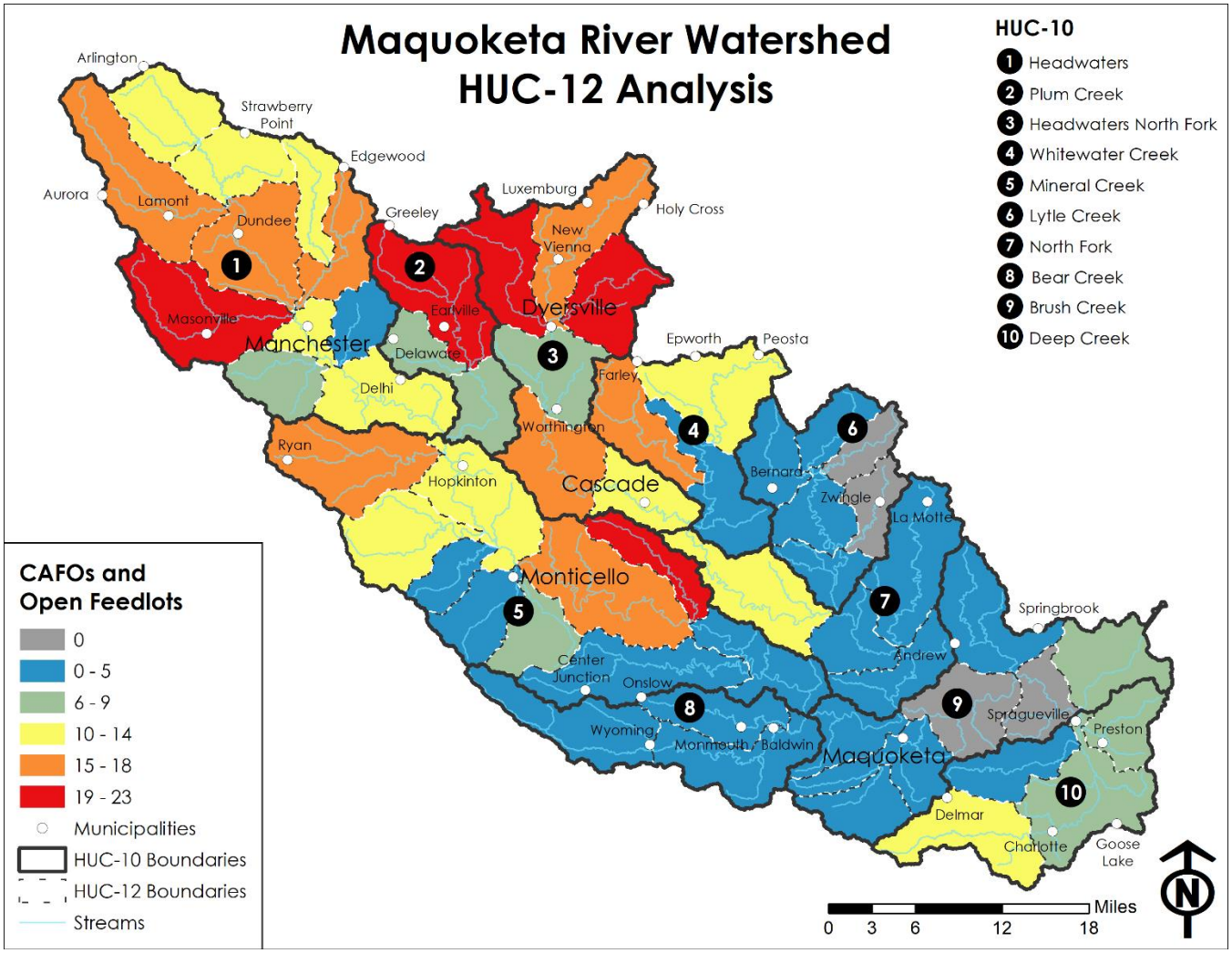


Figure 27: Map showing number of permitted CAFOs and Open Feedlots by HUC-12. (IA DNR, map by authors)

Monitored Nitrate (mg/L)

The MR WMA conducts water quality monitoring three times a year at 45 sites in the watershed. Testing for nitrates is included in the monitoring plan. Figure 28 shows a three-year average for nitrates displayed at monitoring catchment areas that closely mirror HUC-12 boundaries. Higher levels of nitrate are observed in the northern half of the MRW, with lower levels viewed in the southern half. 35 of 45 monitoring sites test above the statewide average of 5.5 mg/L. Additionally, 10 monitoring sites test above US EPA drinking water standard for nitrate of 10 mg/L.

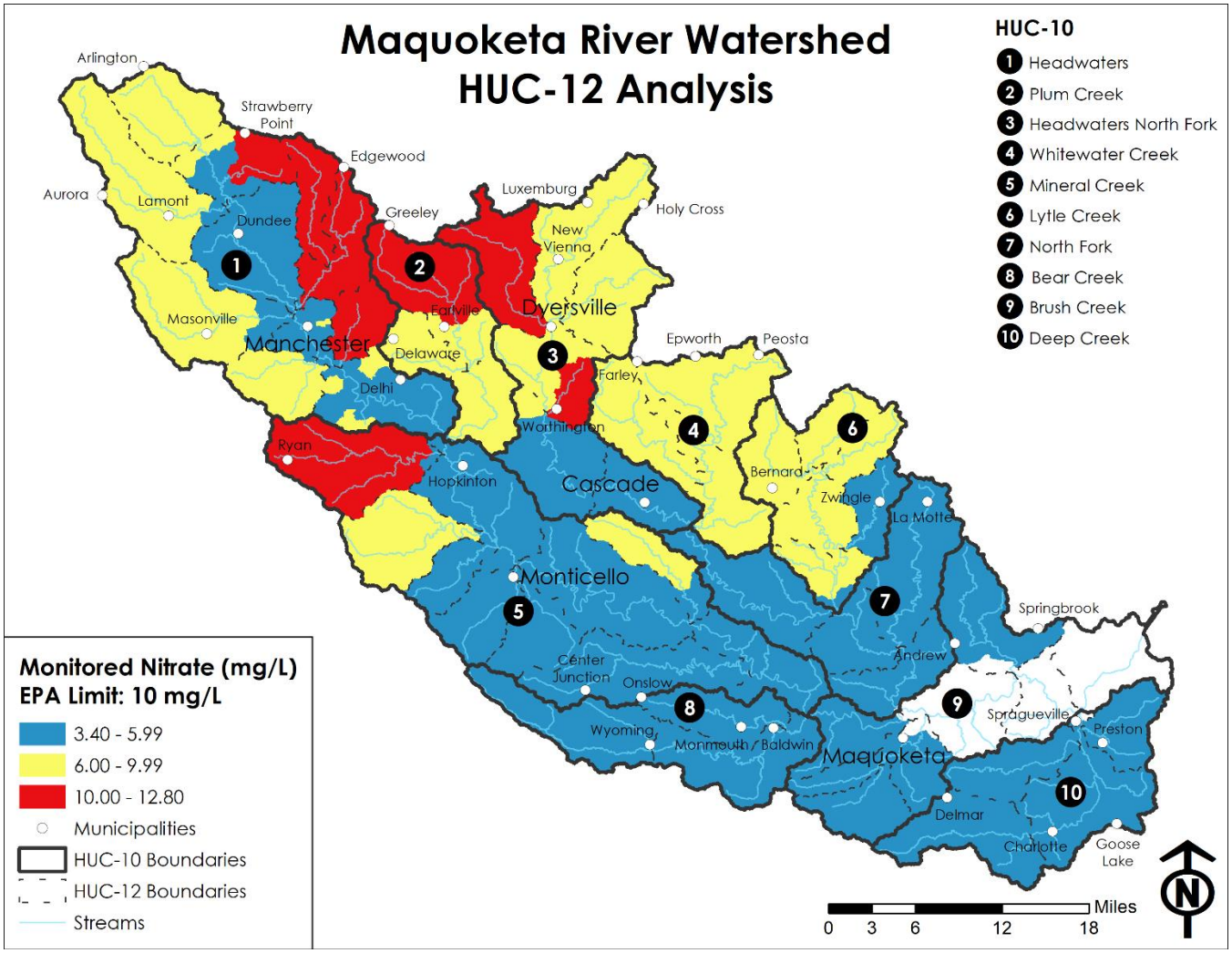


Figure 28: Map showing average monitored nitrates by HUC-12. (MR WMA, map by authors)

Number of susceptible active wells

The planning team used an Iowa DNR dataset that was developed for the Iowa Sourcewater Protection plan to map out public wells used for drinking water that are active and determined to be susceptible or highly susceptible to contamination. Subsurface layers like clay, till, and shale impede the movement of water and can be used to determine the probability of contaminants entering an aquifer. Iowa DNR determined that susceptibility to contamination can be based on the cumulative confining layer thickness above the aquifer. Susceptible wells have a confining layer thickness of less than 50 feet. Figure 29 shows the spatial distribution of active wells used for public drinking water that are susceptible to contamination.

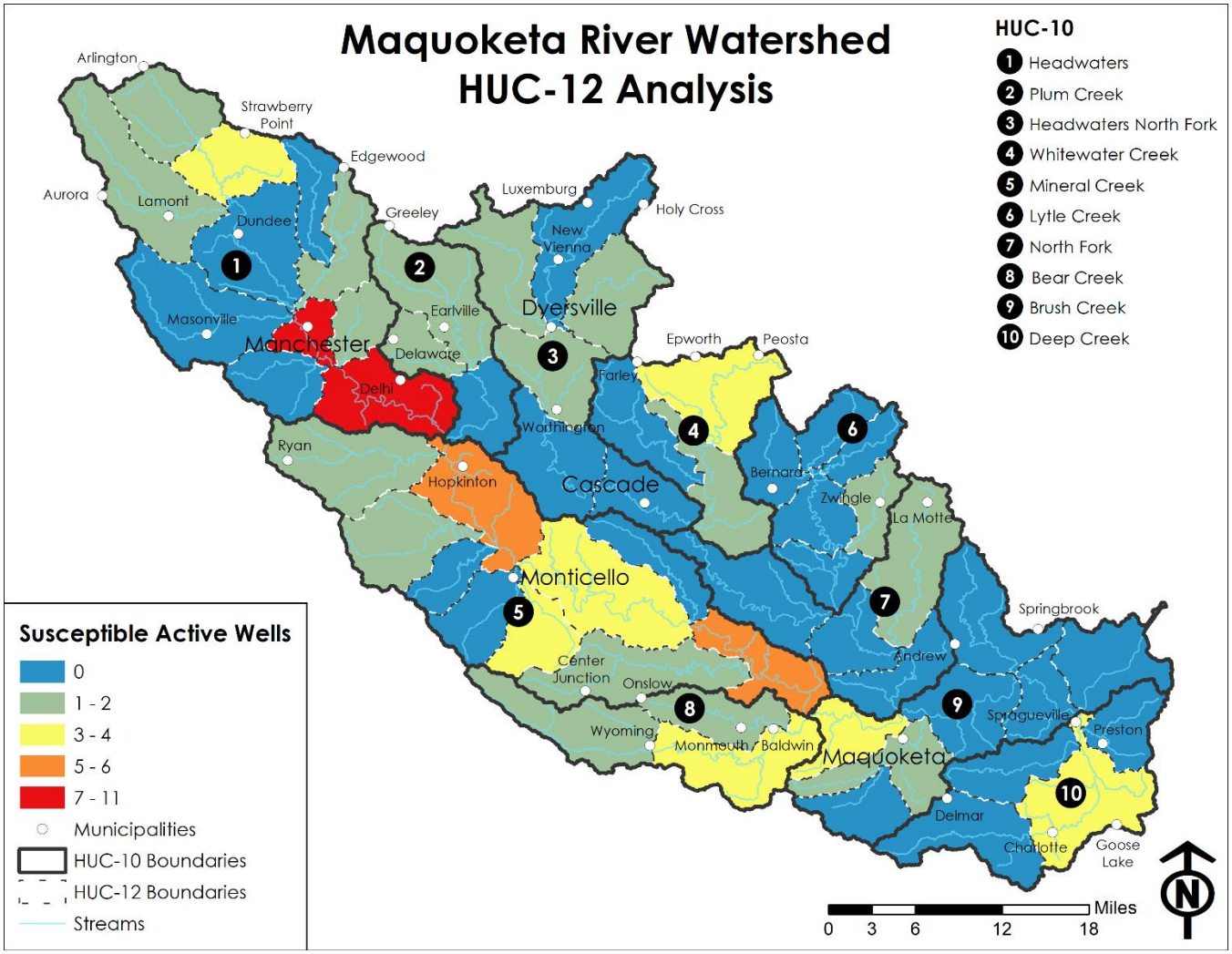


Figure 29: Map showing number of susceptible water wells by HUC-12. (IA DNR, map by authors)

Average Monitored Dissolved Reactive Phosphorus (mg/L)

The MR WMA conducts water quality monitoring three times a year at 45 sites in the watershed. Testing for dissolved reactive phosphorus is included in the monitoring plan. Figure 30 shows a three-year average for dissolved reactive phosphorus displayed at monitoring catchment areas that closely mirror HUC-12 boundaries. Higher levels are observed in the northeast portion of the MRW. 43 of 45 monitoring sites test above the statewide average of 0.1 mg/L.

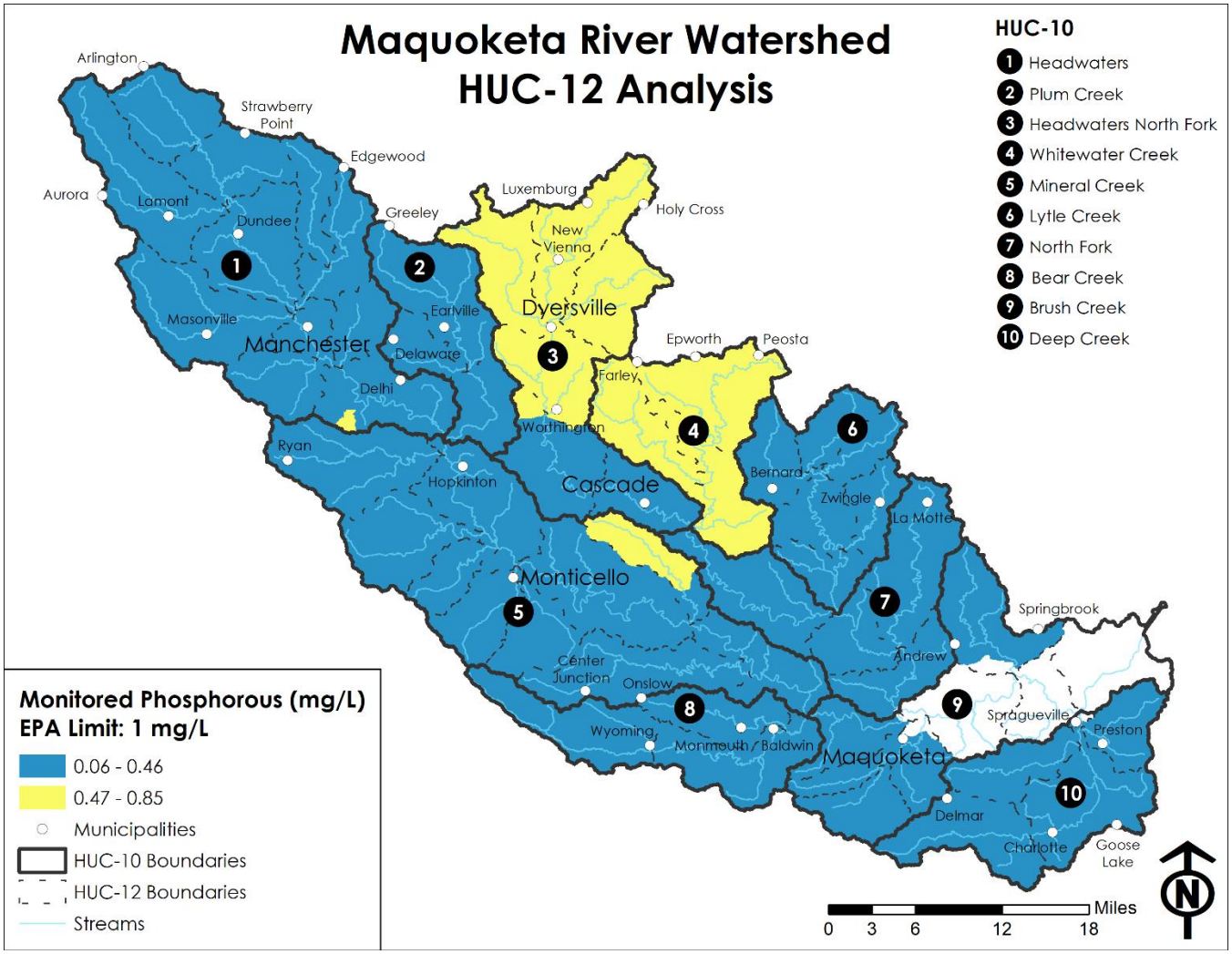


Figure 30: Map showing average monitored phosphorous by HUC-12. (MR WMA, map by authors)

Average Monitored Turbidity (NTUs)

The MR WMA conducts water quality monitoring three times a year at 45 sites in the watershed. Testing for turbidity is included in the monitoring plan. Figure 31 shows a three-year average for turbidity at monitoring catchment areas that closely mirror HUC-12 boundaries.

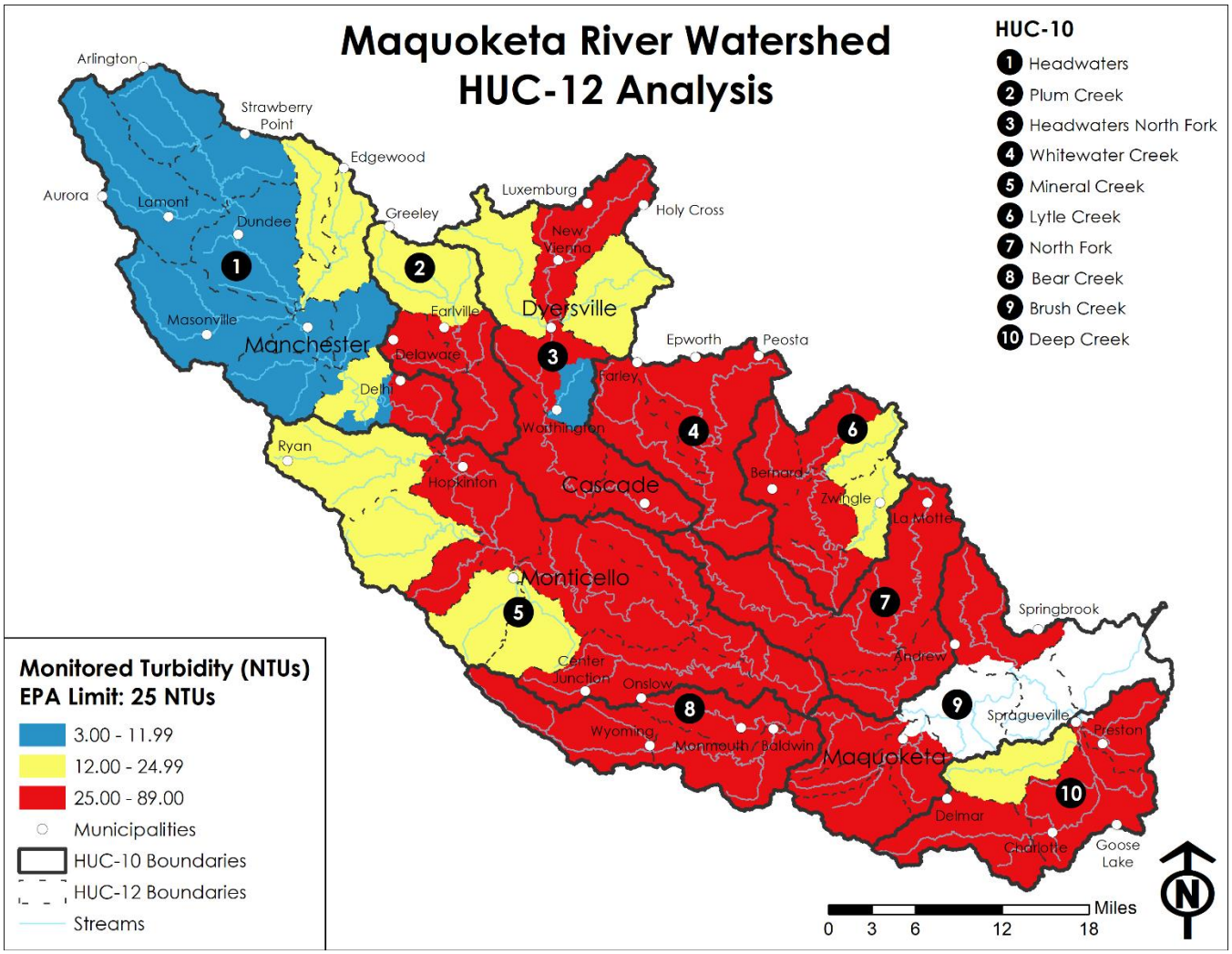


Figure 31: Map showing average monitored turbidity by HUC-12. (MR WMA, map by authors)

Miles of streams impaired by E. Coli

Waterbodies in Iowa have specific designated uses based on what they are commonly used for. This includes uses such as recreation, drinking water, or maintaining a healthy population of fish and other aquatic life. Figure 32 shows the miles of streams in each HUC-12 that has had designated uses impaired due to E. Coli, as outlined in the 2020 integrated report. HUC-12 sub-watersheds along major waterbodies, such as the Maquoketa River show higher levels of impairment due to E. Coli. It should be noted that there may be insufficient information available on all waterbodies to determine whether or not they are impaired, so it is possible that HUC-12 sub-watersheds showing no impairment are indeed facing similar issues with E. Coli.

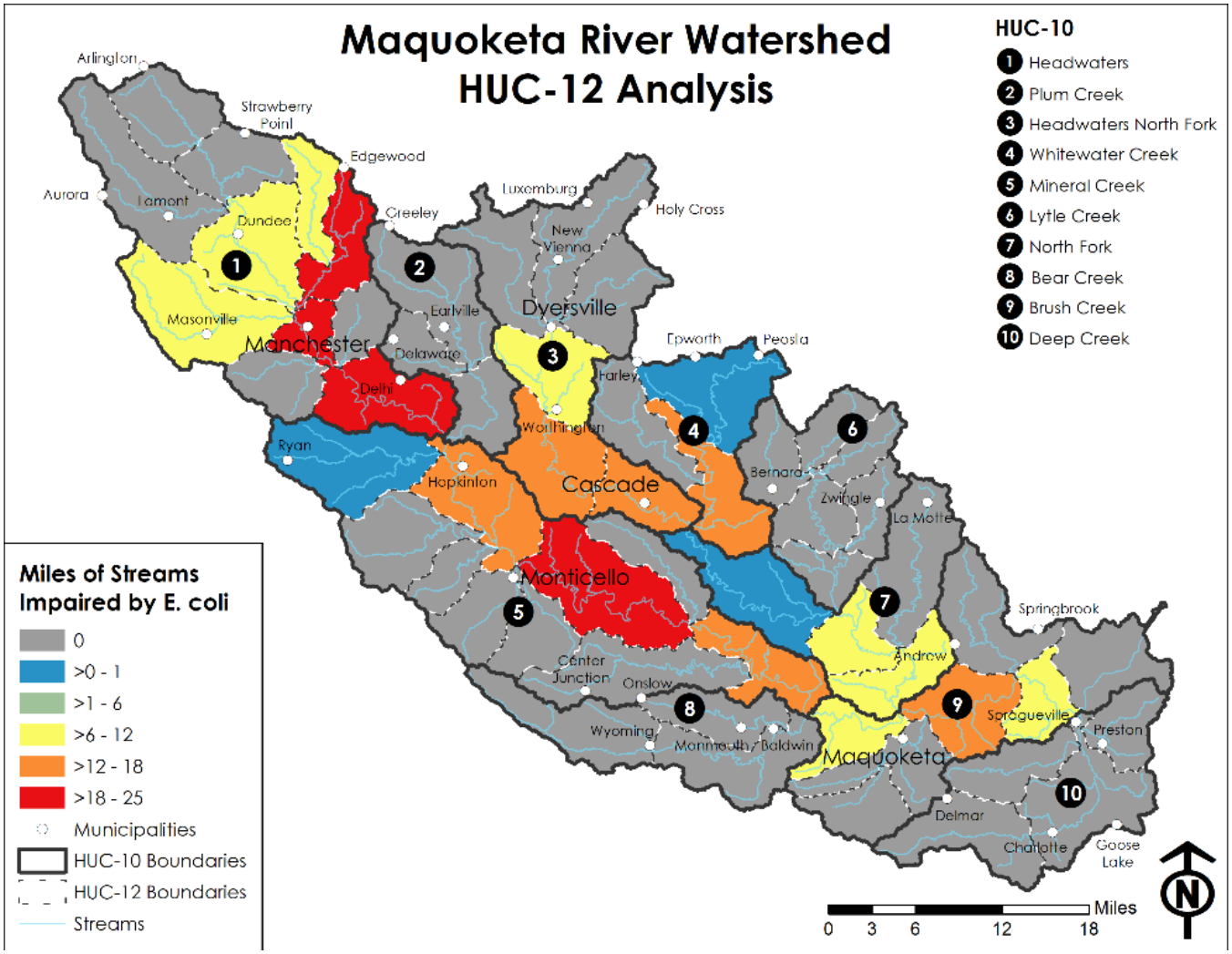


Figure 32: Map showing miles of E. Coli impaired streams by HUC-12. (IA DNR, map by authors)

Miles of streams impaired by fish kills

Waterbodies in Iowa have specific designated uses based on what they are commonly used for. This includes uses such as recreation, drinking water, or maintaining a healthy population of fish and other aquatic life. Figure 33 shows the miles of streams in each HUC-12 that has had designated uses impaired due to fish kill events, as outlined in the 2020 integrated report. HUC-12 sub-watersheds in the northeast part of the watershed show higher levels of impairment due to fish kill events. It should be noted that there may be insufficient information available on all waterbodies to determine whether or not they are impaired, so it is possible that HUC-12 sub-watersheds showing no impairment are indeed facing similar issues with fish kill events.

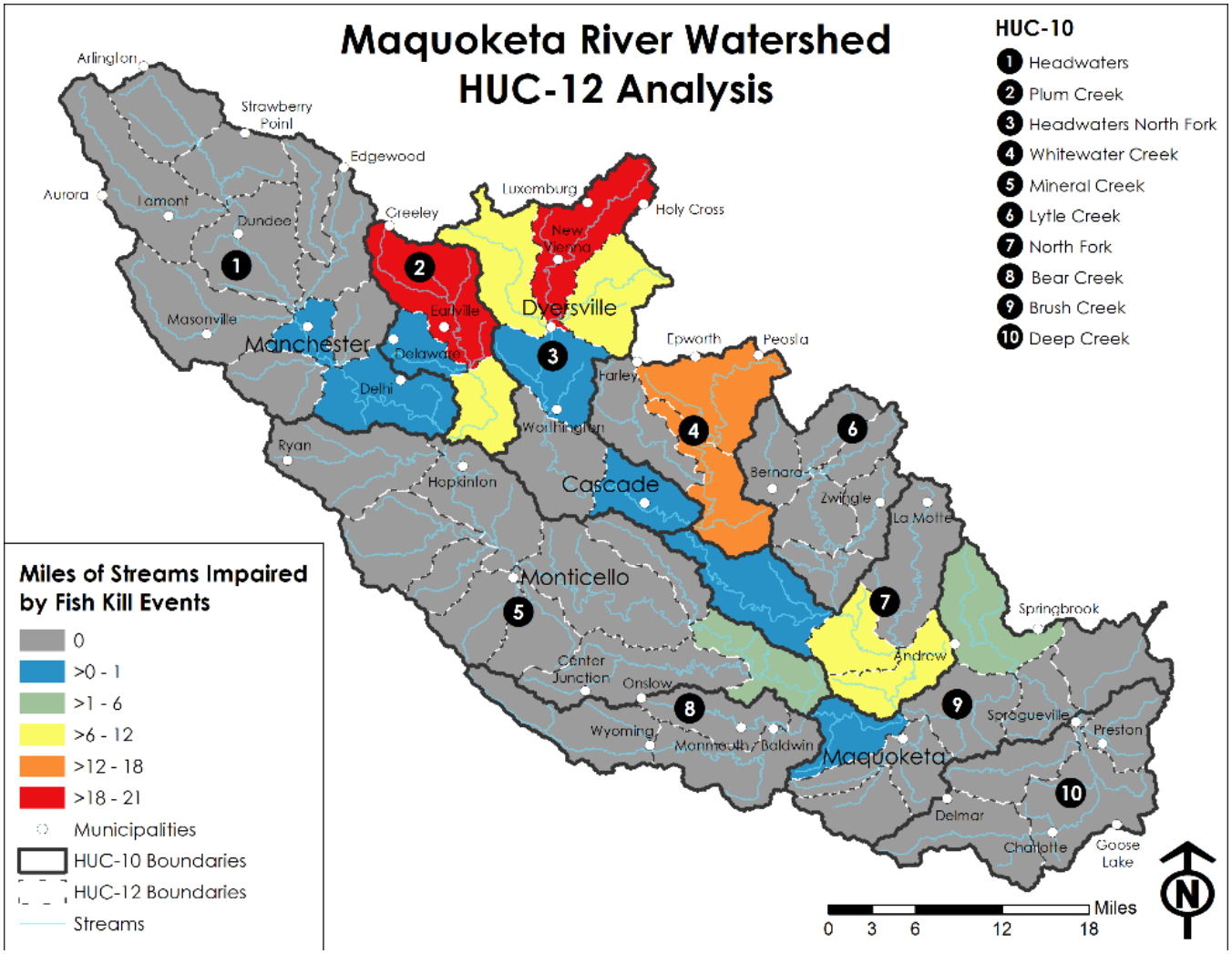


Figure 33: Map showing miles of fish kill impaired streams by HUC-12. (IA DNR, map by authors)

Miles of streams impaired by native mussel loss

Waterbodies in Iowa have specific designated uses based on what they are commonly used for. This includes uses such as recreation, drinking water, or maintaining a healthy population of fish and other aquatic life. Figure 34 shows the miles of streams in each HUC-12 that has had designated uses impaired due to the loss of native mussel species, as outlined in the 2020 integrated report. HUC-12 sub-watersheds along major waterbodies, such as the Maquoketa River show higher levels of impairment due to native mussel loss. It should be noted that there may be insufficient information available on all waterbodies to determine whether or not they are impaired, so it is possible that HUC-12 sub-watersheds showing no impairment are indeed facing similar issues with loss of native mussel species.

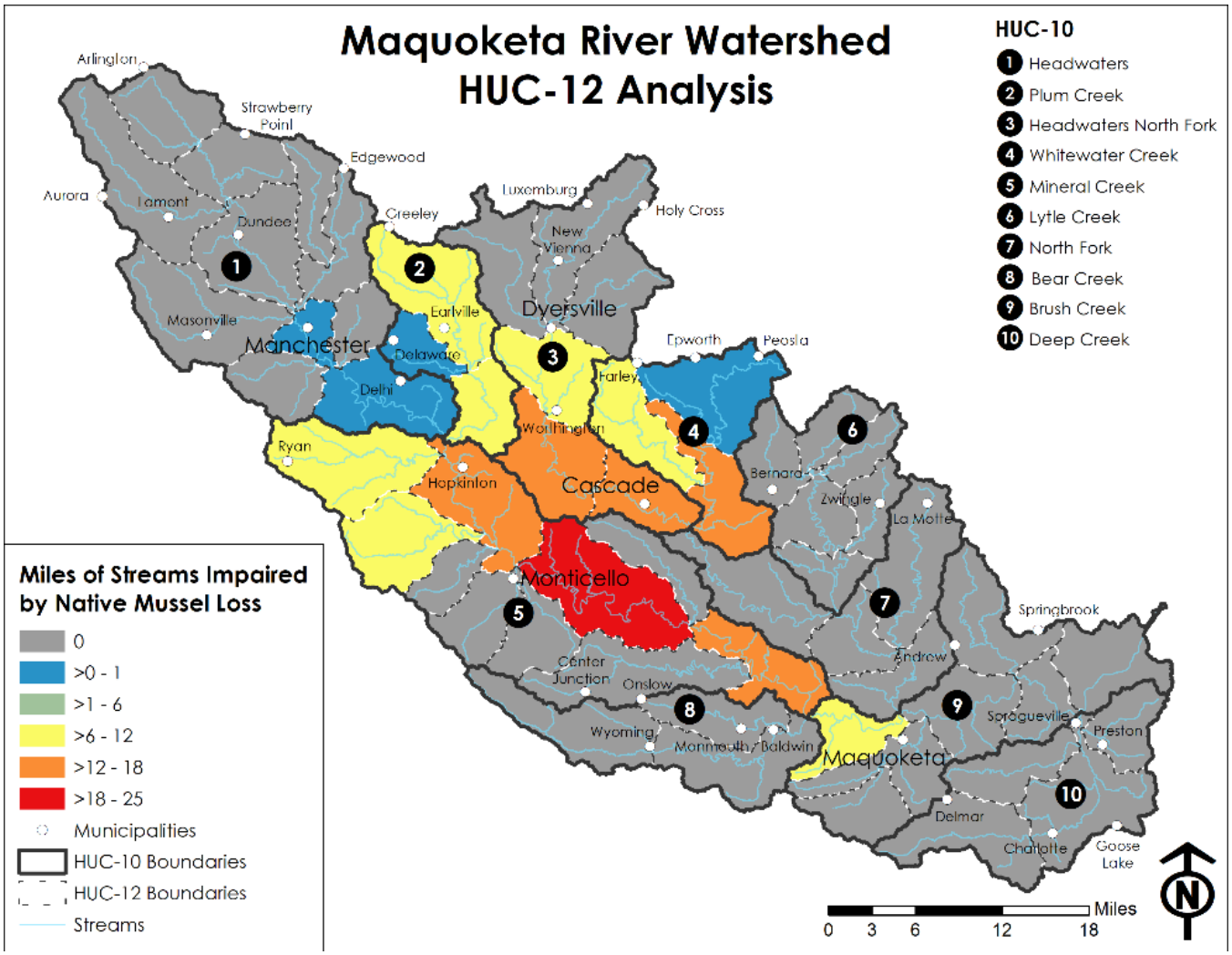


Figure 34: Map showing miles of fish kill impaired streams by HUC-12. (IA DNR, map by authors)

Percent of land that is hydrographic Group D soils

Soils can be characterized by their runoff and water infiltration potential into hydrographic groups assigned by USGS. Group A are sand soils with high infiltration and low runoff, group B are loamy soils with moderate infiltration, group C are fine-grained soils with low infiltration, and group D are soils containing clay, which have low infiltration and high runoff.[xi] Figure 56 maps the percent of each HUC-12 which is group D, where there is likely to be more runoff and phosphorous pollution. Higher percentages of these low-infiltration soils tend to be in the lower end of the watershed, as well as east of Manchester.

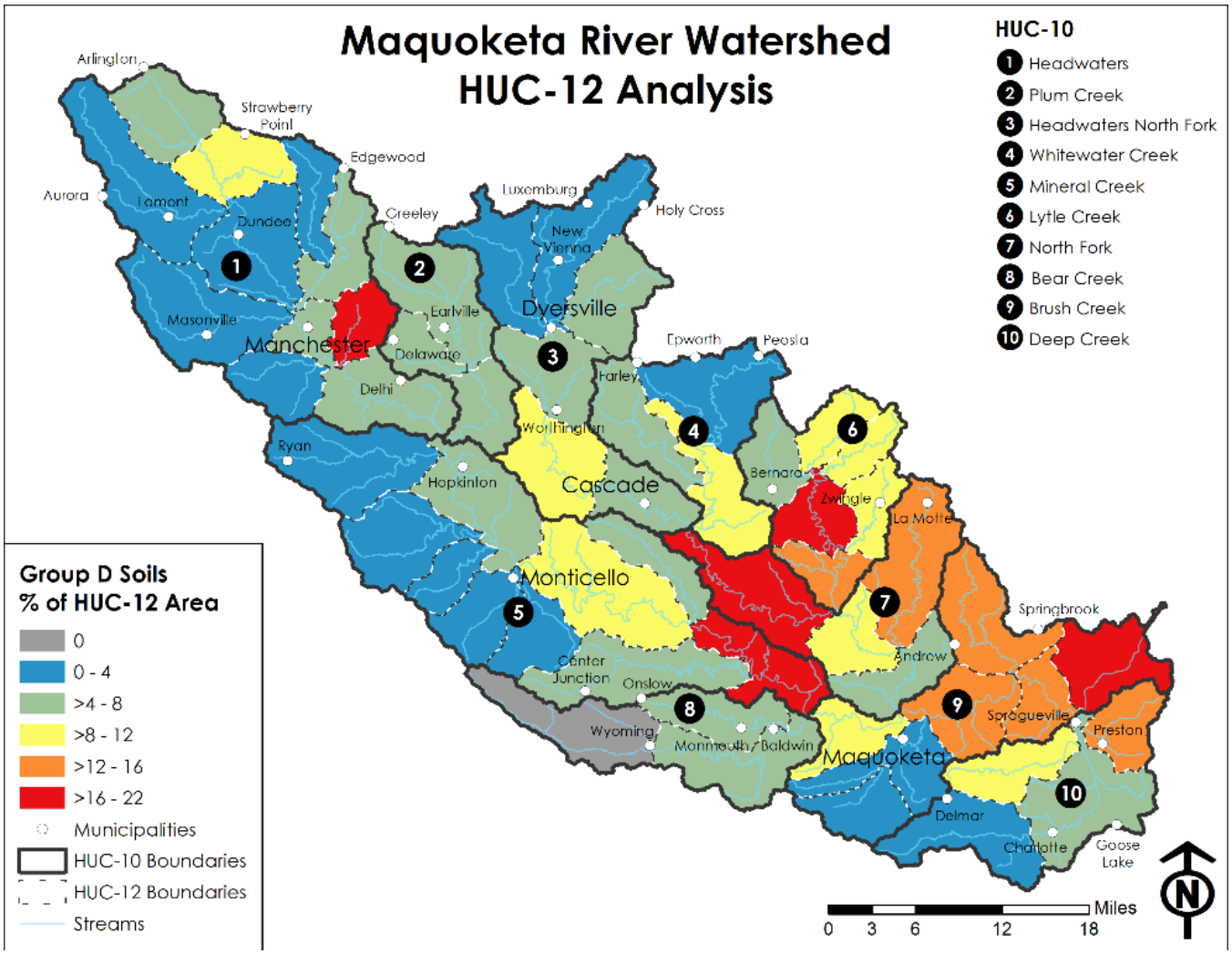


Figure 35: Map showing percent poorly draining soils by HUC-12. (USGS, map by authors)

Acres of wetlands

Wetlands provide opportunities for recreation including hunting, fishing, hiking, and wildlife watching. Figure 36 shows total acres of wetlands in each HUC-12. Greater acres of wetlands (shown in blue) are observed in HUC-12s located in the middle of the watershed, which lines up with the Maquoketa River.

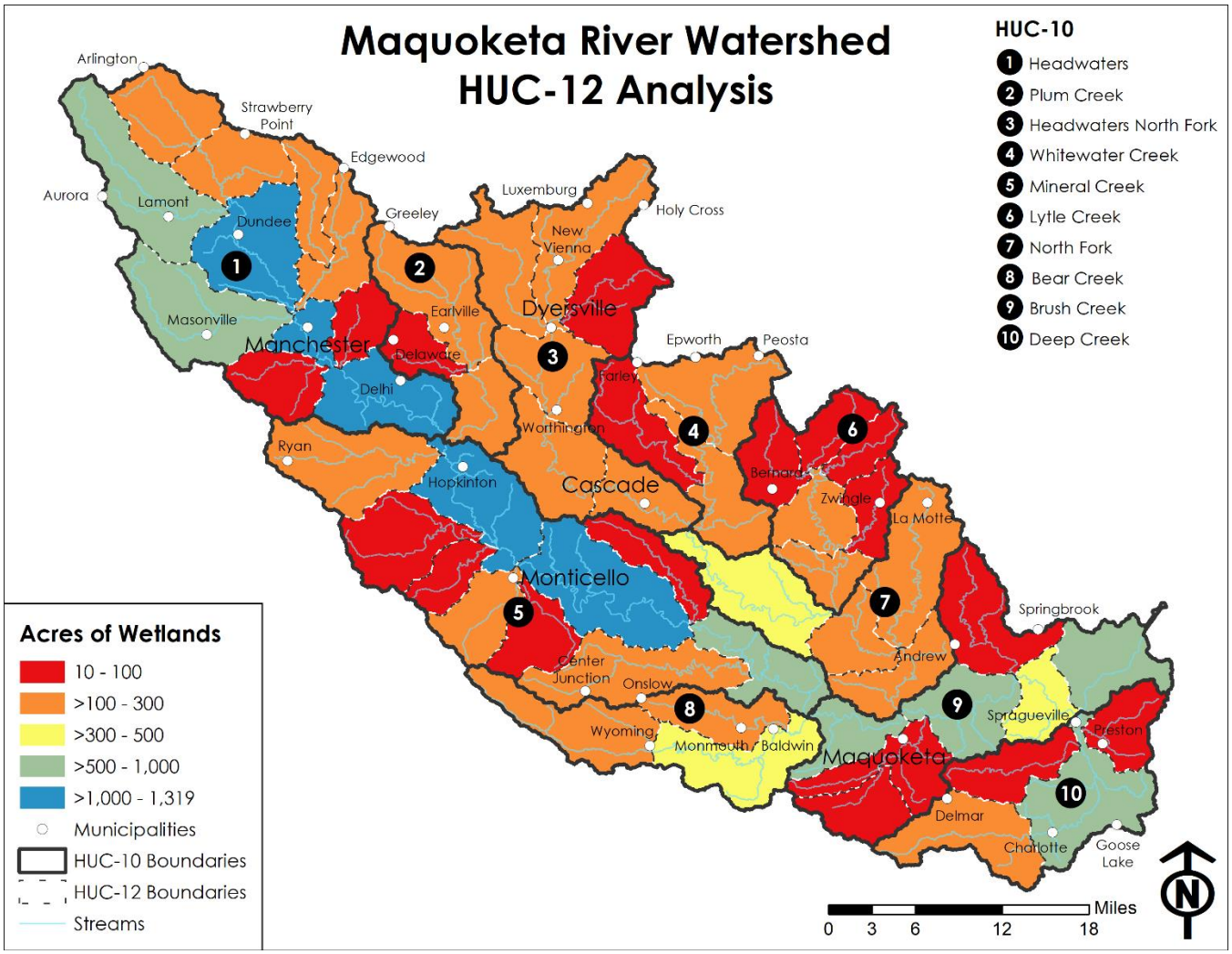


Figure 36: Map showing acres of existing wetlands by HUC-12. (IA DNR, map by authors)

Appendix B: Semi-structured Interview Questions

Farm Service Providers

1. What is your name and profession?
2. How long have you been a farm service provider and why did you choose to become one?
3. What is the role of a farm service provider and what sorts of services do you provide?
4. How have the services you provide changed over time?
   a. Has the emphasis on conservation practices changed as well?
5. How is watershed-level planning important to you?
   a. What would you like to get out of this process?
6. How many farms have you worked with in the MRW?
   a. Are they primarily small-scale farms or large-scale farms? Both?
   b. Family farms or more agri-business operations?
7. What is your main strategy to market your services?
   a. i.e. Do you go directly to farmers? Recommended by word-of-mouth? Work as an intermediary between suppliers and farmers?
8. How much do your services cost? How does this compare to average farm expenses?
9. What has the feedback been like from farmers that have adopted BMP?
10. What holds other farmers back from implementing BMP?
    a. Cost? Traditions? Lack of resources/knowledge?

Communities

1. How would you describe your community? Thinking of aspects such as demographics, history of development, government structure.
2. What are some assets of the water resources in your community?
3. What water-related issues, if any, have you identified in your community?
4. How is watershed-level planning important to you?
   a. What would you like to get out of this process?
5. Are you a member of the WMA?
   a. How involved are you and why or why not?
6. Have you implemented projects within the watershed?
   a. Did the project(s) focus primarily on flooding, water quality, or something else?
   b. Were there other benefits to the project (e.g. social, economic, recreational)?
7. Are there any projects that you would like to implement?
   a. What are constraints?
8. Does your community have any programs or policies on water infrastructure (e.g. stormwater runoff ordinance, retention requirements, or erosion and sediment controls)?
   a. What was the process like to adopt these? Or why have these not been adopted?
9. As a follow-up, would you be willing to note watershed project ideas of interest to your community on a document that we will send via email?

Appendix C: Model Plan Takeaways

MRWMA Phase I Plan (MR WMP)

During the 2020-2021 academic year, a team of 2nd year urban & regional planning students from the University of Iowa's School of Planning and Public Affairs (SPPA) created the first ever comprehensive watershed management plan for the Maquoketa WMA. The team reviewed existing plans from other WMAs in Iowa, researched best management practices, and conducted a variety of public engagement activities in order to develop these 5 goals:

1. Improve water quality through techniques for nutrient management, erosion reduction, and increased infiltration
2. Improve watershed flood management
3. Increase watershed awareness and involvement among stakeholders
4. Preserve, protect and improve ecologically sensitive habitats and ecosystems in the watershed
5. Establish the WMA as a trusted community resource

The plan acts as a guidebook and vision for the people and communities within the watershed, providing ways to mitigate flooding and improve water quality for the coming generations. Phase II is an action plan developed during the 2021-2022 academic year and used the Phase I plan as a base to build upon. Through technical analyses and public engagement, the planning team identified where and how to implement specific recommendations from Phase I.

Turkey River (TR WRP)

The Turkey River Watershed Resiliency Plan (TRWRP), developed by Northeast Iowa RC&D, is one of the go to model plans for WMAs in Iowa that are aiming to develop comprehensive plans that address flood reduction and water quality improvement. Some key takeaways from the TRWRP for the MRW Phase II Action Plan team as they developed the project scope include:

- Set metrics so that results can be quantitatively tracked over time to determine the success of the plan
- Specific, Measurable, Achievable, Realistic, Timely (SMART) Planning should be implemented by communities, particularly when using infrastructure improvements to improve watershed management practices
- Public engagement efforts were aimed at "key stakeholders," but lacked some diversity in the groups that were chosen to be a part of the planning process
- A budget section was included to breakdown different costs across objectives and the current funding status
- Communities were provided a list of potential projects that they would be interested in implementing, which helps determine feasibility

Upper Wapsipinicon River Watershed Resiliency Plan (UWR WRP)

The Northeast Iowa RC&D, on behalf of the Upper Wapsipinicon River WMA, developed this plan between February 2017 and July 2019 with the goal of addressing flooding and water quality concerns in the Upper Wapsipinicon River Watershed. It is similar in size to the Maquoketa River Watershed at 1,003,356 acres, with 85% percent of the land being used for agriculture. Given the proximity and similar characteristics to the

Maquoketa River Watershed, this plan provided valuable insight into what the MRW plan could look like as far as content and presentation. Some of the key takeaways from the UWRW plan that were considered while developing the Phase II action plan for the Maquoketa River Watershed are as follows:

- The plan's content is displayed on an interactive website using things like Story Maps, animations, and videos to add context, rather than just using a traditional static document
- Analyses were conducted by several different partners and then brought together, where they were considered independently and in relation to each other
    - This included Cover Crop Analysis, Iowa BMP Mapping Project, Agricultural Planning Framework Tool, Infrastructure Analysis, and a Hydrological Analysis
- Sub-watershed profiles and analysis to help prioritize areas within the watershed
- The plan is not intended to be implemented by a single entity, rather it is a blueprint for public and private investment, partnerships, and projects

English River Watershed Improvement & Resiliency Plan (ER WIRP)

This plan was adopted in 2015 with the goal of "engaging stakeholders and promoting water quality improvements in a cooperative manner that encourages voluntary action and collaboration." Key takeaways from the plan include:

- Emphasizes resident education and voluntary actions to make project happen that will help reduce flood impacts and improve soil and water quality
- Sub-watershed analysis at the HUC-12 level to identify priority areas for targeted implementation of cost-share funds
    - Sub-watershed priorities are ranked (low, medium, high, very high) for each issue and then given a cumulative score to determine overall priority
- Survey of landowners to determine future outreach and educational needs
- Recommendations are made for both urban and rural areas with the aim of achieving the goals outlined in the voluntary Iowa Nutrient Reduction Strategy

Appendix D: Analysis Methodology Research

The planning team researched watershed planning across Iowa and federal best practice guidance to determine the analysis methodology for this plan. The processes used in five resources, specific descriptions of their analysis methods, and a link to their websites are provided in Figures 37 to 41 below. Many of the steps, such as engaging stakeholders and setting goals, are common across resources and were included in both Phase I and Phase II of the MRW Management Plan. However, data layers used and prioritization methods differ by resource, as shown in Table 7 and described for each resource below. Table 19 also includes data layers to be gathered by a technical committee brought together by the MR WMA (which includes representatives from SCWDs, NRCS, IFC, IA DNR, University of Iowa, and MRW counties and cities).

Data Layers Used	US EPA	English River	Turkey River	Upper Wapsipinicon	Catfish Creek	Technical Committee
Watershed boundaries	X	X	X	X	X	
Hydrology	X	X	X	X		
Topography	X	X	X	X	X	
Soils	X	X	X	X	X	
Erodibility				X	X	X
Climate	X	X	X	X	X	
Habitat (wetlands, conservation easements, etc)	X	X	X	X	X*	X
Wildlife (endangered species list)	X			X		X
Land use/cover	X	X	X	X	X	
Land ownership				X	X	
Public park and trail locations					X	
Existing management practices	X	X		X	X	
Demographics	X	X	X	X	X	
Water quality standards**	X	X	X	X	X	X
Water quality monitoring results		X	X	X	X	X
Impaired waters list	X		X	X	X	
Point source polluters (CAFOs, water treatment facilities, etc)	X			X	X	
Non-point source polluters (animal units, applied fertilizer, urban runoff, etc)	X			X	X	X
Private wells				X	X	
Public wells					X	X
Measure of flooding (peak flood discharge, acres in FHA, etc)		X		X	X	X
Property and crop value in FHA				X	X	
Public infrastructure at flood risk				X	X	

*The Catfish Creek plan includes a manual habitat condition classification.
**Indicators measured differ by plan. The following is a comprehensive list across resources: ammonia, bacteria, chloride, dissolved oxygen, phosphorous, phosphate, pH, nitrogen, nitrate, sediment, sulfate, temperature, and turbidity.

Table 19: Comparison of data layers suggested or used in watershed planning resources. (authors)

US EPA Handbook for Watershed Planning

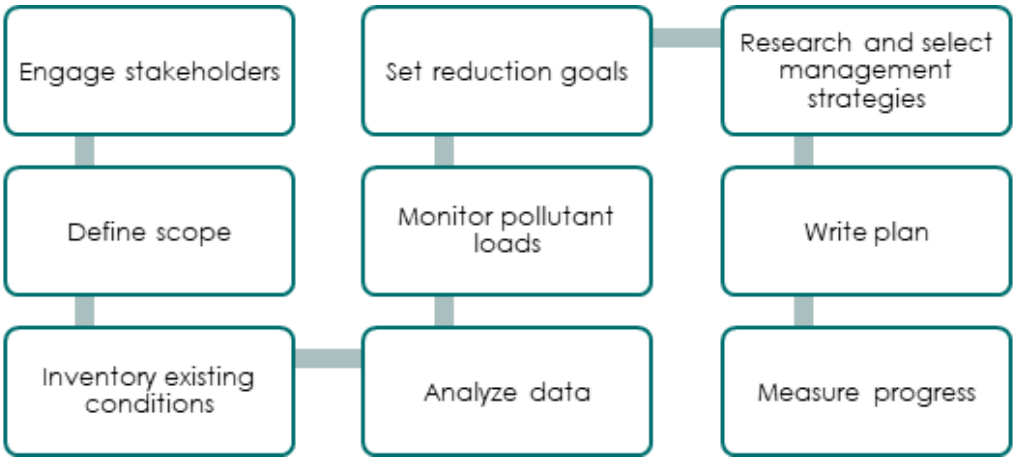


Figure 37: General process in the US EPA Handbook for Watershed Planning. (authors)

Data Analysis Process (various levels): The US EPA Handbook describes a general process for analyzing these data and questions to ask during the process. First, the scale of data analysis needs to be decided based in part on input from stakeholders. Then, summary statistics can be calculated at the chosen scale. If further analysis is needed into certain locations or water concerns, spatial – comparing different areas in the watershed – or temporal – comparing one area to itself at different times – analysis can be carried out. A spatial data analysis will identify upstream and downstream impacts of various practices while a temporal one will reveal patterns and relationships between watershed characteristics and concerns across time. This analysis step of the watershed planning process uses both GIS and visual analysis of the collected data to indicate what, where, and when there are causes of water-related issues.[xii]

English River Watershed Management Plan

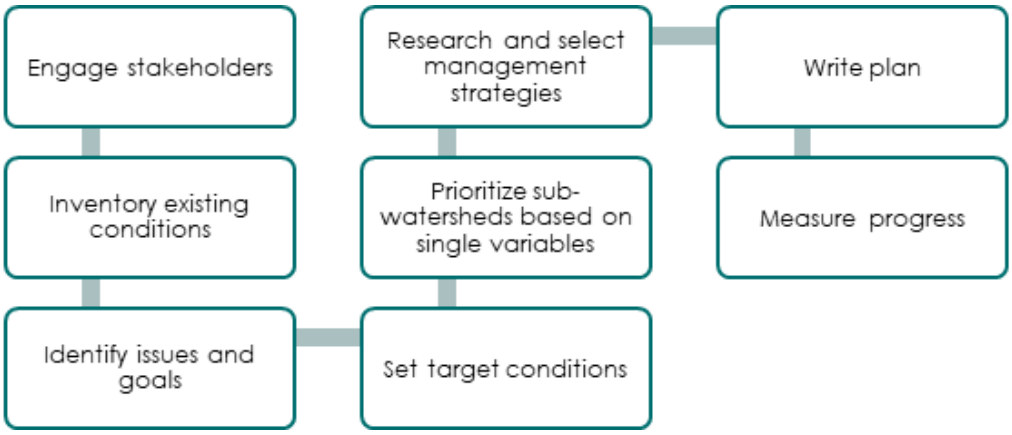


Figure 38: General process in the English River Watershed Management Plan. (authors)

Data Analysis Process (HUC-12 level): The English River WMA considered three main issues when prioritizing sub-watersheds: nitrates (as measured by average nitrate load), phosphorous (as measured by runoff of soil loss, which is closely tied to phosphorous loads), and flooding (as measured by mean annual flood chance). For each issue, they assigned each HUC-12 a value of 1 through 4 (lowest to highest priority) based on the variable associated with that issue, then added these values together. Thus, a HUC-12 which had the lowest nitrate load, soil loss runoff, and mean annual flood chance would

have a total score of 3 "low priority" and a HUC-12 with high nitrate loads, soil loss runoff, and mean annual flood chance could have a total score as high as 12 and be categorized as "very high priority."[xiii]

Turkey River Watershed Management Plan

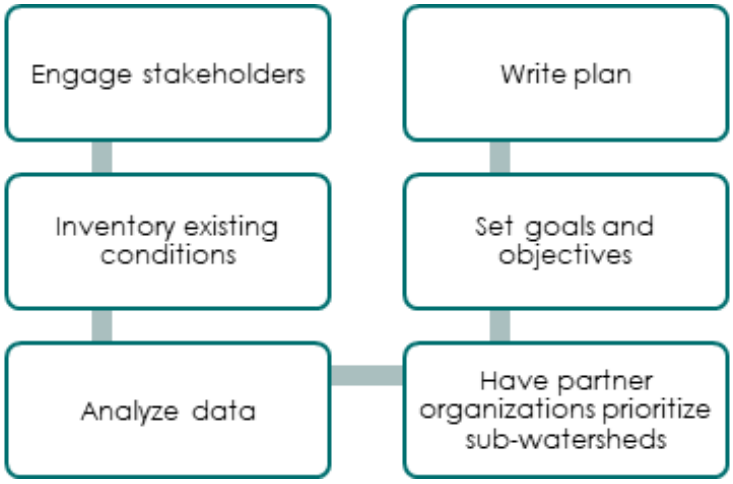


Figure 39: General process in the Turkey River Watershed Management Plan. (authors)

Data Analysis Process (HUC-12 level): The Turkey River Watershed Management Authority partnered with several outside agencies to conduct their sub-watershed data analysis and prioritization. The local NRCS office completed a Rapid Watershed Assessment, which describes the physical, water quality, wildlife, and resource concern characteristics of the entire watershed. The IFC used hydrological models to simulate the effects of different management practices on flooding throughout the watershed. Lastly, the planning team carried out additional spatial analysis using GIS for issues not covered by the NRCS or IFC.[xiv] This identified several additional patterns, including potential project locations based on benefits and community willingness and priority HUC-12s based on water quality monitoring results and IFC guidance.[xv]

Upper Wapsipinicon Watershed Management Plan

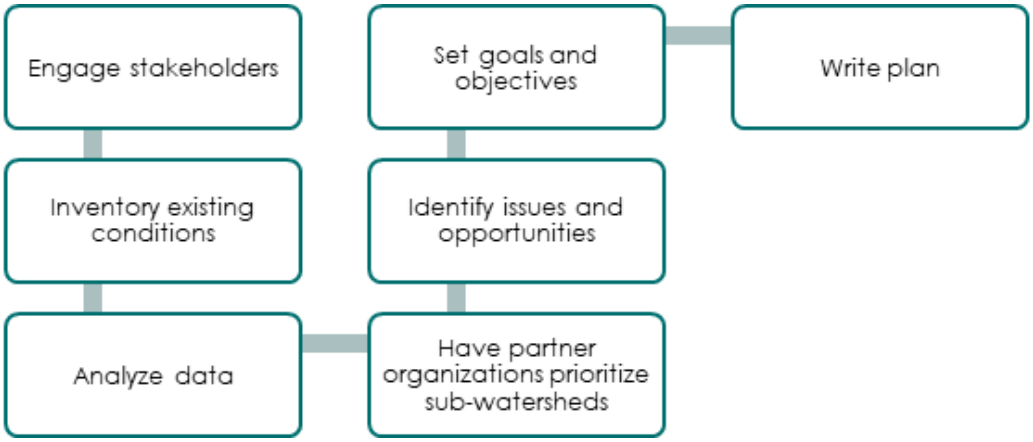


Figure 40: General process in the Upper Wapsipinicon Watershed Management Plan. (authors)

Data Analysis Process (HUC-12 level): During the planning process, outside organizations partnered with the Upper Wapsipinicon Watershed Management Authority to perform various analyses that revealed patterns and priorities across the watershed. Organizations involved included NRCS, IFC, and the University of Iowa. Their

analyses mapped the following topics at the HUC-12 level: percentage of acres in cover crops; percentage of acres using structural best management practices; percentage of acres that are potential management practice sites (according to the Agricultural Conservation Planning Framework); bridges at risk of flood damage; a hydrological assessment by the IFC; and spatial results of water quality monitoring data for bacteria, chloride, nitrates, phosphorous, sediment, and sulfates. Although these did not result in a single list of priority sub-watersheds, the plan states that this information, included in profiles of each HUC-12, "can be used to help guide prioritization."[xvi]

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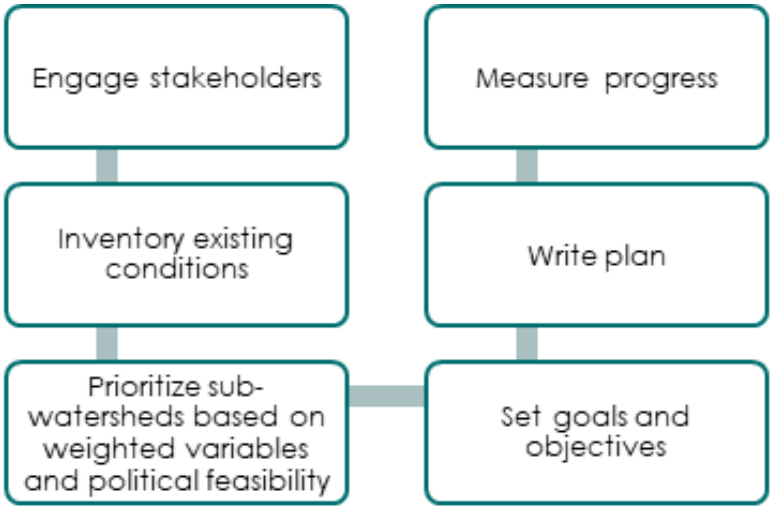

Figure 41: General process in the Catfish Creek Watershed Management Plan. (authors)

Data Analysis Process (HUC-12 level): This plan used stakeholder input and existing conditions to identify five general issue categories on which to rank sub-watersheds: surface water quality, public risk of flooding, private risk of flooding, groundwater contamination risk, and stream/land use characteristics. Within these five categories, 16 metrics were ranked in importance by stakeholders, and given weights based on these rankings (see Table 20). For example, within the private flood risk category, property values in the 200-year floodplain were given a higher weight than crop value in the 100-year floodplain and private wells in the 200-year floodplain because stakeholders found private property loss to be the most important flooding risk to private land. The planning team then applied the determined weights to data layers collected for the metrics and ranked all 28 HUC-12s within the watershed from 1 to 28 for each issue and calculated a composite score across issues. This process used stakeholder input to create a weighted multi-variate analysis that prioritized sub-watersheds and resulted in an overall priority area list.[xvii]

Ranking Category	Ranking Category Weighting Factor	Ranking Criteria Weighting Factor	Ranking Criteria
Surface Water	25%	10%	Sediment yield by HUC-12 watershed normalized to the project area [assessment completed on tons/ac/yr] that identifies export based on the RUSLE
		5%	Total Phosphorus yield by HUC-12 watershed normalized to the project area [assessment completed on lbs/ac/yr] that identifies export based on the RUSLE
		10%	Total Nitrogen yield by HUC-12 watershed normalized to the project area [assessment completed on lbs/ac/yr] that identifies export based on the RUSLE
Public Flooding	25%	10%	Number of county-managed roadway culverts and bridges by HUC-12 based on the perennial stream network prepared for the ACPF model
		10%	Number of county-managed trails culverts and bridges by HUC-12 based on the perennial stream network prepared for the ACPF model
		2.5%	The number of public wells located within the 200-year flood plain, depth of flooding or well embankment not considered, potentially at risk of inundation.
		2.5%	The number of public parks at risk of inundation with a 200-year flood event
Private Flooding	25%	13.5%	Estimated private property losses in dollars with a 200-year flood event (based on the Hazus II model - model completed by IHSEM)
		2.5%	Private well inundation risk to the 200-year flood event
		10%	Crop loss risk to the 100-year flood event as a percent of the HUC-12 watershed
Groundwater	12.5%	4.17%	Percent of HUC-12 area within a Groundwater Capture Zone (source water capture zone identified by the Iowa DNR).
		4.17%	Percent of alluvial aquifer within a HUC-12 with areas with greater potential for surface water infiltration (zones of potential groundwater contamination risk).
		4.17%	Area by percent of HUC-12 with Surface Contamination Risk by Agricultural Drainage Well or Sinkhole
General	12.5%	4.17%	Number of impaired stream reaches per the Iowa DNR 2016 303(d) assessment (2018 303(d) not available at the time of the assessment)
		4.17%	Percent of watershed in row cropping where there is a greater risk of sediment and nutrient loss at the landscape scale.
		4.17%	Stream density within the watershed (miles of stream per square mile of watershed) is a surrogate for runoff risk of a pollutants as a relative distance to a stream

Table 20: Metrics and weighting used for prioritization in the Catfish Creek Watershed Management Plan. (Dubuque County Watershed Planning, 2014)

Appendix E: Model Ordinances

Several recommendations in this plan include voluntary project and policy implementation. One policy many communities expressed interest in is stormwater management regulations. The ordinance from Johnson County, Iowa is one model governments in the Maquoketa River Watershed could adopt. The stormwater management regulations are found in Chapter 8:3.6 of their Unified Development Ordinance, available for download here. This ordinance was chosen for its simplicity, length, and references to the state of Iowa's Stormwater Management Manual, which would make it easy to apply in a local context without much editing. Dubuque County also has a robust stormwater ordinance which cities within their boundaries can adopt in full.

Communities may also be interested in signing intergovernmental agreements, called a 28E Agreement in Iowa, to construct a conservation project in one jurisdiction that is paid for or owned by another. A recent example for a creek restoration project done by a water treatment entity on land under easement to the City of Des Moines can be downloaded here. This gives an example of the format and information to include on a project-specific 28E Agreement between cities, counties, water managers, or other local jurisdictions.

Appendix F: Technical Manual for HUC-12 Sub-Watershed Analysis

Introduction

This manual is a general guide to how the planning team conducted the HUC-12 sub-watershed analysis for Phase II of the Maquoketa River Watershed Management Plan. Enough context is provided so that the WMA can duplicate the analysis when the plan needs to be updated. It should be noted that additional steps may be necessary for individual datasets, but this manual provides a rough idea of how the planning team completed their analysis.

1. Data Collection

The planning team collected secondary data from expert sources for the chosen variables related to each of the four key issues, as shown in Table 21. Important considerations included the spatial extent of the data and the time period that it covered. For example, the planning team wanted to analyze the spatial distribution of manure application across the watershed. The available datasets were all at the county level though, making it impossible to accurately display at the HUC-12 level. The WMA should continue to use the most up to date data when replicating the analysis in order to accurately prioritize sub-watersheds.

2. Data Cleaning and Preparation

The planning team cleaned and prepared the data for analysis in a number of different ways depending on the dataset. Fortunately, most of the data collected required little cleaning or preparation and was already in shapefile format, meaning it could be uploaded to a GIS immediately. Variables that had data stored in spreadsheets, such as the RUSLE data, had to be reformatted and saved as CSV files to upload into a GIS. Easily recognizable file names were selected to distinguish between variables. Once all the data was in the proper format and file types, it was loaded into ArcGIS.

3. Data Analysis

Once loaded, the planning team examined the data to ensure its integrity. Tabular data, like population, was joined to an existing polygon shapefile based on a shared attribute. If needed, polygon and line datasets were clipped down to an area of interest, such as the 100-year FHA (i.e., population in the FHA). Data was then clipped to the individual HUC-12 sub-watershed boundaries within the Maquoketa River Watershed using an iterator. Area or length, depending on the dataset, was then calculated and each feature was assigned the appropriate HUC-12 number. The data was then merged back together and dissolved based on HUC-12, with attributes being summed. The team then joined the data, based on attributes to the HUC-12 polygon shapefile, with the HUC-12 number being the shared attribute. Depending on the dataset, the field in question (i.e. area) was displayed immediately or further calculations were completed using the field calculator (i.e., percent of HUC-12 area).

Point datasets were spatially joined to the polygon HUC-12 dataset, with the sum being calculated. For example, to see the number of CAFOs in each HUC-12, the CAFO point shapefile was spatially joined to the HUC-12 polygon shapefile. The output

shapefile shows the HUC-12 boundary polygons and contains a count of the number of CAFOs in each HUC-12.

4. Mapping

Data for each variable was classified into five classes using an equal interval classification and adjusted for readability. Data was then displayed with a color scheme that transitioned from blue to red, blue being "low priority" and red being "high priority" (which of these are higher numbers depended on the variable, i.e. red for low acres of wetlands but red for high population in the FHA). This presents the data in a way that clearly shows the variation of each dataset across the watershed and makes it easier to identify trends between HUC-12s.

Flooding Metrics	Data Sources
Percent of area that is impervious surfaces	2019 NLCD Developed Imperviousness
Acres of public conservation and recreation land	IA DNR: Public Lands Used for Conservation and Recreation in Iowa
Total parcel value in the FHA	Various County Assessors
Total crop value in the FHA (3-year average of corn and soybeans)	USDA Agricultural Land Use by Field
Total population in the FHA	Various County Assessors
Number of existing management practices	Iowa BMP Mapping Project
Nitrate Pollution Metrics	**Data Sources**
Tons per acre of soil runoff	RUSLE data from IIHR Online Data Portal
Number of CAFOs and water treatment facilities	IA DNR via Facility Explorer
Average monitored nitrate concentrations	Maquoketa River WMA water quality monitoring
Number of susceptible active wells	IA DNR via Iowa Geospatial Data
Number of existing management practices	Iowa BMP Mapping Project
Phosphorous & Soil Loss Metrics	**Data Sources**
Tons per acre of soil runoff	RUSLE data from IIHR Online Data Portal
Number of CAFOs and water treatment facilities	IA DNR via Facility Explorer
Percent of acreage in hydrographic group D soils	SSURGO via USDA Web Soil Survey
Average monitored phosphorous concentrations	Maquoketa River WMA water quality monitoring
Average monitored turbidity	Maquoketa River WMA water quality monitoring
Number of existing management practices	Iowa BMP Mapping Project
Diminished Recreation Metrics	**Data Sources**
Miles of streams impaired by E. Coli	IA DNR: 2020 Impaired Streams of Iowa
Miles of streams impaired by fish kills	IA DNR: 2020 Impaired Streams of Iowa
Miles of streams impaired by native mussel loss	IA DNR: 2020 Impaired Streams of Iowa
Acres of wetlands	IA DNR: National Wetlands Inventory
Acres of public conservation and recreation land	IA DNR: Public Lands Used for Conservation and Recreation in Iowa

Table 21: Data sources for metrics used in HUC-12 sub-watershed analysis. (authors)

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