Middle Cedar Watershed Management Plan

2020
2040

EOR water ecology community

IOWA SOYBEAN Association

FYRA ENGINEERING

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Planning team and partners (Photo Credit: IVRCD)

EXECUTIVE SUMMARY

The Middle Cedar Watershed Plan

The Middle Cedar Watershed (MCW) is one of eight watersheds to receive funding through the Iowa Watershed Approach project (IWA) for developing and implementing a watershed management plan. The initial funding serves as a jump starter for the Middle Cedar Watershed Management Authority (MCWMA) to develop a solid plan that is both sustainable and achievable. During the process, an initial hydrological assessment for the watershed was conducted by the University of Iowa IIHR-Hydroscience & Engineering and the Iowa Flood Center. Their findings show that precipitation in Iowa has increased since the 1970s and stream flow is increasing and becoming more variable in the watershed as a result of changes in land use and climate change. The Iowa Department of Homeland Security and Emergency Management (HSEMD) coordinated with the University of Iowa's Flood Resilience Team for the development of a watershed-based risk assessment. This risk assessment and the associated planning components are consistent with the methodology required in the Federal Emergency Management Agency's Local Hazard Mitigation Planning Guidance.

Watershed Assessment

The MCW is a HUC-8 watershed covering 2,400 square miles in East Central Iowa and spanning 10 counties with 48 cities. The MCW comprises 68 HUC-12 subwatersheds. The land is mostly covered by agricultural fields (74%) with a few urban areas. Eighty percent of watershed residents get their water supply from high quality aquifers, although 23 public wells were identified as being highly susceptible to contamination. There are 106 stream segments and six lakes in the MCW with designated uses including recreation, aquatic species habitat, fishing, and drinking water supply. Two streams, Lime Creek and Bear Creek, are classified as Outstanding Iowa Waters.

In 2015, the Department of Homeland Security Federal Emergency Management Agency (FEMA) developed a Flood Risk Report for the MCW, indicating flood-vulnerable areas. Flood risks are increasing in the watershed as flow rates of the Cedar River have increased by 34 cubic feet per second per year from 1903-2017. Peak flows have also increased in magnitude over time.

The State of Iowa listed 48 impaired waterbodies in the MCW, and seven have had Total Maximum Daily Load (TMDL) studies conducted. Water quality samples on 12 stream reaches in the watershed monitored by Coe College from 2012-2016 and at four Iowa Department of Natural Resources (Iowa DNR) stations monitored from 2000-2017 showed frequent exceedances of water quality standards for nitrate-nitrogen, phosphorus, and bacteria. Total suspended solids (TSS) on the other hand were more consistently below water quality standards. Runoff from agricultural fields contributes the majority of nitrate, phosphorus, bacteria and TSS to streams in the MCW. Iowa DNR conducted biological assessments on 81 stream reaches in the MCW and found that 32% of streams had excellent Fish Index of Biological Integrity (FIBI) scores and 16% of streams had excellent Benthic Macroinvertebrate Index of Biotic Integrity (BMIBI) scores. Six percent of streams had poor BMIBI scores, but no streams had poor FIBI scores. After assessing the state of the MCW, issues were identified and goals were set to improve the condition of the watershed.

Issues, Goals, and Objectives

The main issues identified at meetings with MCWMA board members and stakeholders were flooding/water quantity, water quality, recreation, funding & organization, education & outreach, monitoring & evaluation, watershed policy, and partnerships.

Flooding is an important issue to watershed residents as floods have occurred more frequently and more severely in recent years. Two major flood events occurred in 2008 and 2016, which caused significant damage to property throughout the watershed. These flood events, and smaller, more frequent flooding events have also caused crop losses in agricultural areas of the watershed. Creating flood resilience in the watershed is a top goal of the MCWMP.

Water quality is also an issue in the watershed as many waterways are impaired for nutrients, bacteria, and/or sediment. These pollutants not only pose a threat to aquatic life and impact the aesthetic value of lakes and streams, they can also cause health problems for humans in high enough concentrations. Improving water quality is a crucial goal of the MCWMP. The MCWMP adopts the Iowa Nutrient Reduction Strategy (INRS) target for non-point source nitrogen (41%) and phosphorus (29%) reductions at the watershed scale.

Community members expressed a desire for better recreational areas along rivers. According to the 2009 Iowa Rivers and River Corridors Recreation Study, the Cedar River is one of the most heavily used rivers for recreation in Iowa. According to the 2012 Economic Value of Outdoor Recreation Activities in Iowa Study, $17.5 million is spent on recreation on the Cedar River each year. Improving water quality and recreational opportunities in the MCW is an important goal of the MCWMP.

Securing a reliable, sustainable funding source for MCWMA initiatives is a concern for watershed stakeholders and is crucial in order to complete projects efficiently and for stakeholders to see progress. The MCWMA also requires thorough organization due to its large size. Other WMAs of this size have benefited from having adequate staffing and decision-making guidelines. Securing funding and instituting an organized operations structure for the MCWMA is an essential goal of the MCWMP.

Policy is a useful tool in accomplishing flood control and water quality improvement goals. Implementing and enforcing existing water resource policies is a challenging task for regulatory entities, but concerted efforts to educate watershed residents and inspire voluntary compliance can be effective. Assisting regulatory entities to improve oversight of water resource policies is an important goal of this MCWMP.

Educating the public about the impact of human activities on the watershed is one of the most effective means of improving conditions in the watershed. Effectively spreading the right messages about protecting the MCW to community members is a central goal of the MCWMP.

Monitoring water quantity and quality is important in order to assess not only the current state of waterways for matters of health and safety, but it is also important for understanding long term trends of water quantity and quality. Tracking these trends over time can indicate how climate change and land use change are affecting the MCW and it additionally can be used to evaluate the progress of the MCWMA's projects and initiatives. Expanded and intensified water monitoring is a significant goal of the MCWMP.

Establishing partnerships with existing local environmental organizations is a priority for MCWMA board members. Additionally, the MCW has a unique and powerful network of partners, so maintaining the support and positive connections with these entities can help to concert efforts and in some cases provide a means of funding. Building and maintaining these alliances in a critical goal of the MCWMP.

Prioritization

MCWMA board members, project partners, stakeholders, and watershed residents identified issues that were priorities for them. Water quality improvement was rated as the most important, flood risk reduction and continuing existing projects were rated the second highest, and improving recreational use was ranked as the least important. Based on these concerns, seven HUC-12 subwatersheds emerged as high priority targets and 16 emerged as priority subwatersheds. The seven high priority target subwatersheds are Lime Creek, Wolf Creek, Prescotts Creek - Black Hawk Creek, Dry Run, Morgan Creek, Village of Reinbeck - Black Hawk Creek, and Black Hawk Park – Cedar River. A variety of implementation mechanisms for addressing issues in the MCW were prioritized. Water quality and flood control practices including cost-share programs, capital improvements, and water condition studies were the top priority, but coordination with other agencies and education/outreach were also highly prioritized.

Flood Mitigation & Water Quality Improvement

Controlling water quantity and quality in the watershed will be accomplished through three major components- implementing agricultural conservation practices, managing urban stormwater, and controlling bacteria exposure to waterways. A suite of conservation practices, with target adoption rates designed to meet the nutrient reduction goals of the plan was developed for each of the 68 HUC-12 subwatershed of the MCW.

Funding & Organizational Strategies

To achieve the goals outlined in this plan, the MCWMA needs to establish staffing requirements, base funding levels and methods, strong board leadership, an organizational plan, and training for board officials and staff. There are a variety of grant opportunities dedicated to conservation projects from local, state, and federal government agencies including the Iowa Department of Agriculture and Land Stewardship (IDALS), the Iowa Economic Development Agency (IEDA), the Iowa DNR, the United States Environmental Protection Agency (EPA), the National Fish and Wildlife Foundation (NFWF), the Midwest Row Crop Collaborative (MRCC), Iowa State University Extension & Outreach (ISU Extension) and the Federal Emergency Management Association (FEMA). There are also opportunities to form Private Public Partnerships (PPPs) with nonprofit organizations like The Nature Conservancy (TNC), Iowa Soybean Association (ISA), Iowa Agriculture Water Alliance (IAWA), Ducks Unlimited (DU), Keep Iowa Beautiful, Pheasants Forever, Trees Forever, the Walton Foundation and private foundations such as Coca-Cola and the McKnight Foundation. The MCWMA would benefit from cultivating partnerships with groups such as these to help ensure a comprehensive funding strategy into the future.

Policy Strategies

The most important policy strategy for the MCWMA is to provide support to member communities on their local water resource policies. This could be accomplished through working with and encourage them in establishing uniform permit and design criteria, updating performance standards, and expanding awareness of regulations. The categories of ordinance needs that are associated with specific areas of concern within the watershed are stormwater management, erosion and sediment control, illicit discharges, floodplain management, sanitary sewer systems, feedlot management, and source water protection.

Education & Outreach Strategies

Engaging the public about MCWMA activities is crucial for spreading its messages. An education and outreach plan was developed for the MCWMA by ISU Extension. Distributing regular news articles, speaking on the radio, and having a well-designed website and social media pages will help get the message out. It is also important to attend public events and establish relationships with local businesses and organizations. Spreading the *right* messages is key; messages need to be clear, persuasive, and targeted to the intended audience. Messages about involvement and engagement, embracing stewardship over the watershed, economic opportunities, and providing for the next generation resonate with residents.

Monitoring & Evaluation Strategies

The recommended monitoring activities to assess water quality and quantity are 1) sentinel site monitoring, 2) snapshot monitoring, and 3) flood preparedness monitoring.

The monitoring plan was designed to take advantage of existing monitoring efforts currently being done in the watershed. The monitoring plan builds off and expands upon these efforts. The goal of this monitoring is to detect changes in loads over time and provides a means of evaluating the efficacy of the MCWMA's initiatives. Evaluation criteria have been developed for each of the goals/objectives that were set during the planning process.

Partners in Watershed Management

The plan identifies many partners that have signed on to help the MCWMA achieve its goals. They are: the Iowa Flood Center (IFC), ISU Extension & Outreach, the Iowa Water Center, the United States Geologic Survey (USGS), the Iowa Nutrient Research Center, TNC, Tallgrass Prairie Center, the Iowa DNR, HSEMD, IAWA, ISA, Iowa Rivers Revival, Iowa Learning Farms, the Soil and Water Conservation Society, Practical Farmers of Iowa, Clean Water Iowa, and the Cedar Valley Paddlers. The plan also outlines some strategies to establish new partnerships and maintain existing ones.

Implementation Schedule

The proposed implementation activities of the MCWMA are divided into three sections: Start-up, Implementation, and Evaluation. The Start-up Phase will last from 2020-2022 and will focus on organizing the MCWMA, securing funding, updating policies, and starting to implement conservation practices in High Priority subwatersheds. The Implementation Phase will last from 2023-2037 and is when the bulk of conservation practices will be implemented and when projects in Priority Subwatersheds will begin. The Evaluation Phase will last from 2038-2039 and will focus on continuing conservation practices, evaluating the effectiveness of MCWMA activities, and developing the next 20-year plan. Costs are distributed across the timeline with lower costs in the earliest years and higher costs in later years when the MCWMA has had 20 years of practice in gathering funds and has established many partners.

1. INTRODUCTION

From 2011–13, Iowa suffered eight Presidential Disaster Declarations due to flooding encompassing 73 counties and more than 70% of the state. In January 2016, the state of Iowa received a $97 million award from the U.S. Department of Housing and Urban Development (HUD) for the Iowa Watershed Approach (IWA) to address flooding in Iowa, among other things. The goals of the IWA project include the following: (1) reduction of flood risk; (2) improvement in water quality; (3) increased resilience; (4) engagement of stakeholders through collaboration, outreach, and education; (5) improved quality of life and health for Iowans, especially for susceptible populations; and (6) development of a replicable program. The IWA program takes a holistic approach to address flooding at the watershed scale, recognizing that upstream and downstream communities need to voluntarily work together to increase community flood resilience.

Eight distinct watersheds are involved in the project, including the Middle Cedar Watershed (MCW) (**Figure 1-1**). Each Watershed Management Authority (WMA) was tasked to develop a hydrologic assessment and watershed plan, and implement projects in the upper watershed to reduce the magnitude of downstream flooding and to improve water quality during and after flood events. Flood resilience programs will be implemented in each watershed to help increase community resilience to future floods. The purpose of this plan is to integrate implementation efforts consistent with the watershed member counties' hazard mitigation and disaster recovery plans. Through the Middle Cedar Watershed Management Authority's (MCWMA) planning process, partnerships were developed for the reduction of risk to vulnerable populations and agricultural, private, and public infrastructure.

In coordination with this plan, a Hydrologic Assessment was performed for the MCW by the Iowa Flood Center and the University of Iowa IIHR—Hydroscience & Engineering with support from several state and local agencies including the Iowa Department of Natural Resources (Iowa DNR), Benton County, members of the MCWMA and others. The purpose of the Hydrologic Assessment report was to provide an understanding of the current watershed hydrology in the MCW and evaluate how changes in land use and climate change have affected watershed hydrology. The study provides an overview of current and historical MCW conditions including hydrology, geology, topography, land use, hydrologic/meteorological instrumentation, a summary of previous floods of record and an examination of the water cycle of the MCW using historical precipitation and streamflow records. The Hydrologic Assessment reviews the methods used to build a Generic Hydrologic Overland Subsurface Toolkit (GHOST) model which was used to identify high runoff potential areas within the watershed, and evaluate the potential of various hypothetical flood mitigation strategies that may be leveraged to accomplish goals of the IWA. Two user-friendly, interactive, web-based information systems that provide real-time environmental monitoring data including flooding information and water-quality data were also included in this review. These systems include the Iowa Flood Information System (IFIS) and the Iowa Water-Quality Information System (IWQIS). Specific to IWA, a new online platform was created, the Iowa Watershed Approach Information System (IWAIS). This system incorporates features form IFIS and IWQIS, but also includes new layers to visualize existing BMPs, Agricultural Conservation Practices Framework (ACPF) results, along with flood resilience components such as: social vulnerability data, and flood damage analysis.

Additionally, the Iowa Department of Homeland Security and Emergency Management (HSEMD) coordinated with the University of Iowa's Flood Resilience Team for the development of a watershed-based risk assessment. This risk assessment and the associated planning components are consistent with the methodology required in the Federal Emergency Management Agency's Local Hazard Mitigation Planning

Guidance. The objective of including this information in the MCWMP is to inform and empower the MCWMA to address flood risk and vulnerability through the development and implementation of flood resilience actions.

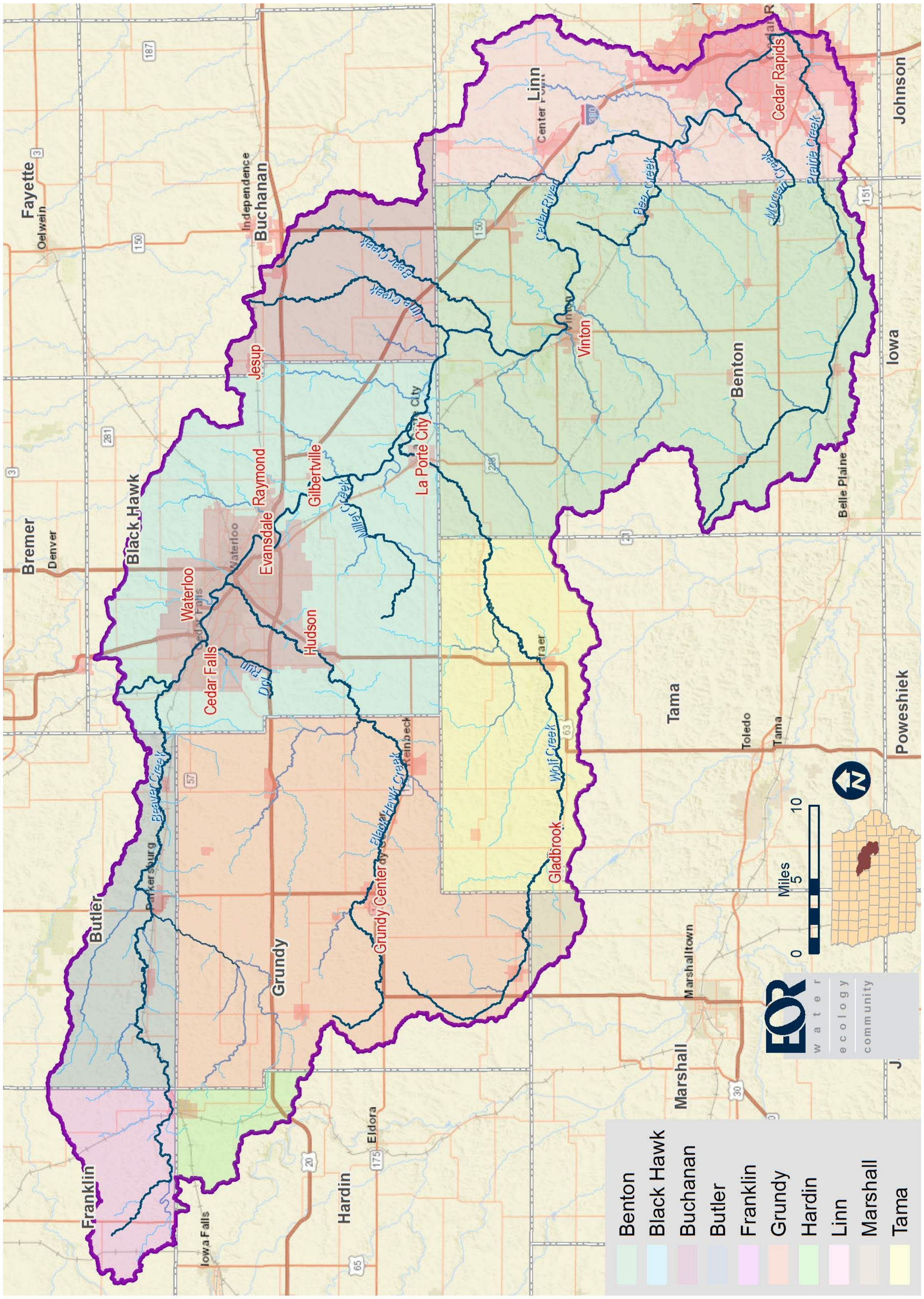

Figure 1-1. Middle Cedar Watershed—County Coverage.

2. WATERSHED ASSESSMENT

2.1. Watershed Characterization

The Middle Cedar Watershed (MCW) is one of six Hydrologic Unit Code (HUC)-8 watersheds that comprise the larger Cedar River Watershed (CRW). The CRW includes a 7,485 square mile area that begins in southern Minnesota near Austin, continuing southeastward to the Cedar River's outlet at the Iowa River near Columbus Junction, Iowa.

The MCW covers approximately 2,400 square miles (32% of the CRW) in East Central Iowa and spans 10 counties: Franklin, Hardin, Butler, Grundy, Marshall, Tama, Blackhawk, Buchanan, Benton, and Linn counties. The watershed consists of mostly agricultural lands but also includes many small towns (i.e. Vinton, Traer, and Grundy Center) and a substantial portion of Iowa's urban areas, including Cedar Rapids, Waterloo, and Cedar Falls. The watershed includes some of the richest farmland in the nation. Seventy-three percent of the land in the watershed is dedicated to row crop agriculture and seed corn production. A study conducted by researchers from Iowa State University (ISU) (2012) estimates that $17.5 million is spent on river recreation annually on the Cedar River between Cedar Rapids and Waterloo. The Cedar River has a long history as a recreational destination. Current water quality conditions in the watershed are the largest factor limiting recreation. Several reaches of the Cedar River and many of its tributaries have levels of bacterial contamination that pose a risk to human health (see **Section 2.94, Table 2-13**).

2.1.1. Hydrologic Setting

The United States Geological Survey (USGS) created a hierarchical system of watershed areas represented by a unique Hydrologic Unit Code (HUC) number. There are six levels in the hierarchy, represented by hydrologic unit codes from two to 12 digits long, called regions, subregions, basins, subbasins, watersheds, and subwatersheds. In this system the MCW is actually referred to as a subbasin. **Table 2-1** below describes the USGS system's hydrologic unit levels and their characteristics, along with example names and codes from the MCW. An illustration of the USGS HUC code system using the MCW examples is shown in **Figure 2-1**.

Table 2-1: USGS Watershed Hierarchical System.

Name	HUC Level	Average Size	Example name from Middle Cedar	Example code (HUC)
Region	2	177,560 sq-mile	Upper Mississippi River	07
Subregion	4	16,800 sq-mile	Upper Mississippi -Iowa-Skunk- Wapsipinicon	0708
Basin	6	10,596 sq-mile	Iowa Basin	070802
Subbasin	8	700 sq-mile	Middle Cedar Watershed	07080205
Watershed	10	40,000–250,000 acres	Wolf Creek	0708020508
Subwatershed	12	10,000–40,000 acres	Village of Conrad-Wolf Creek	070802050803

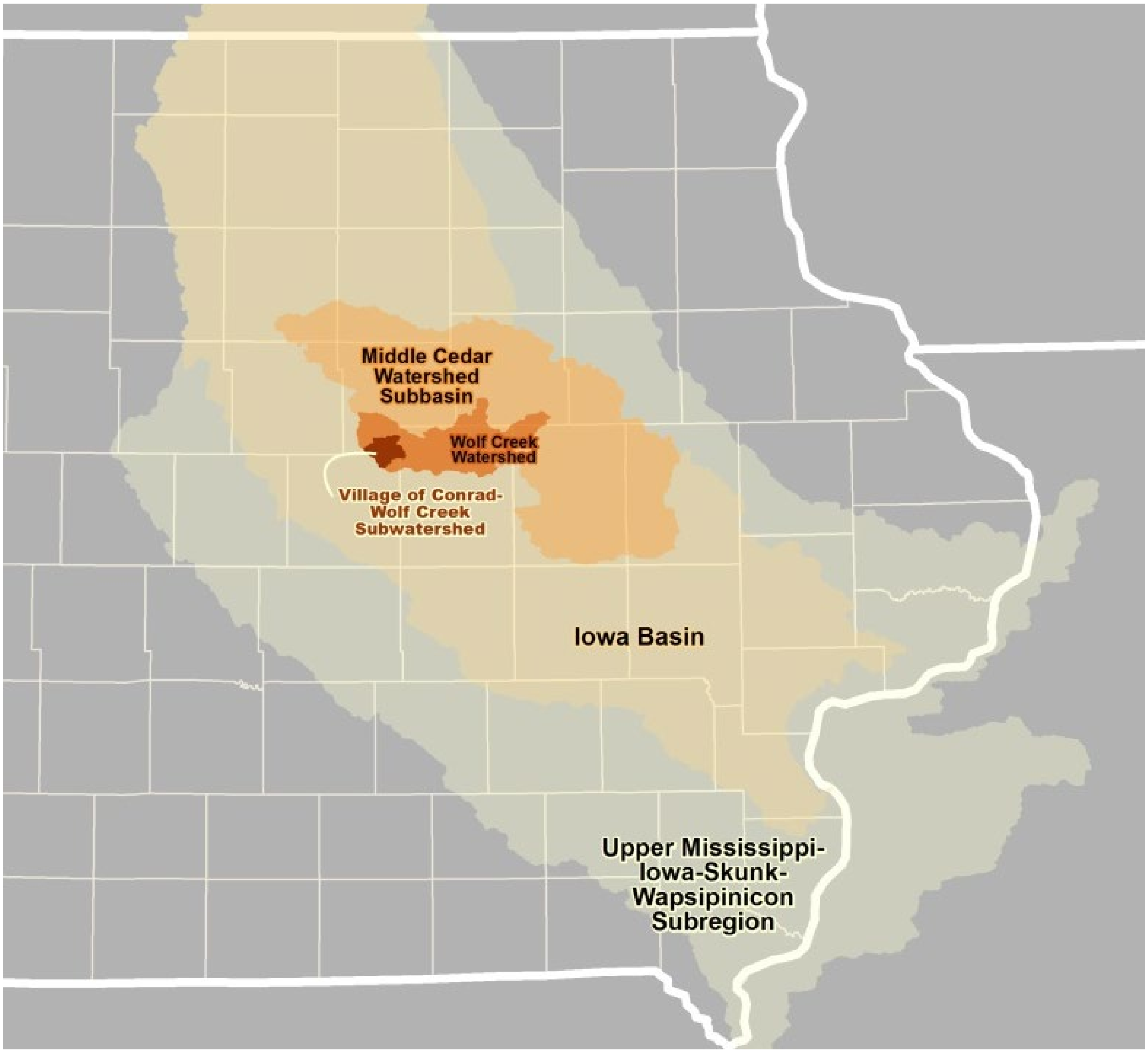

Figure 2-1: Illustration of USGS Hydrologic Unit Code Hierarchy.

The MCW includes 68 HUC-12 subwatersheds within fifteen HUC-10 watersheds as shown in **Figure 2-2** and **Table 2-2**. Subwatersheds are the smallest unit within the USGS system, although many times these are further subdivided for a variety of purposes, particularly in the construction of hydrologic and water quality models. Subwatersheds are the hydrologic-scale that is commonly used for implementation efforts. At this scale landowners are likely to have personal relationships and a small, dedicated group can have a meaningful role in improving the health of a subwatershed. Previous watershed management planning in the MCW has occurred at the subwatershed, or HUC-12 scale, although some of these efforts have involved multiple HUC-12s (**Table 2-3**).

Note that there are three HUC-10 watersheds associated with Beaver and Black Hawk Creeks, which leads to some confusion as these areas are commonly referred to as watersheds. These areas are the equivalent of a HUC-9, although that level does not formally exist within the USGS system. Currently a watershed management initiative is being organized for Black Hawk Creek, which encompasses ten HUC-12 subwatersheds within three HUC-10 watersheds.

Table 2-2. HUC-10 Watersheds and HUC-12 Subwatersheds of the Middle Cedar Watershed.

Watershed / (HUC-10)		Subwatershed (HUC-12)	Subwatershed Name (HUC-12)
Beaver Creek	**South Beaver Creek**	070802050101	Middle Fork South Beaver Creek
		070802050102	Headwaters South Beaver Creek
		070802050103	South Beaver Creek
	Headwaters Beaver Creek	070802050201	Headwaters Beaver Creek
		070802050202	North Middle Beaver Creek
		070802050203	Drainage Ditch 148- Beaver Creek
		070802050204	Gran Creek- Beaver Creek
	Beaver Creek	070802050301	Johnson Creek
		070802050302	Phelps Creek- Beaver Creek
		070802050303	Max Creek- Beaver Creek
		070802050304	Hammers Creek- Beaver Creek
Black Hawk Creek	**North Fork Black Hawk Creek**	070802050401	South Fork Black Hawk Creek
		070802050402	Headwaters North Fork Black Hawk Creek
		070802050403	North Fork Black Hawk Creek
	Headwaters Black Hawk Creek	070802050501	Holland Creek
		070802050502	Headwaters Black Hawk Creek
		070802050503	Mosquito Creek
		070802050504	Minnehaha Creek-Black Hawk Creek
		070802050505	Village of Reinbeck-Black Hawk Creek
	Black Hawk Creek	070802050601	Wilson Creek-Black Hawk Creek
		070802050602	Prescotts Creek-Black Hawk Creek
Dry Run Creek		070802050701	Dry Run
		070802050702	Waterloo Municipal Airport
		070802050703	Black Hawk Park-Cedar River
Wolf Creek		070802050801	Headwaters Wolf Creek
		070802050802	Little Wolf Creek
		070802050803	Village of Conrad-Wolf Creek
		070802050804	Fourmile Creek
		070802050805	Coon Creek
		070802050806	Rock Creek
		070802050807	Twelvemile Creek
		070802050808	Devils Run-Wolf Creek
		070802050809	Wolf Creek
Miller Creek		070802050901	Elk Run
		070802050902	Poyner Creek
		070802050903	Indian Creek
		070802050904	Headwaters Miller Creek
		070802050905	Miller Creek

Watershed / (HUC-10)	Subwatershed (HUC-12)	Subwatershed Name (HUC-12)
	070802050906	Sink Creek-Cedar River
	070802050907	Mud Creek-Cedar River
Spring Creek	070802051001	Rock Creek-Cedar River
	070802051002	Spring Creek
	070802051003	Lime Creek
	070802051004	Bear Creek-Cedar River
	070802051005	McFarlane State Park-Cedar River
Pratt Creek	070802051101	Pratt Creek
	070802051102	Hinkle Creek
	070802051103	Prairie Creek-Cedar River
	70802051104	Mud Creek
	070802051105	Dudgeon Lake State WMA-Cedar River
Bear Creek	070802051201	Opossum Creek
	070802051202	Wildcat Creek
	070802051203	Little Bear Creek
	070802051204	Bear Creek
Otter Creek	070802051301	West Otter Creek
	070802051302	East Otter Creek-Otter Creek
Prairie Creek	070802051401	Headwaters Prairie Creek
	070802051402	Village of Van Horne-Prairie Creek
	070802051403	Mud Creek-Prairie Creek
	070802051404	Weasel Creek-Prairie Creek
	070802051405	Prairie Creek
Blue Creek	070802051501	East Branch Blue Creek
	070802051502	Blue Creek
	070802051503	Wildcat Bluff-Cedar River
	070802051504	Nelson Creek-Cedar River
	070802051505	Dry Creek
	070802051506	Morgan Creek
	070802051507	Silver Creek-Cedar River

Table 2-3. Past Watershed Planning Initiatives in the Middle Cedar Watershed.

Past Planning Initiatives	USGS HUC Level	HUC-12 Subwatersheds Involved
Benton/Tama Nutrient Reduction Demonstration Project	3 HUC-12s	070802050809 Wolf Creek 070802051001 Rock Creek-Cedar River 070802051101 Pratt Creek
Miller Creek Water Quality Improvement Project	2 HUC-12s	070802050904 Headwaters Miller Creek 070802050905 Miller Creek
Lime Creek Watershed Improvement Association	HUC-12	070802051003 Lime Creek
Dry Run Creek Watershed Management Plan	HUC-12	070802050701 Dry Run
Black Hawk Creek Water and Soil Coalition	3 HUC-10s	070802050401 South Fork Black Hawk Creek 070802050402 Headwaters North Fork Black Hawk Creek 070802050403 North Fork Black Hawk Creek 070802050501 Holland Creek 070802050502 Headwaters Black Hawk Creek 070802050503 Mosquito Creek 070802050504 Minnehaha Creek-Black Hawk Creek 070802050505 Village of Reinbeck-Black Hawk Creek 070802050601 Wilson Creek-Black Hawk Creek 070802050602 Prescotts Creek-Black Hawk Creek

Stakeholder engagement, (Photo Credit: EOR)

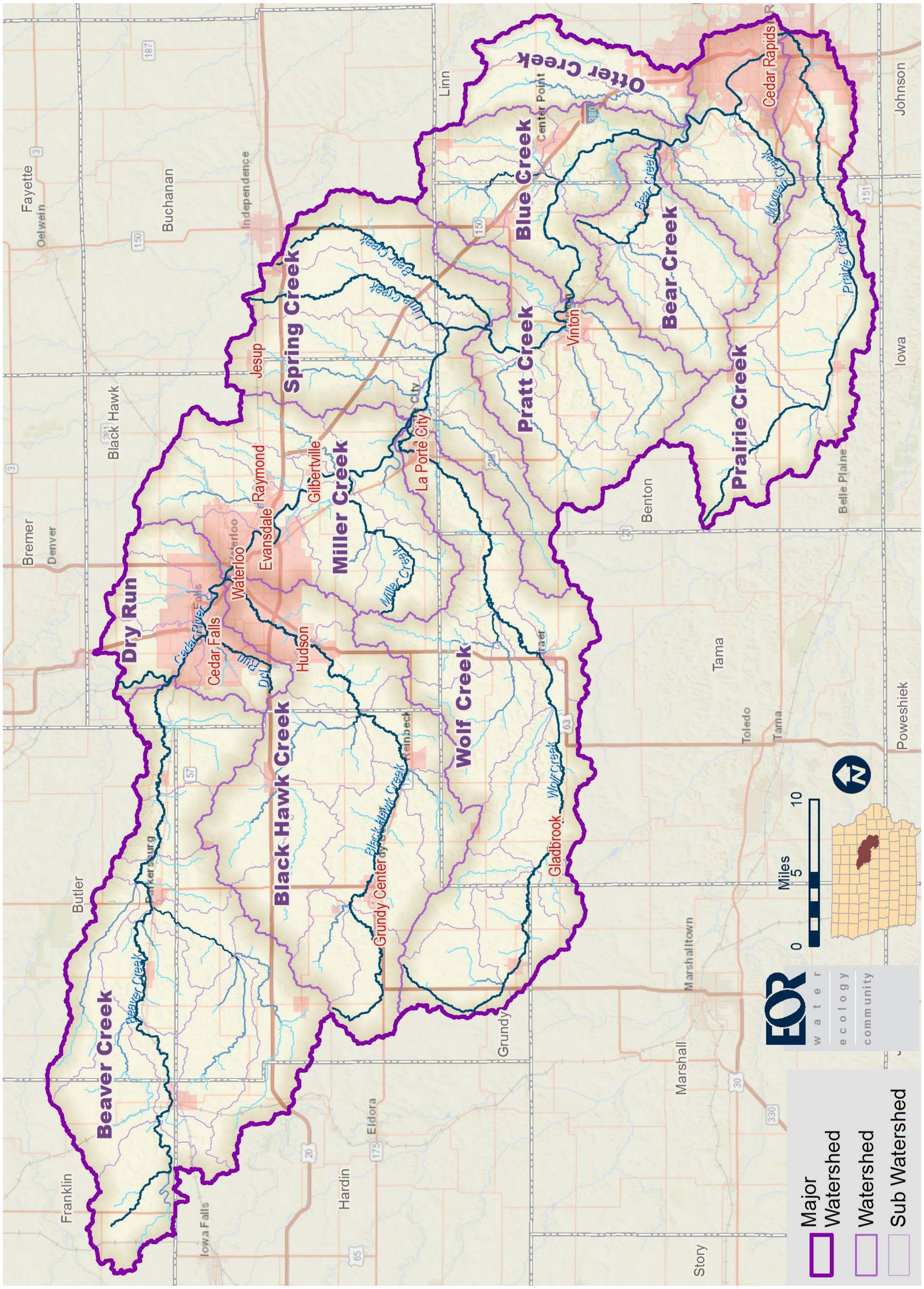

Figure 2-2: Middle Cedar Watershed—HUC-10 Watersheds and HUC-12 Subwatersheds.

2.1.2. Demographics

The MCW covers approximately 1.5 million acres in East Central Iowa and spans 10 counties: Franklin, Hardin, Butler, Grundy, Marshall, Tama, Blackhawk, Buchanan, Benton, and Linn Counties. The watershed population was estimated at approximately 300,000 people based on the 2010 Census as extrapolated to the watershed boundaries. **Table 2-4** shows the estimated population by political subdivision within the watershed. Cedar Rapids is the political subdivision with the most people, accounting for 34 percent of the watershed population. **Figure 2-3** depicts the population density (people per 1,000 acres) by subwatershed as well as the actual population estimate for each subwatershed.

Table 2-4. Estimated 2010 Population within the Middle Cedar Watershed by Political Subdivision.

County	City	2010 Population in Watershed	Percent of Watershed Population	County/ City Acres in Watershed	Percent of Watershed Land Area
Benton		16,125	5%	385,613	25%
	Vinton	5,257	2%	3,086	0%
Black Hawk		9,495	3%	235,616	15%
	Cedar Falls	39,260	13%	18,931	1%
	Evansdale	4,751	2%	2,631	0%
	Gilbertville	712	0%	254	0%
	Hudson	2,282	1%	5,420	0%
	Jesup	117	0%	1,139	0%
	La Porte City	2,285	1%	1,675	0%
	Raymond	788	0%	1,044	0%
	Waterloo	68,406	23%	40,435	3%
Buchanan		2,178	1%	83,582	5%
	Jesup	2,403	1%	1,139	0%
Butler		4,851	2%	79,900	5%
Franklin		583	0%	49,512	3%
Grundy		9,495	3%	291,029	19%
	Grundy Center	2,706	1%	1,616	0%
Hardin		1,829	1%	26,080	2%
Linn		19,477	7%	130,850	8%
	Cedar Rapids	101,912	34%	33,433	2%
Marshall		147	0%	10,215	1%
Tama		3,632	1%	143,188	9%
	Gladbrook	945	0%	445	0%

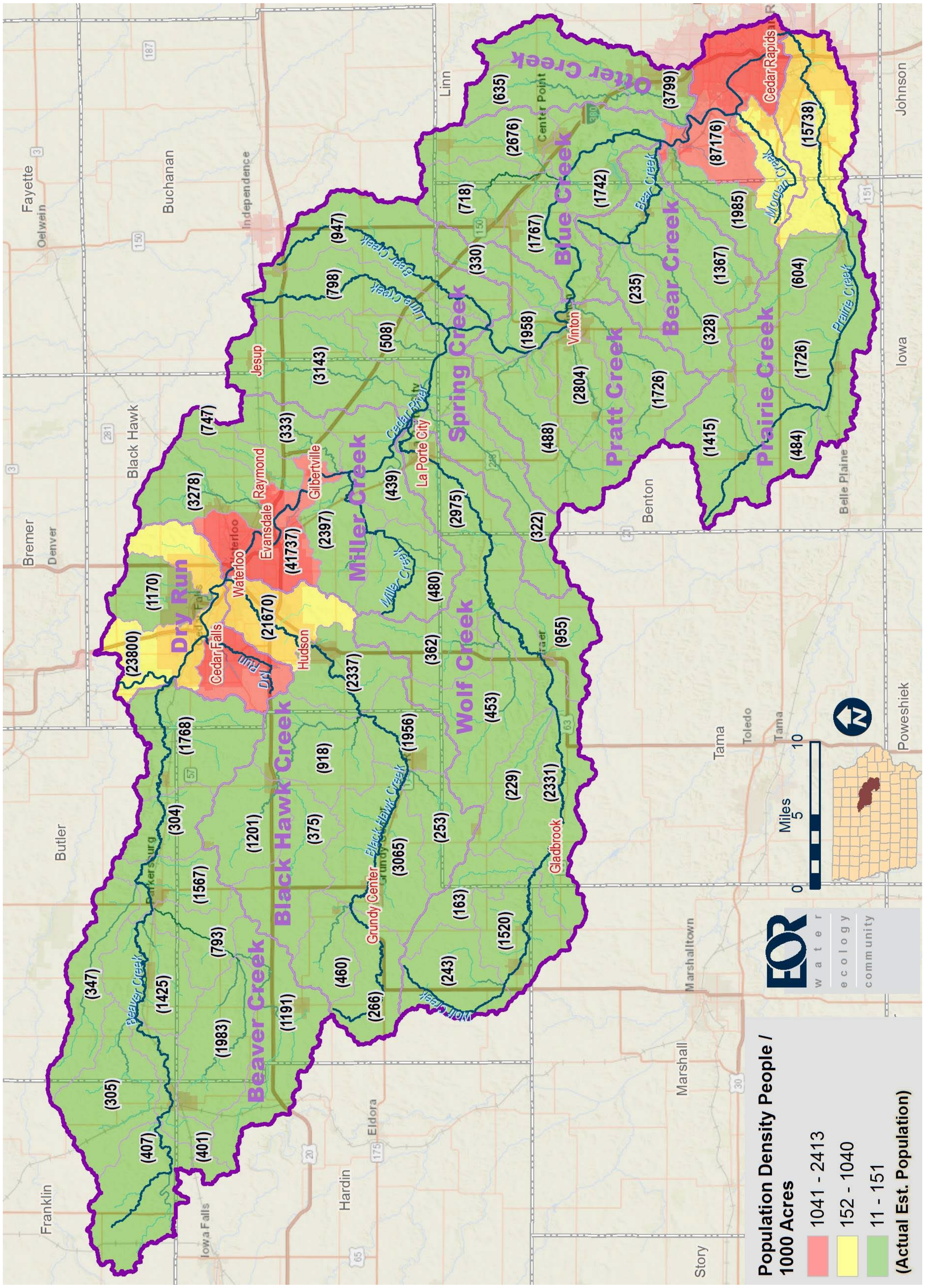

Figure 2-3. Middle Cedar Watershed—Estimated 2010 Population Density by Subwatershed.

2.1.3. Social Vulnerability Index

The social vulnerability Index (SVI) is a combined metric of 12 indicators: African American, language barrier, renters, unemployed, poverty, children, elderly, Hispanic, low education, female head of household, disabled, and no vehicle access. They represent a percent of the population at the census tract level. All data was retrieved from the U.S. Census Bureau using the 2016 ACS 5-year estimates. The data was developed by the Iowa Watershed Approach Flood Resilience Program at the census tract level. The data was then intersected with the HUC-12 subwatersheds within the MCW. Each subwatershed was than assigned the SVI score for the highest census tract it contained (see **Figure 2-4**).

Black Hawk Creek near Grundy Center, Iowaa, (Photo Credit: EOR)

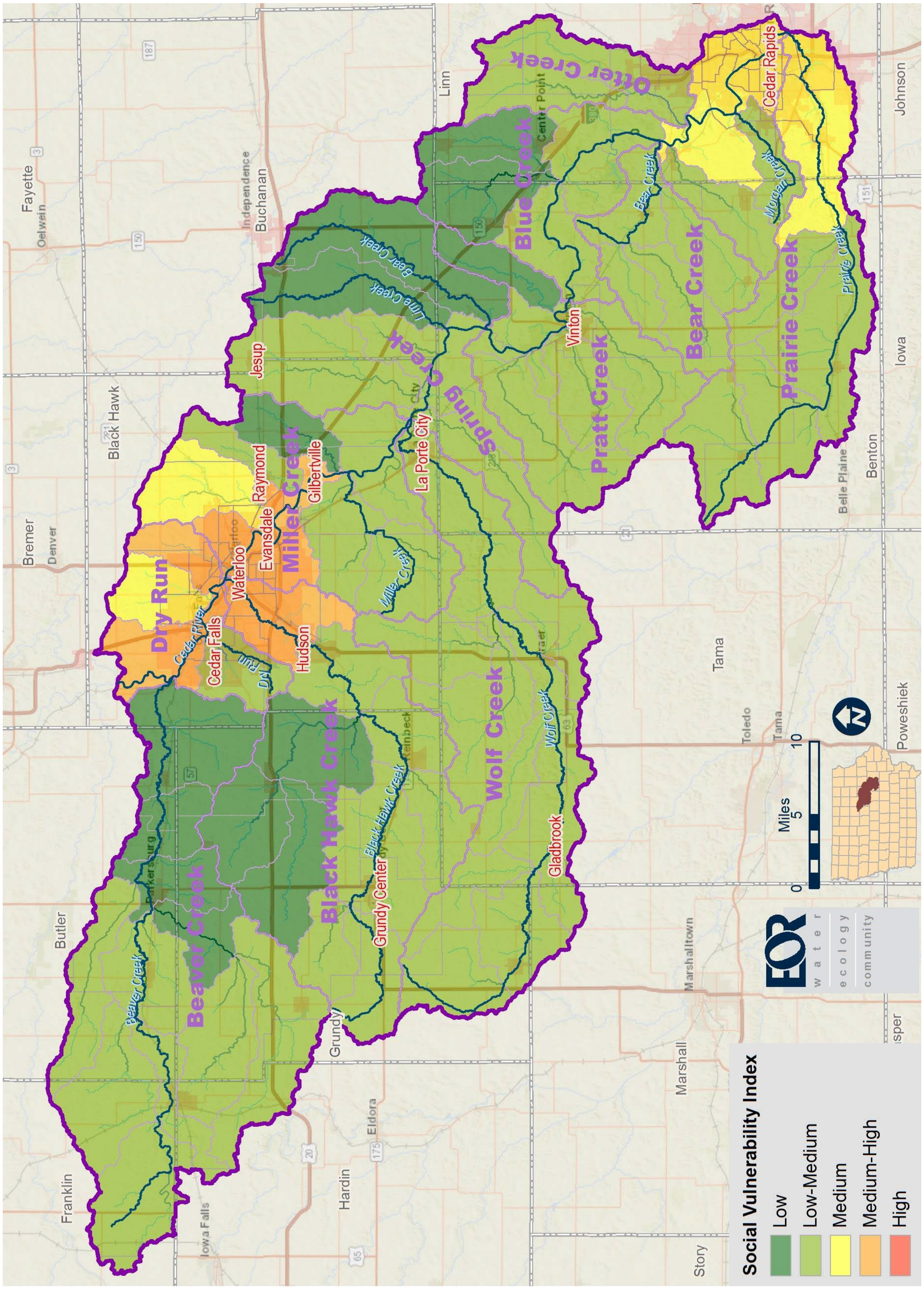

Figure 2-4. Middle Cedar Watershed—Social Vulnerability Index by Subwatershed.

2.1.4. Land Cover

Land cover and use, both natural and human influenced, are the main factors driving the quality and character of water resources in the MCW. Land use within the MCW is predominately (around 74 percent) agricultural with development largely limited to the larger communities surrounding Waterloo in the northcentral portion of the watershed and Cedar Rapids in the eastern most portion of the watershed (see **Table 2-5** and **Figure 2-5**). The distribution of land cover in the MCW was determined using Iowa's High Resolution Land Cover Dataset with a spatial resolution of one square meter (**Figure 2-6**). This dataset illustrates that the forested/grassland riparian areas are primarily located along the portion of Cedar River between Waterloo and Cedar Rapids. The riparian areas within the Blue Creek watershed downstream of the City of Vinton contain the most intact riparian corridor; more than 40 percent of the Blue Creek watershed is either forested or grassland. Land cover is varied within the developed portions of the watershed.

The impact various land cover has on water quality is further described in the Watershed Pollutant Source Assessment discussion within this report.

Table 2-5. Middle Cedar Watershed – Land Cover

HUC-10 Name*	% Forested	% Grassland	% Water/Wetland	% Row Crop	% Developed
Bear Creek	5%	15%	1%	76%	3%
Beaver Creek	4%	12%	1%	81%	2%
Black Hawk Creek	3%	11%	0%	82%	3%
Blue Creek	20%	21%	3%	48%	8%
Dry Run	16%	21%	3%	50%	10%
Miller Creek	8%	16%	2%	68%	6%
Otter Creek	11%	18%	1%	67%	4%
Prairie Creek	3%	14%	1%	77%	5%
Pratt Creek	7%	16%	1%	73%	3%
Spring Creek	6%	13%	1%	78%	2%
Wolf Creek	3%	12%	0%	82%	2%
Watershed Totals	**6.7%**	**14.3%**	**1.2%**	**73.8%**	**3.9%**

**Beaver Creek and Black Hawk Creek watersheds include multiple HUC-10 watersheds.*

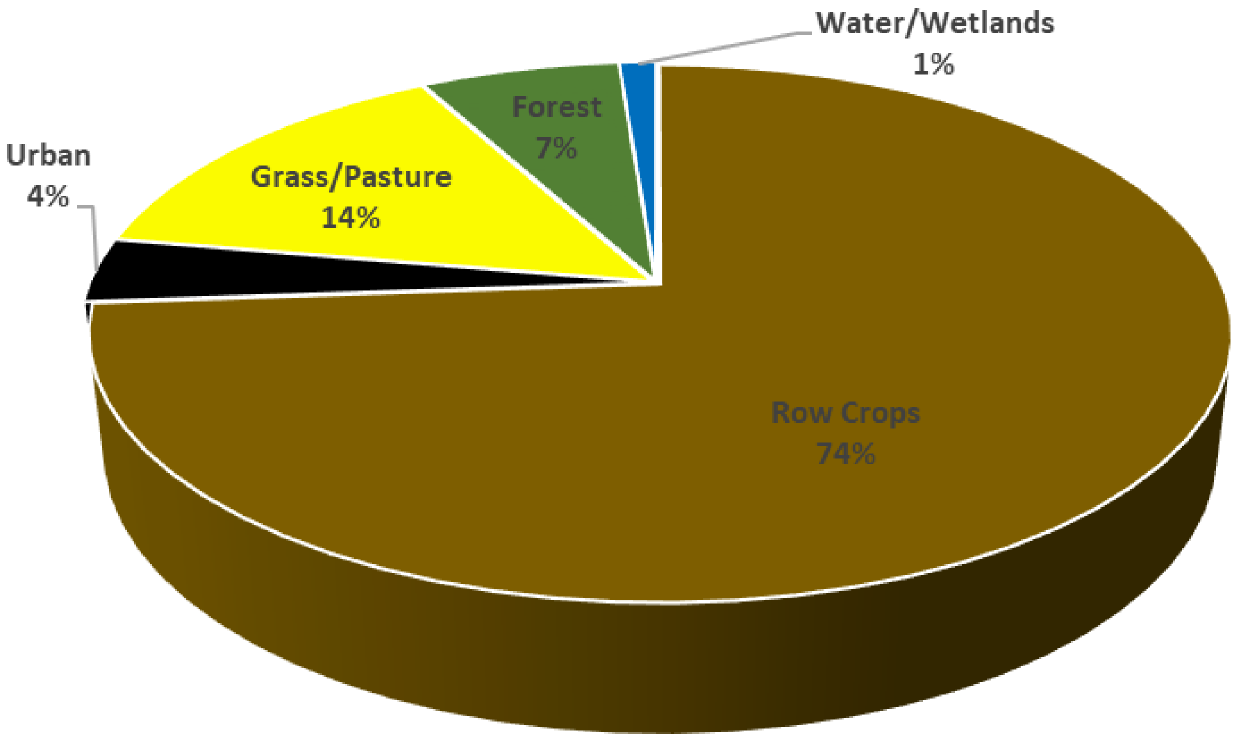

Figure 2-5. Land Cover Distribution in the Middle Cedar Watershed.

Agricultural land in Beaver Creek watershed (Photo Credit: EOR)

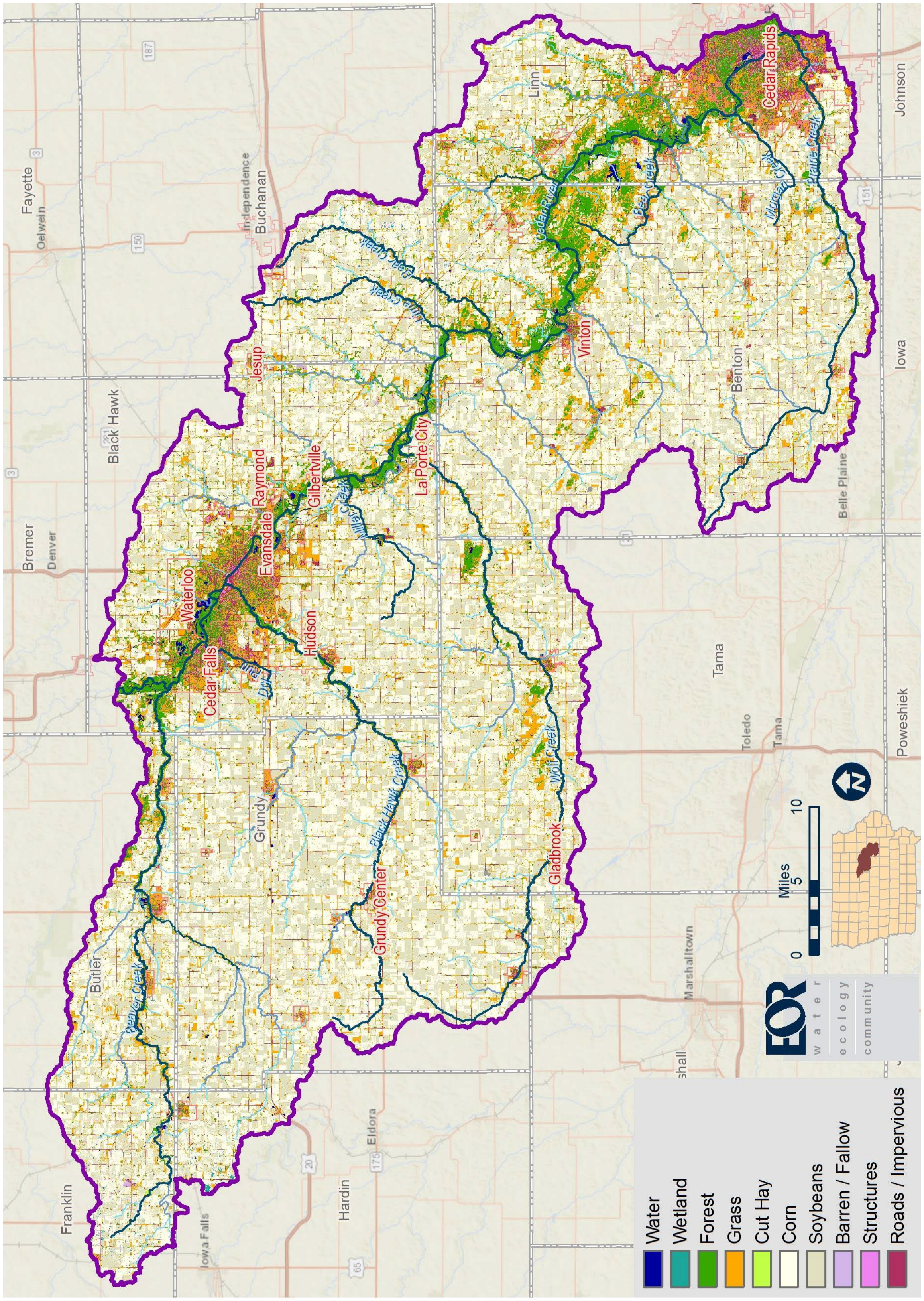

Figure 2-6. Middle Cedar Watershed – Land Cover Distribution.

2.1.5. Soils

The Soil Survey Geographic (SSURGO) soils Geographic Information System (GIS) layer available from the United States Department of Agriculture (USDA) was compiled for the watershed. The USDA SSURGO GIS layer contains tabular data including hydrologic soil group classification; the tabular data was joined to the spatial data via a common attribute (Map Unit Symbol). Each Map Unit Symbol corresponds to a soil series description, which describes the major characteristics of the soil profile for the given Map Unit.

Group A:
Soils consist of sand, loamy sand, or sandy loam soil types. These soils have very low runoff potential and high infiltration rates.

Group B:
Soils consist of silty loams or loams. These soils have moderately high infiltration rates and low runoff potential.

Group C:
Soils consist of sandy clay loam. The have low infiltration rates and consist of soils with a layer that impedes the downward movement of water and soils. These soils have moderately high runoff potential.

Group D:
Soils consist of clay loam, silty clay loam, sandy clay, silty clay, or clay soils with the highest runoff potential. These soils have very low infiltration rates and a high water table.

The Natural Resources Conservation Service (NRCS) has classified soil series into Hydrologic Soils Groups (HSG) based on the soil's runoff potential. There are four major HSGs (A, B, C, and D) and 3 dual HSG groups (A/D, B/D, and C/D). HSG A soils have the lowest runoff potential whereas HSG D soils have the greatest. Dual soil series include those soils that have an upper soil profile which is conducive to allowing water to infiltrate similar to a type A, B, or C soil and an underlying confining layer within 60 inches of the soil surface that restricts the downward movement of water. The first letter applies to the drained condition, if undrained, the soil will act more like a D soil with a higher runoff potential and lower infiltration rates. Dual soil series were grouped into one category for mapping purposes.

A Rapid Watershed Assessment of the Middle Cedar Watershed (2009) reported that soils in the MCW were comprised of a variety of different classes of loams including sandy loam, sandy clay loam, clay loam, silty clay loam, and silt loam. These soils formed primarily in glacial till, but are also derived from loess and alluvial deposits, and in some cases from the local bedrock. The drainage class of the soils in the watershed varies from poorly-drained to well-drained and is largely dependent on landscape position. The hydrologic soil groups in the MCW are illustrated in **Figure 2-7**. The primary Hydrologic Soil Groups immediately adjacent to the Cedar River (*note: any reference to the Cedar River with no specified reach refers to the portion within the MCW*) include well drained (HSG A and B), coarse, sandy loam soil series.

Soil series located within the many concave depressions associated with former prairie-pothole wetlands include deep, poorly drained, silty, clay-loams. Areas containing row crop (Corn/Soybean) land cover with B/D or C/D soils represent likely locations for subsurface tile drainage. The installation of subsurface tile drainage in areas with B/D and C/D soils has allowed for row crops to thrive in areas that were historically wetland.

Soil is a naturally occurring mixture of mineral and organic ingredients with a definite form, structure, and composition. The exact composition of soil changes from one location to another. A soil survey is a detailed report on the soils of an area. The soil survey has maps with soil boundaries and photos, descriptions, and tables of soil properties and features. The relationship between different soil types is shown in **Figure 2-8.** Soil surveys are used by farmers, real estate agents, land use planners, engineers and others who desire information about the soil resource. The creatures living in the soil are critical to soil health. They affect soil structure and therefore soil erosion, runoff and water availability. They can protect crops from pests and diseases. They are central to decomposition and nutrient cycling and therefore affect plant growth and amounts of pollutants in the environment. Finally, the soil is home to a large proportion of the world's genetic diversity.

The MCW encompasses many counties, so this plan will use Linn County as an example of a typical soil survey in the watershed. To find all of Iowa's soil surveys, visit the NRCS soil survey website.

To view the Linn County pdf manuscript, visit:
https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/iowa/IA113/0/linn_text.pdf

These manuscripts typically contain the following information:

1. Properties of soil map units like including color, permeability, stoniness, depth to bedrock, pH, structure, salinity, texture, slope, H2O availability, horizon thickness, engineering properties, erosion hazard, and other physical and chemical properties.
2. Position on the landscape.
3. Percent area in the landscape.
4. Capacities such as yield for crop, pasture, or vegetable; suitability for recreation, wildlife and water infrastructure; and engineering potentials and hazards.

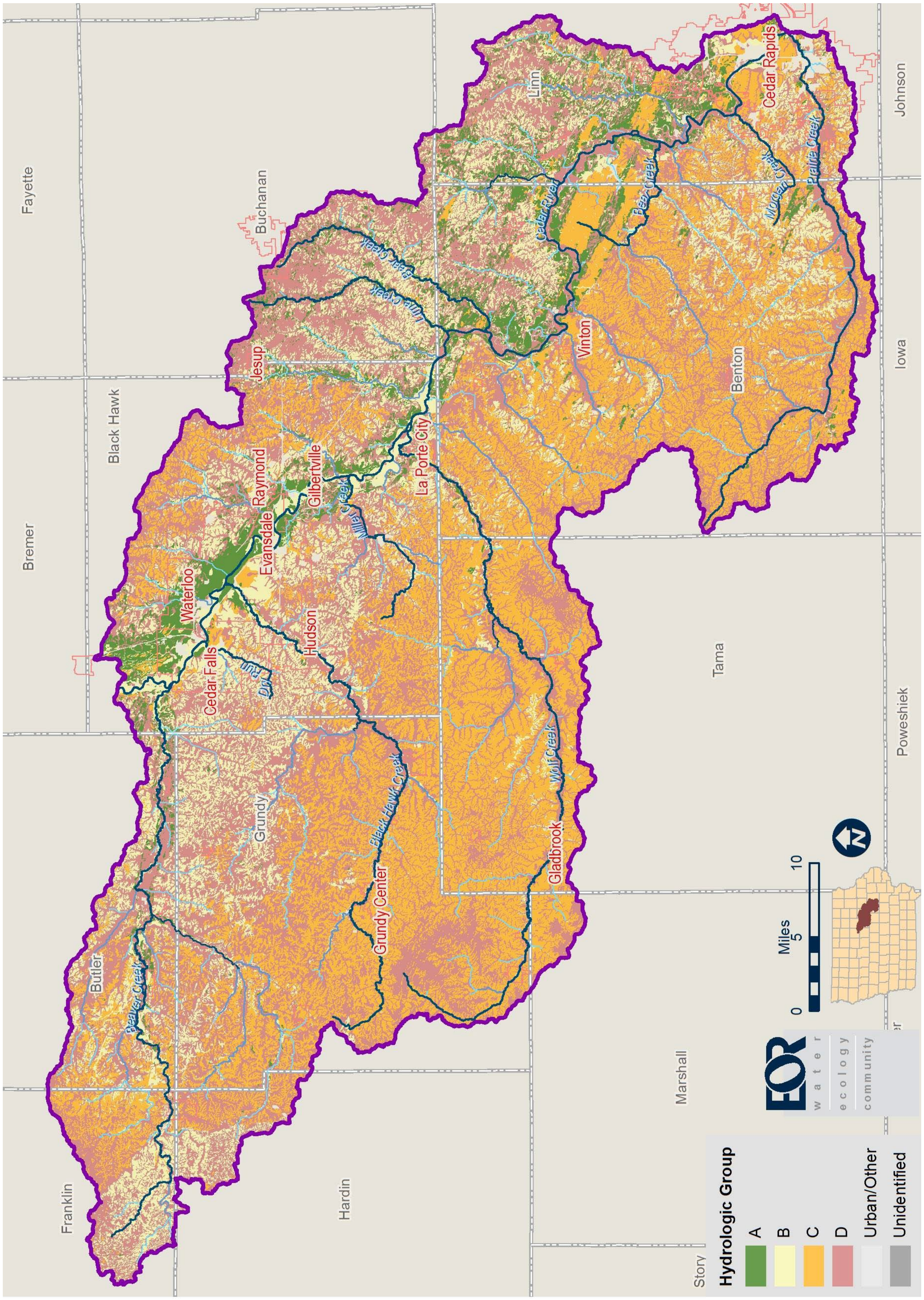

Figure 2-7. Middle Cedar Watershed – Hydrologic Soil Group.

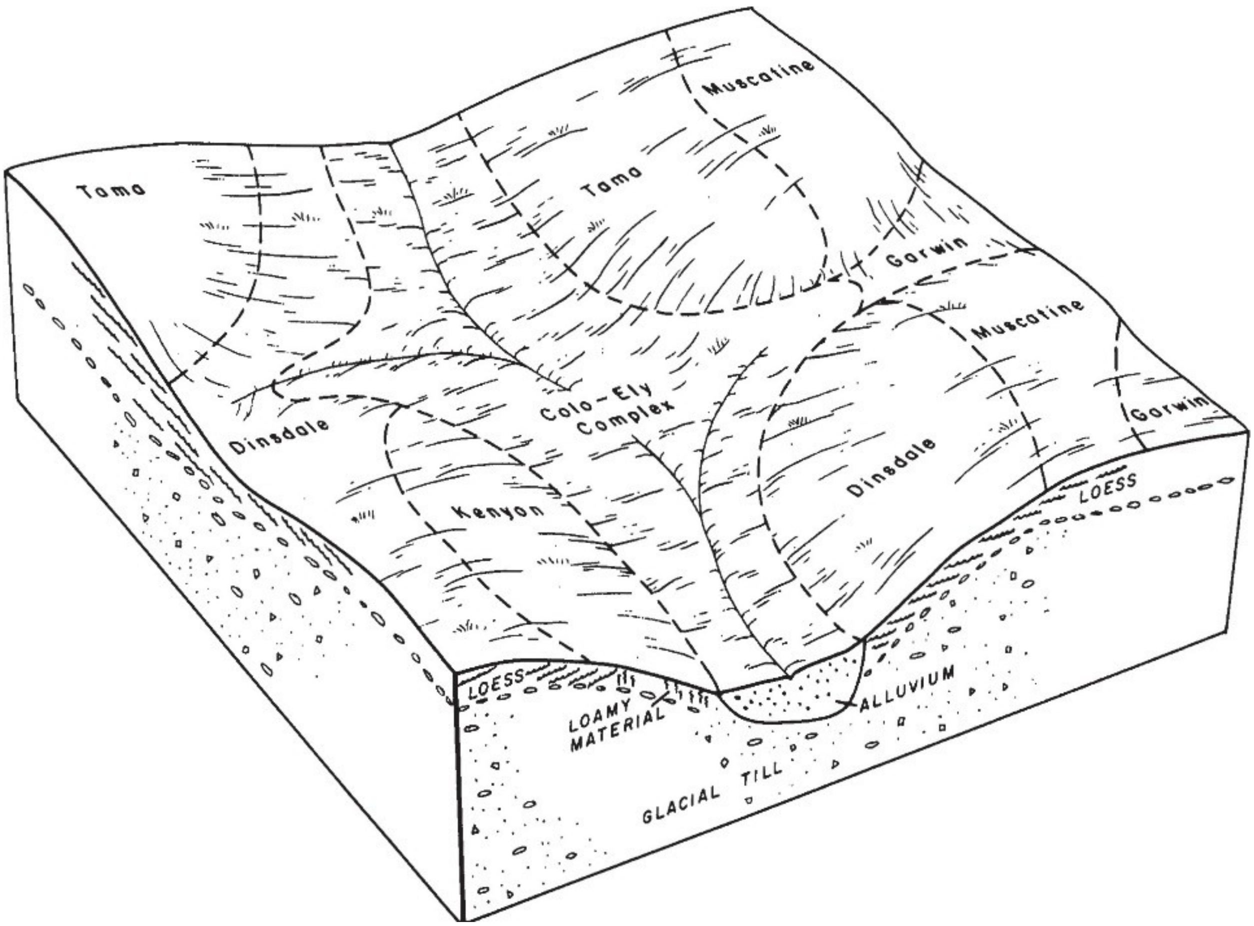

Figure 2-8. Relationship between Soil Mapping Units.

2.1.6. Geology and Groundwater Resources

The following is a summary of the groundwater resources and underlying geology of the MCW based on available data included in a review of the NRCS Rapid Watershed Assessment (USDA-NRCS 2009), *Geology of Grundy County* (Arey 1910), *Geology of Benton County* (Savage 1905), *Geology of Black Hawk County* (Arey 1906) , *Geology and Ground-Water Resources of Linn County, Iowa* (Hansen 1970), and data collected by the Iowa DNR.

Approximately 80 percent of Iowa residents in both urban and rural settings rely on groundwater as their primary source of drinking water. In general, the portions of the watershed in Grundy County which includes the towns of Conrad, Dike, and Reinbeck contain abundant supplies of high quality (not requiring excessive treatment) drinking water sufficient for local domestic uses. The central portion of the watershed that falls within Black Hawk County contains a number of wells which provide a noteworthy abundance of high quality groundwater (low dissolved solids and organic matter). Most wells in the river valley are within 10-35 feet of the surface. Outside of the river valley, most wells are located from 60-280 feet of the surface.

The City of Waterloo draws its water from 14 wells located in the Cedar Valley Aquifer, a limestone rock formation which contains a large supply of water. Well depths range from 76 to 225 feet. The southern portion of the watershed that falls within Benton County obtains groundwater from shallow wells (25-75 feet deep) that provide an ample supply of high quality groundwater. The town of Vinton obtains water from two deep wells, which penetrate the Saint Peter formation at a depth of more than 1,200 feet below the surface. The southeastern most portions of the watershed including the City of Cedar Rapids obtain groundwater from a shallow aquifers and artesian wells located next to the Cedar River. In Linn County, an ample supply of groundwater is available from both shallow drift aquifers in the alluvium of buried channels and in shallow bedrock aquifers where drift cover is thin.

Surficial Hydrogeology

The upper half of the MCW is part of the Iowan Erosion Surface. This landscape consists of gently sloping till plains dissected by narrow, shallow stream valleys. The southeastern portion of the watershed (Benton, Linn counties) lies in the Southern Iowa Drift Plain. This area was largely unaffected by the Wisconsinan glaciation and contains steeply rolling hills and valleys. Outcroppings of Devonian and Mississippian limestone are visible in the portions of Butler and Franklin Counties that are adjacent to stream valleys.

Corn stover bales near Grundy Center, Iowa (Photo Credit: EOR)

The Cambrian-Ordovician aquifer covers nearly the entire state of Iowa and is the major deep aquifer in the watershed. It includes the St. Peter Sandstone, the Prairie du Chien dolomite, and the Jordan Sandstone, the last being the major water producer (Thompson 1982). The Cambrian-Ordovician aquifer is confined by a series of geologic units comprised of shale, dolomite and limestone that control downward groundwater transport to the aquifer. Generalized hydrogeological cross-sections for Iowa including the Des Moines River are shown in (**Figure 2-9**). In the MCW, the Cambrian-Ordovician aquifer is covered by the Mississippian Aquifer which overlays a series of confining layers consisting of limestone, dolomite, and shale. In the MCW, these confining layers include the Cedar Valley Group, the Lime Creek Formation, the Kinderhookian Group, and the Scotch Grove Formation (**Figure 2-10**).

Recharge to the Mississippian aquifer is from: a) precipitation where the bedrock is at or near the surface, b) leakage to the aquifer from the Cedar River and its tributaries, and c) groundwater inflow from areas outside of the MCW. The Mississippian Aquifer is heavily used as a drinking and industrial water supply. The Devonian-Silurian Aquifer (Middle Bedrock Aquifer) is also used by several communities and rural residents. The main water-producing units in the Devonian-Silurian are a series of limestones and dolostones. There are also more than 200 shallow, quaternary and alluvial wells that are heavily used as both a drinking water source and industrial water supply.

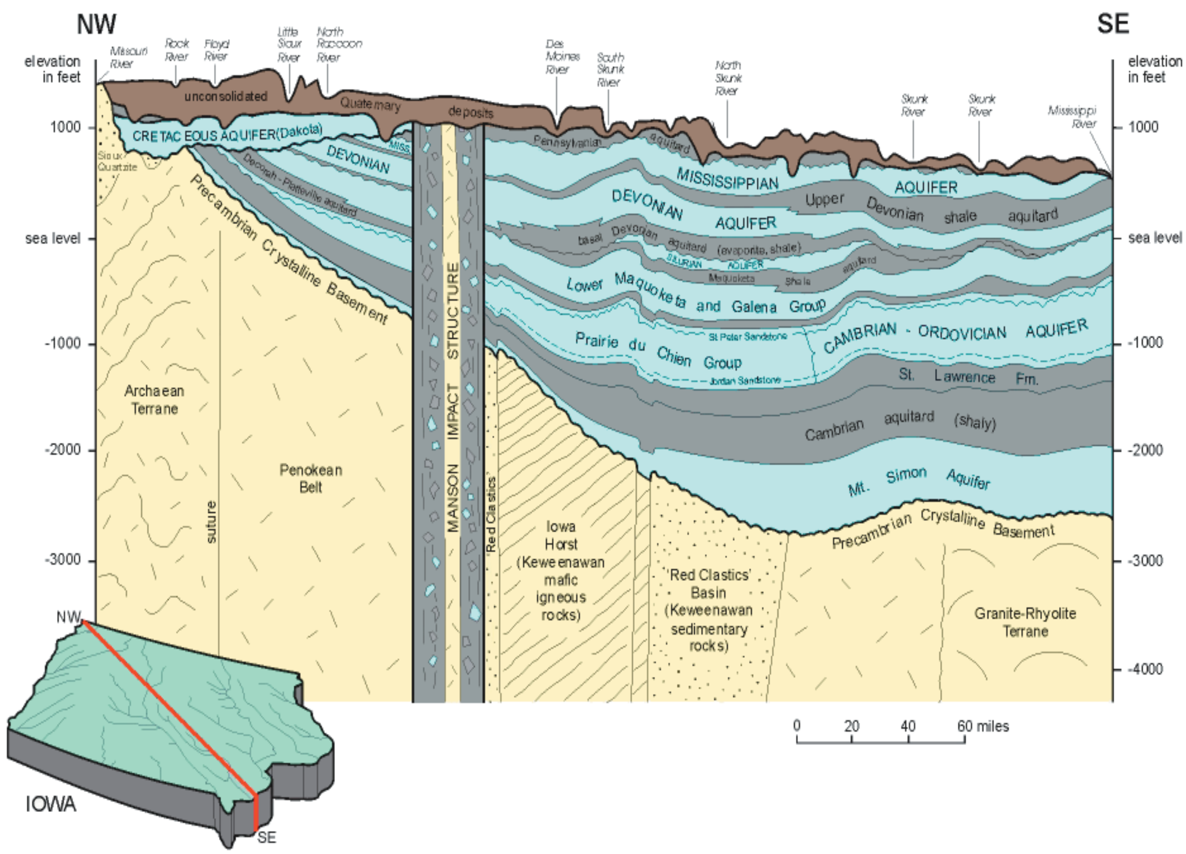

Figure 2-9. Generalized hydrogeological cross-section from northwestern to southeastern Iowa (modified from Prior and others, 2003).

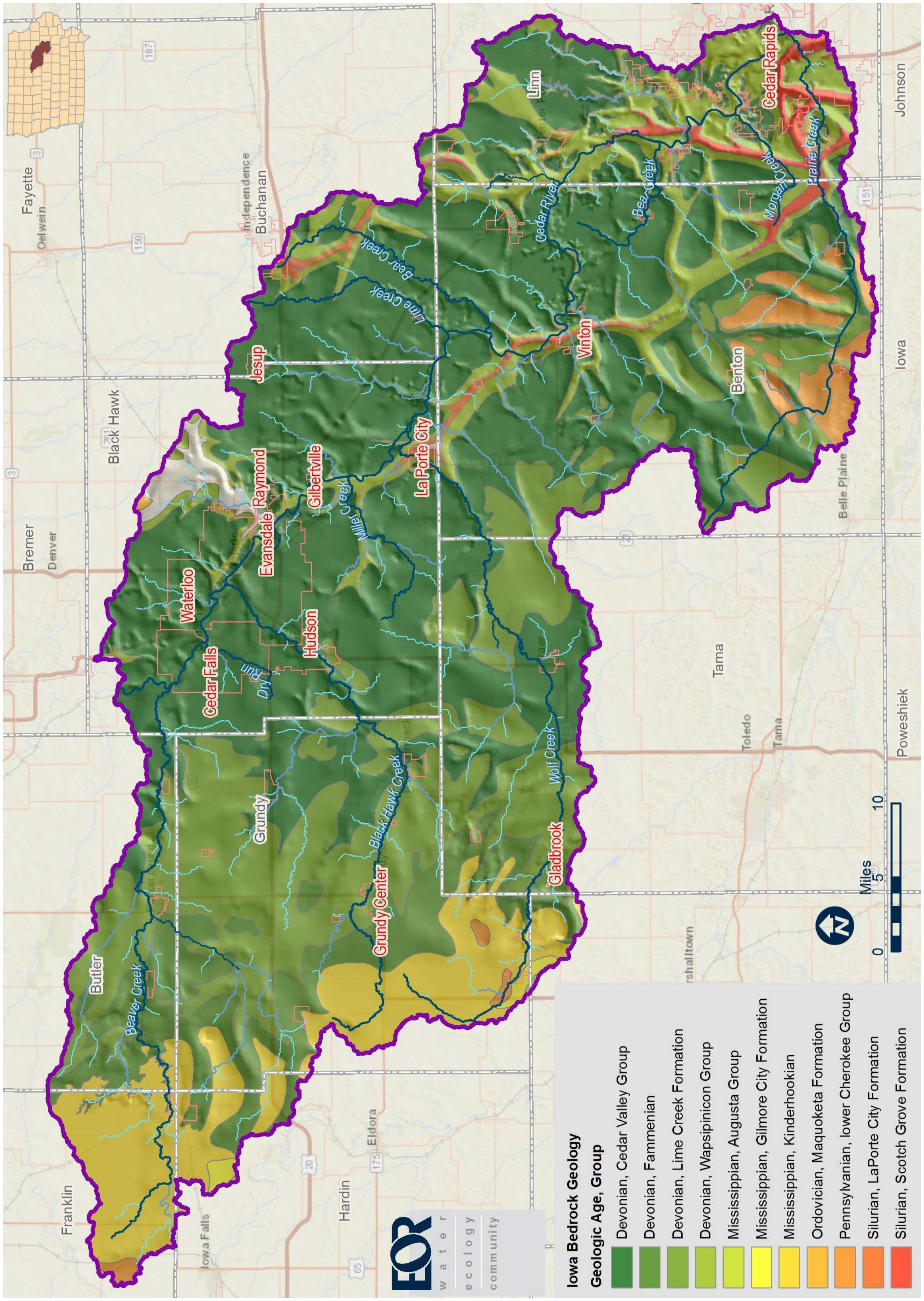

Figure 2-10. Middle Cedar Watershed—Bedrock Geologic Age and Group.

Groundwater Vulnerability

In 1991, the Iowa DNR identified regions of Iowa with similar hydrogeological characteristics and classified these characteristics into 10 unique groups (map units) based on their relative vulnerability to groundwater contamination. Reviewing these classifications for the MCW makes it possible to see where groundwater protection issues are most relevant (**Figure 2-11**). Groundwater quality, yield, and susceptibility to contamination is described below for each map unit:

Alluvial Aquifers: Areas underlain by sand and gravel aquifers situated beneath floodplains along stream valleys, alluvial deposits associated with stream terraces and benches, and glacial outwash deposits; natural water quality generally excellent (less than 500 mg/L total dissolved solids[TDS]) and yields vary with texture and thickness of alluvium (commonly greater than 100 gallons/minute [GPM] in larger valleys, less in smaller valleys); most wells are very shallow; high potential for aquifer contamination; high potential for well contamination.

Bedrock Aquifers: Area underlain by regional bedrock aquifers, primarily fractured carbonate units; other regional aquifers usually available at various depths. Natural water quality usually excellent (less than 500 mg/L TDS) and high yields commonly available (greater than 100 GPM).

Thin Drift Confinement: Less than 100 feet of glacial drift overlie regional aquifers; most wells are deep and completed in the bedrock aquifers; high potential for aquifer contamination; high potential for well contamination.

Moderate Drift Confinement: 100 to 300 feet of glacial drift overlie regional aquifers; most wells are deep and completed in the bedrock aquifers; low potential for aquifer contamination low potential for well contamination.

Variable Bedrock Aquifers: Area underlain by regional bedrock aquifers including carbonate and sandstone units; aquifers vary considerably in natural water quality (500-2000 mg/L TDS) and yields (although generally above 20 GPM).

Thin Drift Confinement: Less than 100 feet of glacial drift overlie regional aquifers; most wells are deep and completed in the bedrock aquifers; moderate to high potential for aquifer contamination; moderate to high potential for well contamination.

Moderate Drift Confinement: 100 to 300 feet of glacial drift overlie regional aquifers; most wells are deep and completed in the bedrock aquifers; low potential for aquifer contamination low potential for well contamination; high potential for contamination of drift wells.

Shale Drift Confinement: Cherokee shales or Upper Cretaceous shales overlie Mississippian carbonate or Dakota Sandstone aquifers respectively; most wells are shallow and developed in the drift, some wells are deep and completed in the bedrock aquifers; low potential for aquifer contamination; high potential for contamination of drift wells; moderate potential for contamination of bedrock wells.

Drift Groundwater Source: Bedrock aquifers are absent or overlain by greater than 300 feet of glacial drift; wells are completed in thin, discontinuous deposits of sand and gravel within the till or at the interface between overlying loess and rill: natural water quality is highly variable (250-2500 mg/L TDS) and yields are generally low (less than 10 GPM); most wells are shallow and completed in the drift; low potential for bedrock aquifer contamination; high potential for well contamination.

Sinkholes: Naturally occurring depressions in the landscape caused by solution or the collapse of carbonate rocks; common where limestone is less than 30 feet below land surface. Contaminated surface water may enter the aquifer via sinkholes, contaminating the aquifer in a localized area; contaminant levels can fluctuate significantly during periods varying from minutes to weeks; increases contamination potential in areas with thin drift confinement.

Agricultural Drainage Wells: Wells drilled to drain surface water and soil into carbonate aquifers; their presence allows contaminants in surface or tile water to enter the aquifers at much higher rates than naturally would be possible; increases contamination potential much like sinkholes.

Twenty-three highly susceptible wells and three priority communities (Waterloo, Cedar Falls, and Conrad) have been identified within the MCW (**Figure 2-11**). Communities can coordinate with the Iowa DNR to conduct a site investigation to determine if the contaminant is from a point or non-point source.

Hinkle Creek, Vinton, Iowa (Photo Credit: EOR)

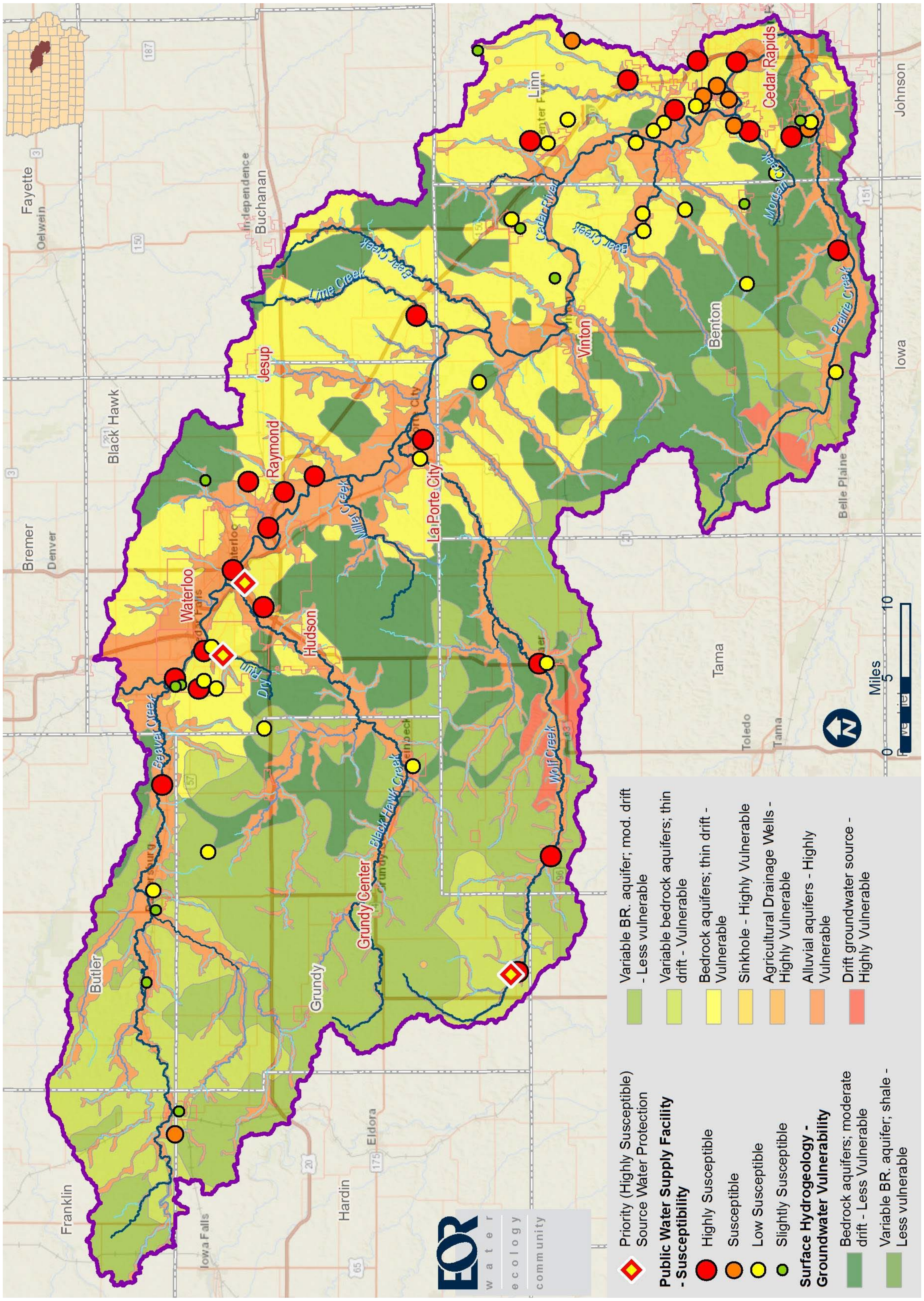

Figure 2-11. Middle Cedar Watershed—Highly Susceptible Wells and Groundwater Vulnerability.

Source Water Protection Areas and Highly Vulnerable Groundwater Wells

The Iowa DNR has also developed a GIS layer depicting groundwater capture zones – the land surface area that has been determined to provide water to a public water supply well based on available geologic and hydrogeologic information. Groundwater capture zones located in areas with high vulnerability for aquifer and well contamination and/or areas with high-observed pollutant concentrations (i.e., nitrate-nitrite concentrations exceeding 10 mg/L) should be prioritized as source water protection areas (**Figure 2-12**). The Iowa DNR operates a Source Water Protection Program, which requires a Phase 1 Assessment that defines the source water area and susceptibility to contamination. Gilbertville and Jesup have both completed the Phase 2 Storm Water Protection Plan and Cedar Rapids is currently working on their Phase 2 plan.

Black Hawk Creek, Grundy Center, Iowa (Photo Credit: EOR)

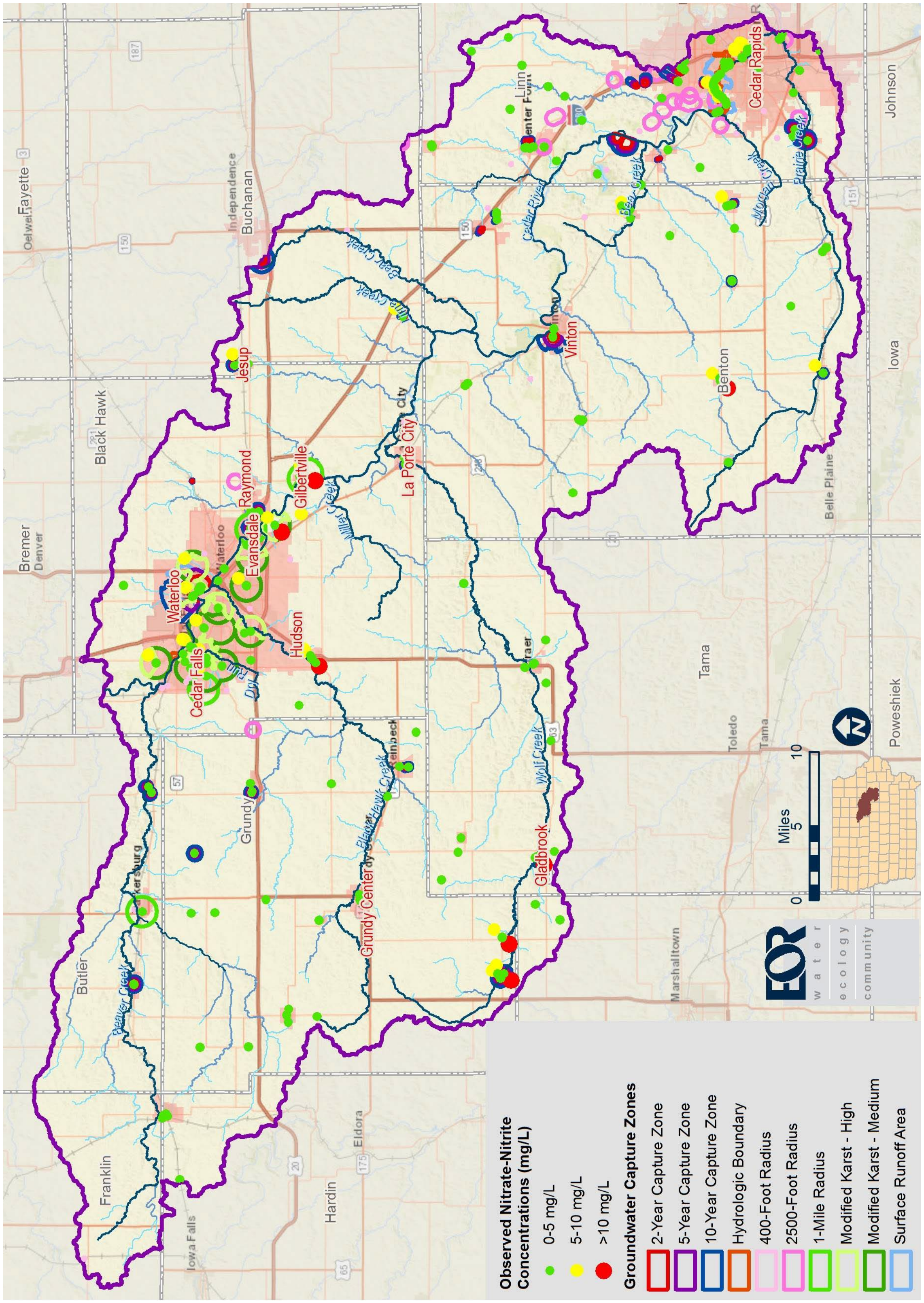

Figure 2-12. Middle Cedar Watershed—Groundwater Capture Zones and Observed Nitrate-Nitrite Concentrations.

2.2. Water Resources

The following section describes the current state of lakes and streams within the MCW. The section begins with a general summary of the stream network within the watershed followed by a discussion of water quality conditions of each streams.

2.2.1. Watershed Streams

The streams within the MCW have been classified into the following management categories based on their designated uses and local significance.

Primary Streams: Streams within the MCW with a DNR Designated Use of Primary Recreation and/or Human Health are classified as “primary streams” (**Figure 2-13**). Primary streams should be managed to meet their designated use classifications; these streams represent the highest priority for protection and restoration measures. Unnamed streams with water quality impairments are included within the primary streams. In some cases, the management category for a given stream differs from the upper portion to the lower reaches.

Secondary Streams: Named streams that maintain flow and/or pooled areas sufficient to maintain a viable aquatic community and support recreational uses that have not been assigned a designated use are classified as “secondary streams” (**Figure 2-13**). Secondary streams represent the major tributaries to the MCW’s Primary streams. Secondary streams represent the second highest priority for conservation measures.

Others Streams: General use, unnamed streams within the MCW are shown as “other streams” in **Figure 2-13.** These other streams are typically used for livestock and wildlife watering, aquatic life, noncontact recreation, and industrial, agricultural, or domestic withdrawal uses but do not represent the highest primary targets for implementation of conservation measures.

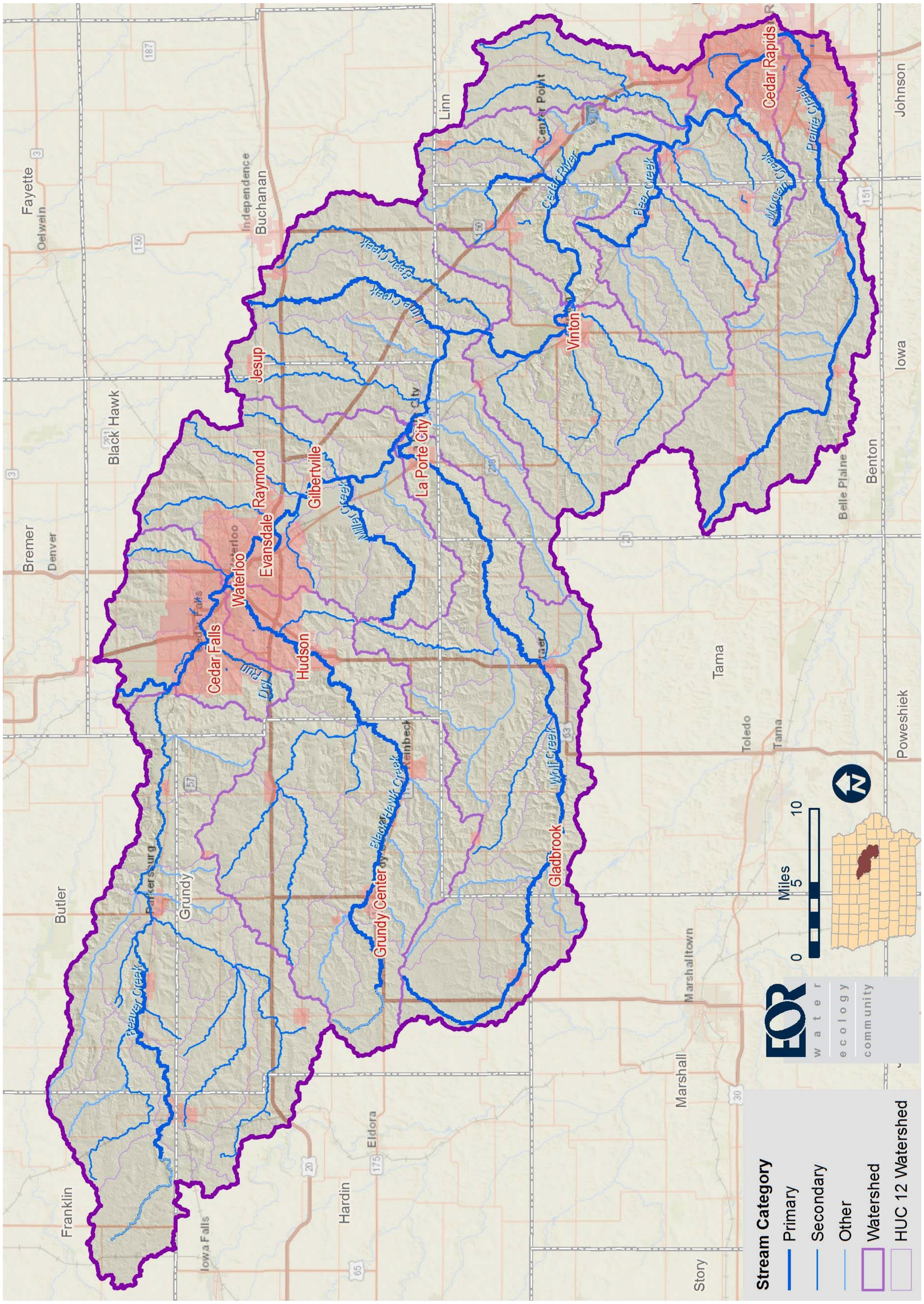

Figure 2-13. Middle Cedar Watershed—Streams.

2.2.2. Watershed Lakes

There are eight public lakes larger than 10 acres in the MCW, the largest of which is Pleasant Creek Lake, at approximately 404 acres (**Figure 2-14**).

Table 2-6 describes each lake's morphometry, recreational amenities, water quality trends, impairment status, and includes a link to the Iowa DNR's website, which provides additional information regarding recreational opportunities, as well as fish stocking information and bathymetric maps of the lake.

Pleasant Creek Lake recently underwent a $2.4 million restoration project which was funded through the Lake Restoration Program, marine fuel tax, coast guard funds, Resource Enhancement and Protection (REAP), and fishing license fees. The lake is now fully supportive of primary contact recreational uses and is being considered for potential de-listing from the Impaired Waters List.

While some designated uses are being met on Green Belt Lake, Rodgers Park Lake, and South Prairie Lake, an insufficient amount of data has been collected to date to determine whether the remaining uses are met. Similarly, an insufficient amount of information exists to determine whether any designated uses are met on George Wyth Lake and Mitchell Lake. A Total Maximum Daily Load Study (TMDL) is needed to address the Algal Growth and Chlorophyll-A Impairment on Meyers Lake.

Table 2-6. Middle Cedar Watershed Public Lakes.

Lake Name	Size (Acres)	Max. Depth (Feet)	Public Amenities								Trophic Status	Water Quality Trend (ADBNet)	2016 Impairment Category (ADBNet)
			Boat Access	Trails	Shore Fishing	Camping	Playground	Beach	Picnic	DNR Link			
Casey Lake (Hickory Hills)	36.9	22	✓	✓	✓	✓	✓		✓	Y	Eutrophic	Improving	4a
George Wyth Lake	74.87	18.7	✓	✓	✓	✓	✓	✓	✓	Y	Eutrophic	Improving	3
Green Belt Lake	18.67	N/A		✓	✓					Y	Eutrophic	Declining	2
Meyers Lake	31.04	27	✓		✓		✓		✓	Y	Eutrophic	Stable	5a
Mitchell Lake	12.61	N/A								N	Eutrophic	Stable	3
Pleasant Creek Lake	404.43	55	✓	✓	✓	✓	✓	✓	✓	Y	Eutrophic	Stable	5*
Rodgers Park Lake	21.25	18	✓	✓	✓	✓	✓	✓	✓	Y	Eutrophic	Unknown	2
South Prairie Lake	24.66	22	✓	✓	✓				✓	Y	Eutrophic	Stable	2

5* - 303(d)-impaired last cycle; fully supporting this cycle; potential de-listing

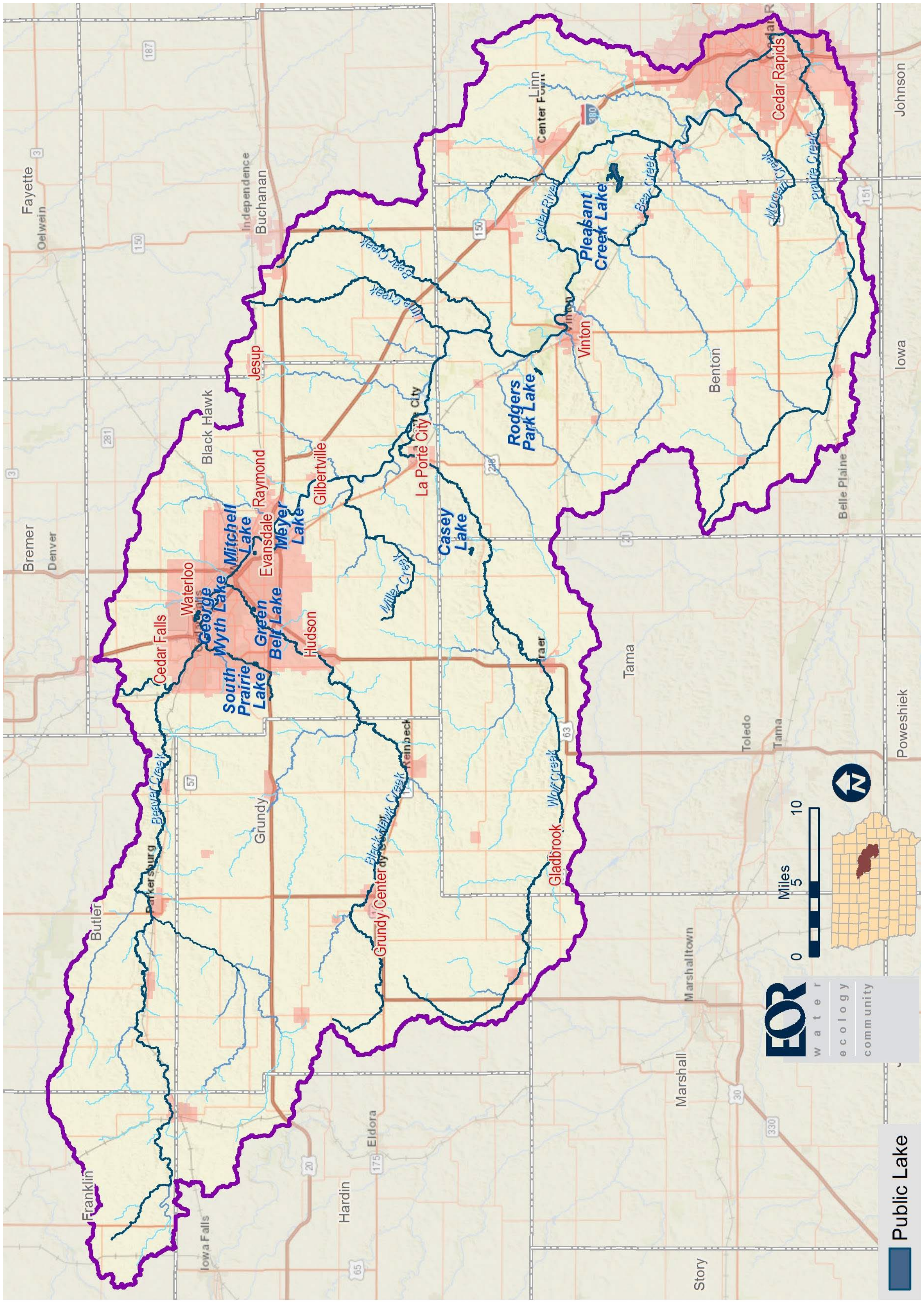

Figure 2-14. Middle Cedar Watershed—Public Lakes.

2.2.3. Iowa Waters Designated Uses

Iowa's surface water classifications are described in Iowa Administrative Code IAC 61.3(1) as two main categories, **Designated Uses** and **General Uses**.

Designated use segments are water bodies which maintain flow throughout the year or contain sufficient pooled areas during intermittent flow periods to maintain a viable aquatic community. There are a total of 6 lakes and 106 stream segments in the MCW, some of which have multiple designations. Designated use classifications for the streams of the MCW are shown in **Table 2-7.**

Primary contact recreational use: Class A1
Waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risk of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, canoeing and kayaking.
There are 32 Class A1 stream designations and 4 Class A1 lake designations in the Middle Cedar Watershed.

Secondary contact recreational use: Class A2
Waters in which recreational or other uses may result in contact with the water that is either incidental or accidental. During the recreational use, the probability of ingesting appreciable quantities of water is minimal. Class A2 uses include fishing, commercial and recreational boating, any limited contact incidental to shoreline activities and activities in which users do not swim or float in the water body while on a boating activity.
There are 42 Class A2 stream designations in the Middle Cedar Watershed.

Children's recreational use: Class A3
Waters in which recreational uses by children are common. Class A3 waters are water bodies having definite banks and bed with visible evidence of the flow or occurrence of water. This type of use would primarily occur in urban or residential areas.
There are 20 Class A3 stream designations in the Middle Cedar Watershed.

Warm water Type 1: Class B(WW-1)
Waters in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrate species. These waters generally include border rivers, large interior rivers, and the lower segments of medium-size tributary streams.
There are 16 Class BWW-1 stream designations in the Middle Cedar Watershed.

Warm water Type 2: Class B(WW-2)
Waters in which flow or other physical characteristics are capable of supporting a resident aquatic community that includes a variety of native nongame fish and invertebrate species. The flow and other physical characteristics limit the maintenance of warm water game fish populations. These waters generally consist of small perennially flowing streams.
There are 77 Class BWW-2 stream designations in the Middle Cedar Watershed.

Warm water Type 2: Class B(WW-3)
Waters in which flow persists during periods when antecedent soil moisture and groundwater discharge levels are adequate; however, aquatic habitat typically consists of nonflowing pools during dry periods of the year. These waters generally include small streams of marginally perennial aquatic habitat status. Such

waters support a limited variety of native fish and invertebrate species that are adapted to survive in relatively harsh aquatic conditions.

There is one Class WW-3 stream designation in the Middle Cedar Watershed.

Lakes and wetlands: Class B(LW)

These are artificial and natural impoundments with hydraulic retention times and other physical and chemical characteristics suitable to maintain a balanced community normally associated with lake-like conditions.

There are eight Class B(LW) designation in the Middle Cedar Watershed.

Drinking Water: Class C

Waters which are used as a raw water source of potable water supply.

There is one Class C stream designation in the Middle Cedar Watershed. It is the reach of the Cedar River from its confluence with McLoud Run to its confluence with Bear Creek.

Human health: Class HH

Waters in which fish are routinely harvested for human consumption or waters both designated as a drinking water supply and in which fish are routinely harvested for human consumption.

There are 16 Class HH stream designations and 2 Class HH lake designations in the Watershed.

General use: GU

General use segments are intermittent watercourses and those watercourses which typically flow only for short periods of time following precipitation and whose channels are normally above the water table. These waters do not support a viable aquatic community during low flow and do not maintain pooled conditions during periods of no flow.

Table 2-7. Surface Water Designated Use Classifications for Middle Cedar Watershed Streams.

Class	Sub-Class	Description	# of MCW Stream Designations	# of MCW Lake Designations
Class A	*A1*	Primary Contact Recreation (full body contact with the water, such as swimming or water skiing)	32	4
	A2	Secondary Contact Recreation (incidental contact with the water, such as fishing)	42	0
	A3	Children's Contact Recreation (limited contact with the water, such as wading or playing in the water)	20	0
Class B	*WW-1*	Larger rivers capable of supporting a wide variety of species, including game fish	16	0
	WW-2	Smaller streams with resident fish populations, but not usually game fish	77	0
	WW-3	Intermittently flowing streams with permanent pools capable of supporting a resident aquatic community in harsher conditions	1	0
Class C		Drinking water supply	1	0
Class HH		Human Health (waters in which fish are routinely harvested for human consumption)	16	2

2.2.4. Iowa Outstanding Waters

An Outstanding Iowa Water (OIW) is defined as the following: A surface water that the DNR has classified as an outstanding state resource water in the water quality standards. All OIW receive important protection referred to as Tier 2 ½ protection. Tier 2 ½ protection refers to the set of federal and state regulations that are designed to protect these high quality waters from unnecessary pollution. According to Dan Kirby, Iowa DNR Manchester District Fisheries Biologist, Lime and Bear Creek (**Figure 2-15**) qualify for as an OIW primarily due to observed exceptional fish community characteristics. Biological sampling conducted by the DNR on Lime Creek in 2008, 2010, and 2013 identified good to excellent communities of both fish and macroinvertebrates as well as several state-listed mussel species. Additional information on biological data collected to date on Lime Creek can be found on the Iowa DNR's ADBNET website (Iowa DNR 2019a). Similarly, biological data collected in 2009, 2010, and 2013 identified good to excellent communities of both fish and macroinvertebrates in Bear Creek. It should be noted that the primary contact recreation uses in both streams are currently assessed as "not supported" due to high levels of indicator bacteria *Escherichia coli* (*E. coli*).

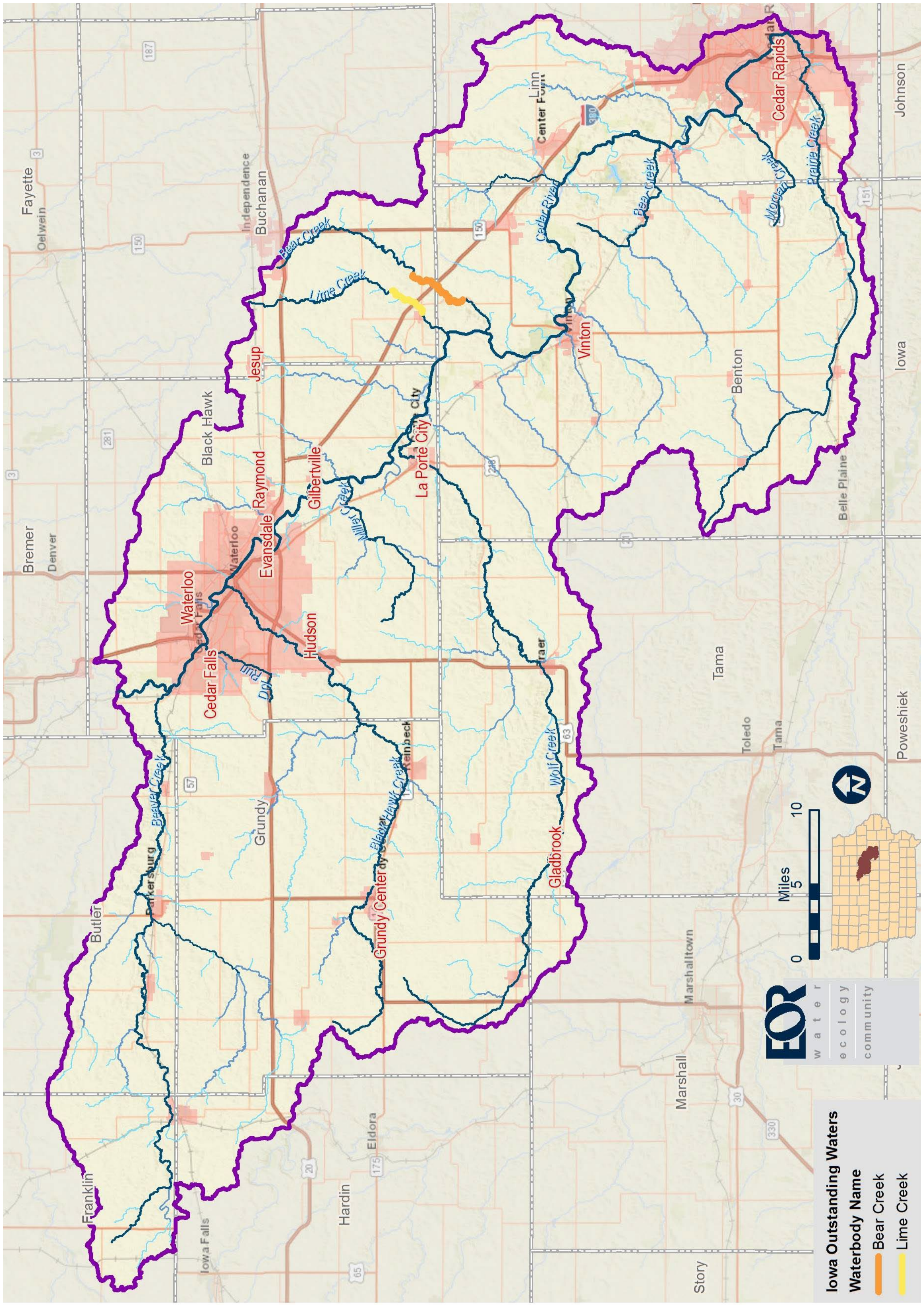

Figure 2-15. Middle Cedar Watershed—Outstanding Waters.

2.2.5. Recreational Use

According to a survey conducted by ISU the Cedar River is one of the most heavily used rivers in the state (Ji, Herriges, and Kling 2010) Furthermore, the Cedar River represents an ecologically significant resource as it provides habitat for a rich assemblage of fish species including many Species of Greatest Conservation Need, which are designated through the State Wildlife Action Plan process (personal communication with Dan Kirby, Iowa DNR Manchester District Fisheries Biologist). **Figure 2-16** identifies some of the most important recreational resources within the MCW including Iowa DNR Outstanding Waters, High Value Fisheries, Public parks, Wildlife Management Areas and Preserves larger than 50 acres, Hiking/Walking Trails, and Designated Paddling Routes.

Lime Creek and Bear Creek represent two of the three **warm-water** streams listed as "Outstanding Iowa Waters" in the entire state. More information about Outstanding Iowa Waters (including Lime Creek and Bear Creek) is presented in Section 2.2.4. Iowa DNR fisheries professionals provided a qualitative evaluation of streams in the watershed with regards to their importance as a fishery resource based on professional judgement. High value fisheries in the MCW include McLoud Run which is Iowa's only urban trout stream, Black Hawk Creek, which is an Iowa DNR designated Canoe Route, and Wolf Creek which is regularly used for canoeing and kayaking from La Porte City to the confluence with the Cedar River (**Figure 2-16**). There is a total of 156 river miles of designated paddling trails within the MCW.

There are 77 publicly owned green spaces larger than 50 acres in the watershed including 34 city/county parks, 4 state parks/preserves, one state off-highway vehicle area, one state recreation area, one historic site, one public access (Falls Access), and 35 wildlife management areas. Forty-four of the 77 publicly owned greenspaces are open to hunting, the remaining natural areas provide valuable greenbelts for wildlife and offer opportunities for a variety of recreational activities including cross-country skiing, hiking, walking, bird-watching, and geocaching.

An excellent resource for recreational users of MCW waters can be found on the Cedar Falls Tourism website. The map was developed by the Cedar Valley Paddlers, Iowa DNR, Iowa Water Trails and Grundy County Conservation Board.

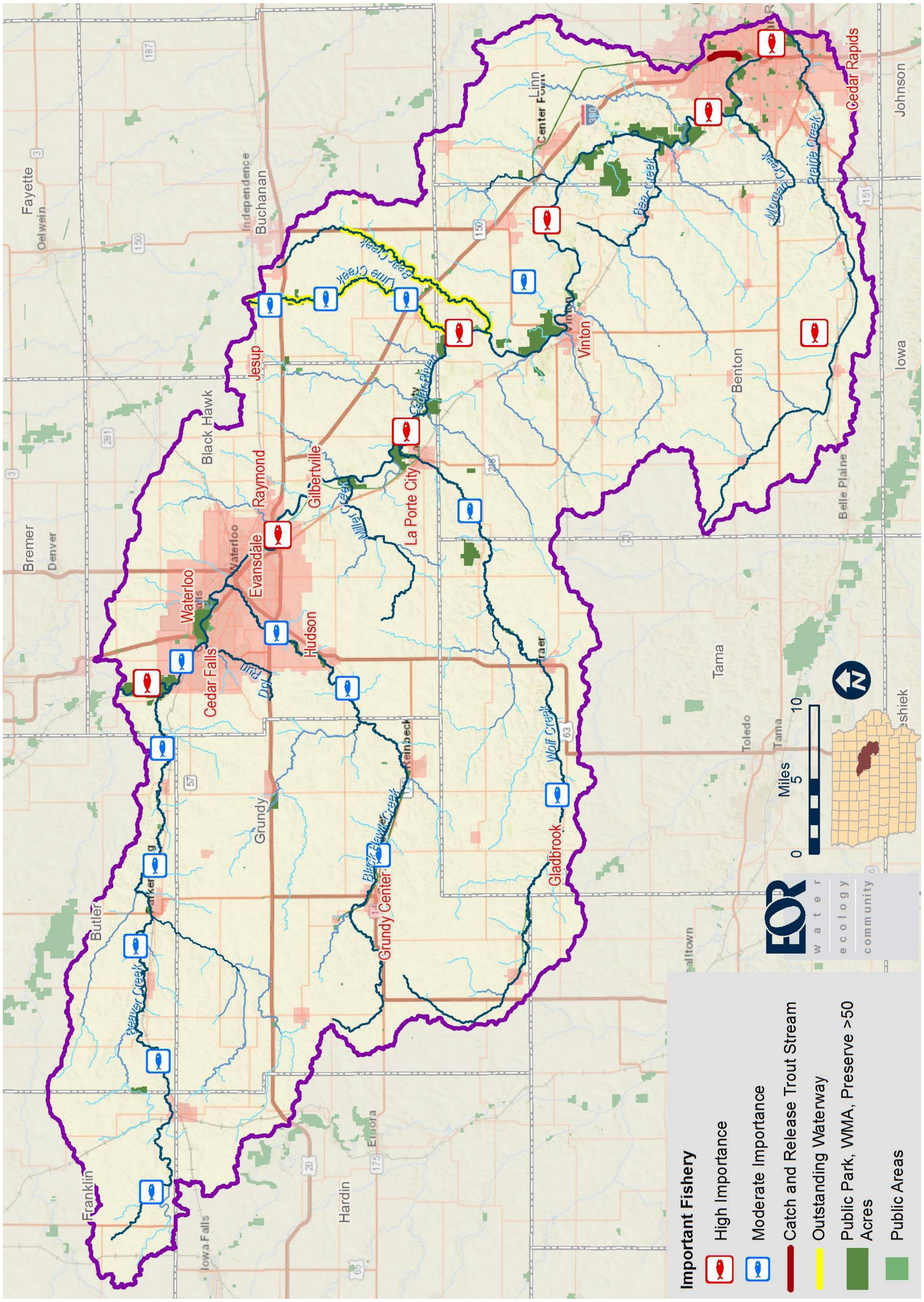

Figure 2-16. Middle Cedar Watershed—Recreational resources.

2.2.6. Impaired Waters

The State of Iowa has developed State Water Quality Standards that are found in Chapter 61 of the Iowa Administrative Code. The water quality standards are based on the designated use of the receiving water. As water quality monitoring data is collected on streams and lakes, compliance to these standards determines whether a given water body is meeting its designated use. In cases where the water body does not meet its designated use, it is considered to be an impaired water. This process is prescribed under the Clean Water Act. The State of Iowa develops a list of impaired waters every two years that is presented to the U.S. Environmental Protection Agency. This list, referred to as the Impaired Waters List includes information on impaired use, the source of impairment and whether or not a TMDL Study will be required.

The most recent Impaired Waters List for the State of Iowa (Iowa DNR 2016) included 48 impaired waterbodies in the MCW; 35 primary contact recreation impairments (**Table 2-8**), 12 aquatic life impairments (**Table 2-9**) and one drinking water impairment. The impaired waters list was prepared according to U.S. EPA guidelines that combine (integrate) requirements of Sections 305(b), 303(d), and 314 of the federal Clean Water Act. These guidelines suggest that states place all their waters (lakes, wetlands, streams, and rivers) into one of five general categories of their Integrated Report (Iowa DNR 2016):

Category 1:
All designated uses (e.g., water contact recreation, aquatic life, and/or drinking water) are met.

Category 2:
Some of the designated uses are met, but insufficient information exists to determine whether the remaining uses are met.

Category 3:
Insufficient information exists to determine whether any uses are met.

Category 4:
The waterbody is impaired but a TMDL is not required.

Category 5:
The waterbody is impaired and a TMDL is required.

The state of Iowa has further divided impaired waterbodies (Category 4, 5) into the subcategories described below. The relevant categories for all impaired streams and lakes in the MCW are provided in **Table 2-8**.

Category 4a TMDL Completed:
A TMDL has been completed for the water-pollutant combination.

Category 4d:
Water is impaired due to a pollutant-caused fish kill and enforcement actions were taken against the party responsible for the kill: a TMDL is neither appropriate nor needed.

Category 5a TMDL Needed:
Water is impaired or threatened by a pollutant stressor and a TMDL is needed.

Category 5b:
Impairment is based on results of biological monitoring or a fish kill investigation where specific causes and/or sources of the impairment have not yet been identified.

5b-t [tentative]:
The aquatic life uses of a stream segment with a watershed size within the calibration range of the IDNR biological assessment protocol (~10 to 500 square miles) are assessed as Section 303(d)-impaired based on an evaluated assessment. The reasons for residency in this subcategory include: 1) data quantity (only one of the two biological samples needed to identify an impairment have been collected), 2) data age (data older than five years), 3) data quality (marginal sampling conditions for biota), and 4) sampling frequency (multiple samples collected in same year, not multiple years).

5b-v [verified]:
The aquatic life uses of a stream with a watershed size within the calibration range of IDNR biological assessment protocol (~10 to 500 square miles) are assessed as Section 303(d)-impaired based on results of the required two or more biological sampling events in multiple years within the previous five years needed to confirm the existence of a biological impairment.

Category 5p Presumptive Use:
Impairment occurs on a waterbody presumptively designated for Class A1 primary contact recreation use or Class B (WW1) aquatic life use.

Drinking Water Supply Impairment

There is one drinking water supply impairment on the Cedar River. A TMDL has been completed for this reach as described in the Cedar River Nitrate TMDL (Section 3.7.1).

Primary Contact Impairments

There are 31 bacteria, one turbidity, two pH, and one algal growth impairments currently listed on Iowa's 303(d) list in the MCW which do not support the designated use of primary contact recreation (**Figure 2-17** and **Table 2-8)**. The Bacteria Impairments are based on monitoring data which show that the geometric mean *E. coli* concentrations exceeded the 126 organisms/100 mL standard. Bacteria TMDLs have been completed for Black Hawk Creek and two reaches of the Cedar River. A Turbidity TMDL has also been completed for Casey Lake (Hickory Hills Lake).

There are five streams identified as Impairment Category 5a waterbodies; a TMDL is needed to address the Bacteria Impairment on these 5 streams. A TMDL is needed to address the two segments of the Cedar River with pH impairments. The remaining 23 streams with Bacteria Impairments are listed as Impairment Category 5p waterbodies. Category 5p waterbodies are defined as waterbodies that are presumptively designated for Class A1 primary contact recreation use or Class B (WW-1) aquatic life use. Due to changes in the Iowa Water Quality Standards that became effective in March 2006, all perennial streams are assumed to be capable of supporting the highest level of primary contact recreation use (Class A1) and the highest level of aquatic life use [Class B (WW-1)]. A Use Attainability Analysis (UAA) must be conducted, including field investigations, to determine whether a presumptively-applied use is, in fact, the appropriate designated use for the stream segment in question. Until a UAA has been conducted and the appropriate designated uses have been applied and approved by U.S. EPA, any impairments on presumptively-designated Iowa streams will be placed in IR Category 5p.

Table 2-8. Middle Cedar Watershed Primary Contact Recreation Impaired Streams and Lakes.

Waterbody	Segment ID	Year	Category	Impairment
Black Hawk Creek	545	2002	4a TMDL Completed	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/545
Cedar River	461	2004	4a TMDL Completed	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/461
Cedar River	468	2004	4a TMDL Completed	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/468
Casey Lake	531	2014	4a TMDL Completed	Turbidity https://programs.iowadnr.gov/adbnet/Segments/531
Dry Run	554	2008	5a TMDL Needed	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/554
Cedar River	456	2014	5a TMDL Needed	pH https://programs.iowadnr.gov/adbnet/Segments/456
Cedar River	457	2014	5a TMDL Needed	pH https://programs.iowadnr.gov/adbnet/Segments/457
Cedar River	462	2008	5a TMDL Needed	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/462
Cedar River	469	2008	5a TMDL Needed	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/469
Cedar River	470	2008	5a TMDL Needed	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/470
Pleasant Creek Lake	459	2012	5a TMDL Needed	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/459
Meyers Lake	463	2008	5a TMDL Needed	Algal Growth; Chlorophyll a https://programs.iowadnr.gov/adbnet/Segments/463
McLoud Run	508	2014	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/508
Morgan Creek	513	2014	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/513
Otter Creek	514	2014	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/514
Bear Creek	517	2014	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/517
Mud Creek	519	2014	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/519
Bear Creek	523	2014	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/523

Waterbody	Segment ID	Year	Category	Impairment
Lime Creek	524	2014	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/524
Lime Creek	525	2014	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/525
Wolf Creek	530	2008	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/530
Black Hawk Creek	546	2008	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/546
Black Hawk Creek	550	2008	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/550
North Black Hawk Creek	551	2008	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/551
Holland Creek	552	2008	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/552
Dry Run (South Branch)	2062	2008	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/2062
Dry Run (North Branch)	2063	2008	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/2063
Blue Creek	518	2014	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/518
Dry Run	6293	2012	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/6293
Unnamed Tributary to Dry Run	6294	2012	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/6294
Unnamed Tributary to Lime Creek	6432	2014	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/6432
Beaver Creek	555	2008	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/555
Mosquito Creek	6489	2012	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/6489
Minnehaha Creek	6490	2012	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/6490
Holland Creek	6491	2012	5p Presumptive Use	Bacteria: Indicator Bacteria, *E. coli* https://programs.iowadnr.gov/adbnet/Segments/6491

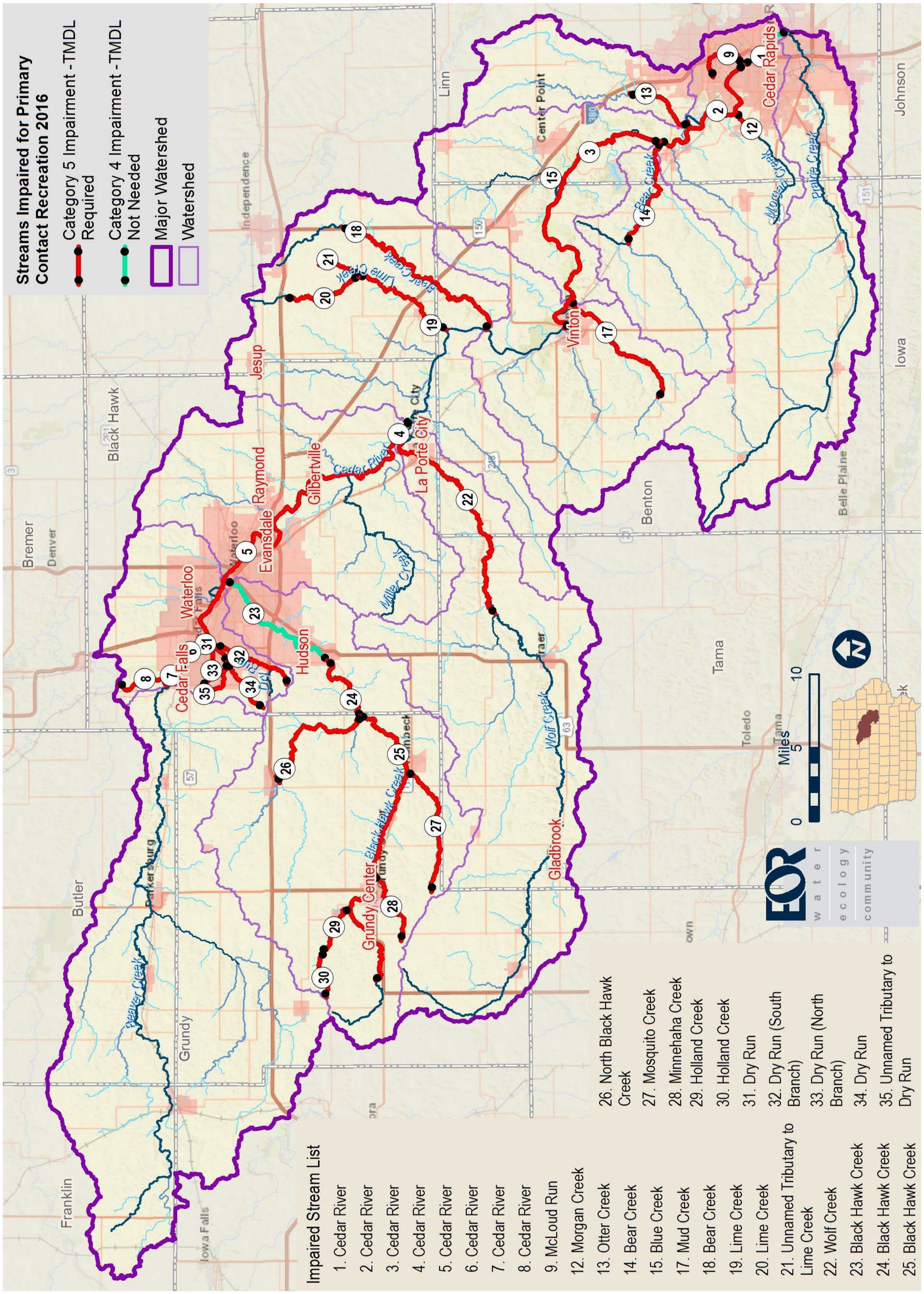

Figure 2-17. Middle Cedar Watershed—Primary Contact Recreation Impaired Streams and Lakes.

Aquatic Life Impairments

There are a total of 12 impairments to the aquatic life designated use (**Figure 2-18** and **Table 2-9**). These include biologic sources/stressors that in some cases have led to fish kills: thermal, chlorine, low dissolved oxygen, ammonia, low index of biotic integrity (IBI), organic enrichment, and at least one unknown toxicity. TMDLs have been completed for McLoud Run (thermal modification) and Middle Fork South Beaver Creek (IBI). Two impairments do not require a TMDL, as they were caused by fish kills where enforcement action has been taken (unnamed tributary to McLoud Run and Prairie Creek). Lime Creek was de-listed in the 2016 cycle due to improved mussel biodiversity.

Table 2-9. Middle Cedar Watershed Aquatic Life Impaired Streams.

Waterbody	Segment ID	Year	Category	Impairment
McLoud Run	508	2002	4a TMDL Completed	Fish Kill: Due To Thermal Modifications https://programs.iowadnr.gov/adbnet/Segments/508
Middle Fork South Beaver Creek	563	1998	4a TMDL Completed	Biological: low Biological Integrity https://programs.iowadnr.gov/adbnet/Segments/563
Prairie Creek	510	2004	4d TMDL not needed	Fish Kill: Caused By Animal Waste https://programs.iowadnr.gov/adbnet/Segments/510
Unnamed Tributary to McLoud Run	6302	2012	4d TMDL not needed	Fish Kill: Caused By Spill https://programs.iowadnr.gov/adbnet/Segments/6302
Cedar River	456	2014	5a TMDL needed	Biological: low Biological Integrity https://programs.iowadnr.gov/adbnet/Segments/456
Cedar River	457	2014	5a TMDL needed	Biological: low Biological Integrity https://programs.iowadnr.gov/adbnet/Segments/457
McLoud Run	508	2006	5b TMDL needed	Fish Kill: Due To Unknown Toxicity https://programs.iowadnr.gov/adbnet/Segments/508
McLoud Run	508	2014	5b TMDL needed	Fish Kill: Caused By Chlorine https://programs.iowadnr.gov/adbnet/Segments/508
East Branch Blue Creek	1880	2006	5b TMDL needed	Fish Kill: Caused By Fertilizer Spill https://programs.iowadnr.gov/adbnet/Segments/1880
Black Hawk Creek	546	2006	5b-t TMDL needed	Biological: low aquatic macroinvertebrate IBI https://programs.iowadnr.gov/adbnet/Segments/546
Dry Run	554	2004	5b-v TMDL needed	Biological: low fish & invert IBIs, cause unknown https://programs.iowadnr.gov/adbnet/Segments/554
Beaver Creek	557	2008	5b-v TMDL needed	Biological: low aquatic macroinvertebrate IBI https://programs.iowadnr.gov/adbnet/Segments/557

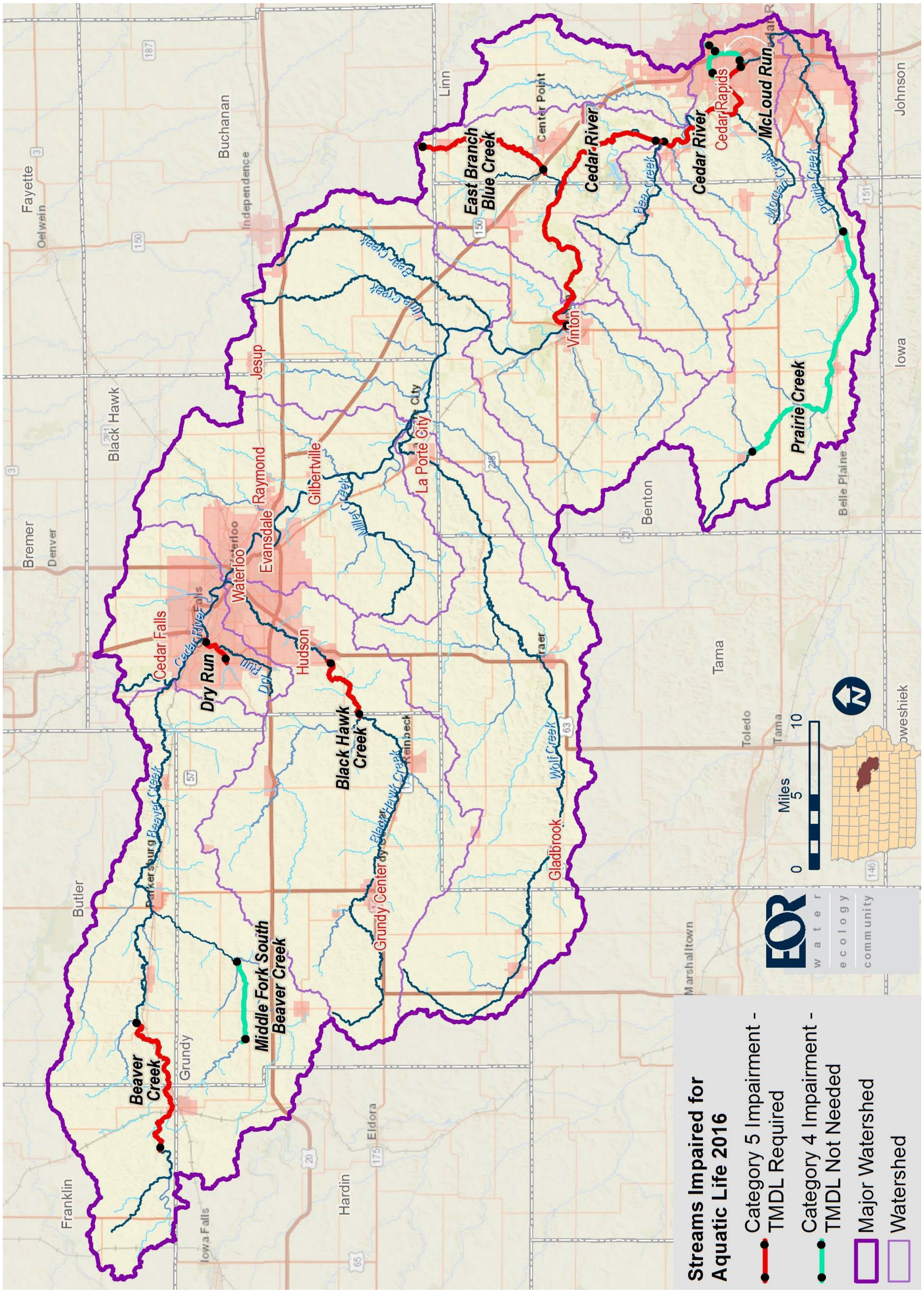

Figure 2-18. Middle Cedar Watershed—Aquatic Life Impaired Streams.

2.2.7. Total Maximum Daily Load Studies

A TMDL study is a determination of the maximum load of pollutant a given water body can receive and continue to meet water quality standards for that particular pollutant. TMDLs are conducted on water bodies where pollutant levels have been found to be in excess of water quality standards resulting in that water body failing to meet a designated use, also referred to as having an impairment.

TMDL studies determine a pollutant reduction target and allocate a portion of the needed reductions to each source of pollutant, which all include a margin of safety. Pollutant sources are characterized as either point sources or nonpoint sources. Point sources receive a wasteload allocation (WLA) and include all sources that are subject to regulation under the National Pollutant Discharge Elimination System (NPDES) program, e.g. wastewater treatment facilities, stormwater discharges in Municipal Separate Storm Sewer System (MS4) Communities and concentrated animal feeding operations (CAFOs). Nonpoint sources receive a load allocation (LA) and include all remaining sources of the pollutant as well as natural background sources. There have been seven TMDLs developed in the MCW. The TMDLs vary in watershed area, impairment and pollutant as shown in **Figure 2-19** and **Table 2-10**. TMDLs can be found on the IDNR website (Iowa DNR 2019b).

McCloud Run, Cedar Rapids Iowa (Photo Credit: EOR)

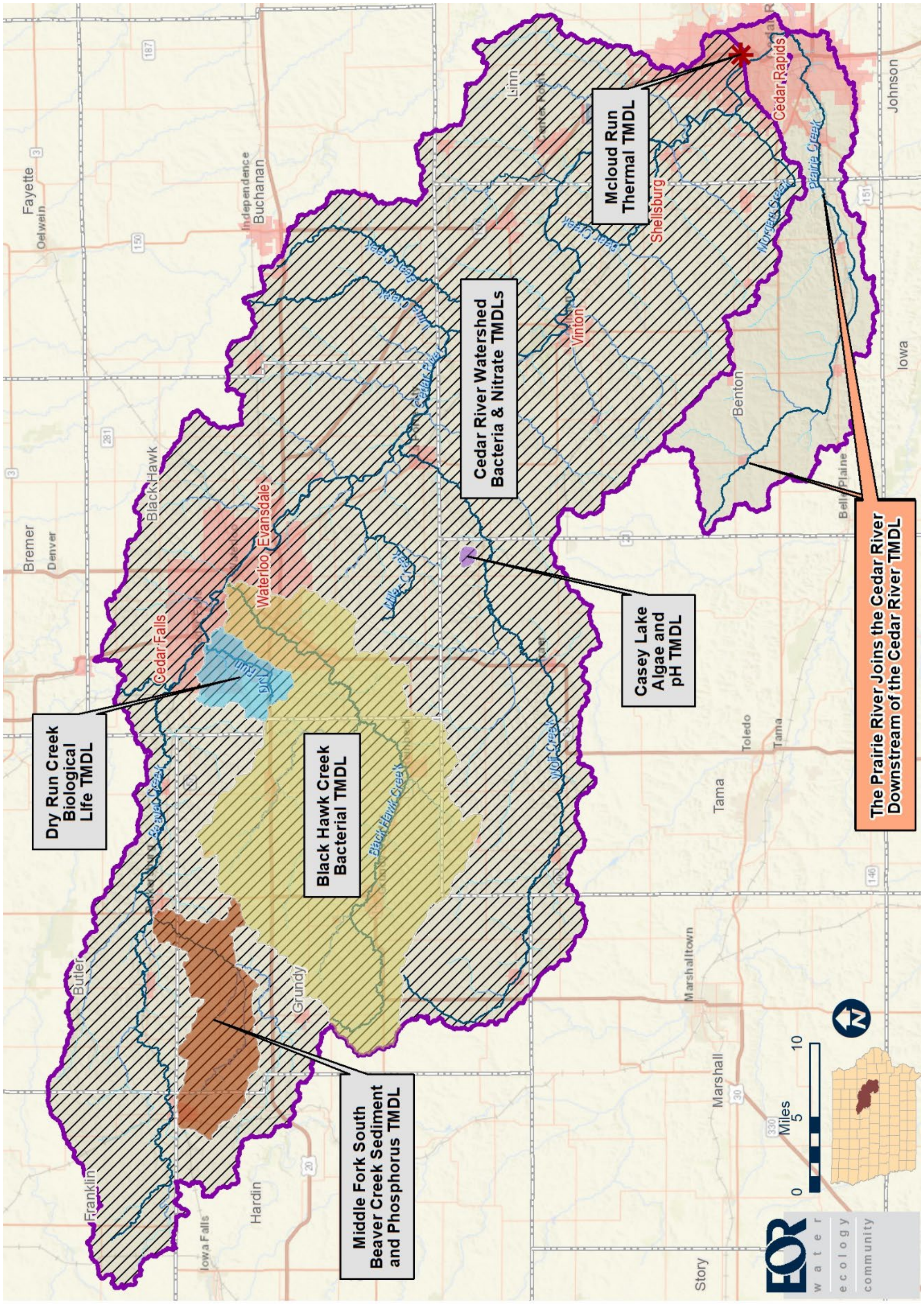

Figure 2-19. Middle Cedar Watershed—Completed TMDL Studies.

Table 2-10. Summary of TMDLs within the Middle Cedar Watershed.

TMDL	TMDL Targets	Applicable HUC-12s
Cedar River Watershed Bacteria	Unpermitted feedlots will control/ capture the first one-half inch of rain. Cropland bacteria loading will be reduced by 40% through proper timing and application of animal waste. Cattle in streams will be reduced by 40% Leaking septic systems will be eliminated	All Middle Cedar HUC-12s
Cedar River Nitrate	37% reduction in nitrate loading for nonpoint sources. The adjusted reduction (from the overall 35% target) accounts for wildlife, atmospheric deposition, and point sources	All Middle Cedar HUC-12s above the impaired reach. Excluded HUC-12s: *Headwaters Prairie Creek* *Village of Van Horne-Prairie Creek* *Mud Creek-Prairie Creek* *Weasel Creek-Prairie Creek* *Prairie Creek*
Black Hawk Creek Bacteria	85% reduction in rain driven surface runoff loads and a 98% reduction in continuous nonpoint source bacterial loads	South Fork Black Hawk Creek Headwaters North Fork Black Hawk Creek North Fork Black Hawk Creek Holland Creek Headwaters Black Hawk Creek Mosquito Creek Minnehaha Creek-Black Hawk Creek Village of Reinbeck-Black Hawk Creek Wilson Creek-Black Hawk Creek Prescotts Creek-Black Hawk Creek
Middle Fork South Beaver Creek Sediment and Phosphorus	59% annual loading reduction for sediment from nonpoint sources 40% annual loading reduction for phosphorus from nonpoint sources	Middle Fork South Beaver Creek
Casey Lake Algae and pH	89.5% target reduction in annual loading of total phosphorus from nonpoint sources	Wolf Creek (priority area: Casey Lake drainage area)
McLoud Run Thermal	Heat reductions for Cedar Rapids and Hiawatha NPDES Permits	Silver Creek-Cedar River (TMDL does not apply to nonpoint sources)
Dry Run Creek Biological Life	26% reduction in average streamflow rates associated with the 24 hour, 1.25 inch rain event will be set for the Dry Run Creek HUC-12 watershed	Dry Run Creek

Cedar River Nitrate TMDL

The Iowa DNR approved the *Total Maximum Daily Load For Nitrate Cedar River, Linn County, Iowa* in 2006. The TMDL was developed to address a reach of the Cedar River that had been identified as being impaired by excess nitrate. The impaired reach is defined as the Cedar River from its confluence with McLoud Run (S16, T83N, R07W) to the Cedar River confluence with Bear Creek (S21, T84N, R08W). Designated uses for the impaired segment are significant resource warm water [Class B (WW-1)], primary contact recreational use (Class A1) and drinking water supply (Class C). Excess nitrate loading has impaired the drinking water supply water quality criteria (567 IAC 61.3(3)) and hindered the designated use. The target of this TMDL is the drinking water nitrate concentration standard of less than 10.0 mg/L NO3-N.

The TMDL was written as a phased TMDL. Phasing TMDLs is an iterative approach to managing water quality that becomes necessary when the origin, nature and sources of water quality impairments are not well understood. In this first phase the waterbody load capacity, existing pollutant load in excess of this capacity, and the source load allocations were estimated based on the limited information available. A monitoring plan was then developed to determine if prescribed load reductions result in attainment of water quality standards and whether or not the target values are sufficient to meet designated uses. Monitoring activities may include routine sampling and analysis, biological assessment, fisheries studies, and watershed and/or waterbody modeling. A future phase of the TMDL will consist of implementing the monitoring plan, evaluating collected data, and readjusting target values if needed.

The targeted Nitrate reduction is 35 percent. This would equal a yearly reduction of 9,999 tons nitrate-N/year from the current loading of 28,561 tons nitrate-N/year. The TMDL states that the majority (91 percent) of the nitrate delivered downstream in the watershed is from nonpoint agricultural sources and sets a reduction target for nonpoint sources at 37 percent. The adjusted reduction (from the overall 35 percent target) accounts for wildlife, atmospheric deposition, and point sources.

The TMDL included an implementation plan that recommended use of incentive-based, best management practices focused on reducing surface water nitrate-N concentration. These practices include fertilizer reduction, wetland construction, and Conservation Reserve Program enrollment. The implementation plan further recommended focusing more heavily on subbasins that have higher nitrate loading per unit area.

Key Findings of the Cedar River Nitrate TMDL

- Model results indicate that the load of nitrate-nitrogen entering the Cedar River (within the watershed) is greater than the load of nitrate leaving the Cedar River by 4,000 tons/year; equivalent to 12 percent of the total annual nitrate-nitrogen load.
- Nitrate concentrations exhibit clear seasonality, with higher concentrations occurring during April, May and June as well as November and December.
- Observed nitrate concentrations from January, 2001- December, 2004 ranged from a high of 14.66 mg/L on June 13, 2003 to a low of 0.36 mg/L on September 3, 2003.
- The load duration curve clearly indicates that Nitrate-N exceedances occurred during wetter conditions and high flows of the Cedar River, and therefore are caused by nonpoint source pollution.

- Historical data indicates that nitrate loads in the Cedar River have increased dramatically in the past century (Iowa Geological Survey, 1955)
- Point sources contribute to nine percent of the total nitrate load and nonpoint sources contribute 91 percent of the total nitrate load in the watershed.
- Established a target in-stream Nitrate concentration of 9.5 mg/l
- The target nonpoint source nitrate reduction target for the impaired segment of the Cedar River is 37%

Casey Lake Algae and pH TMDL

The Iowa DNR approved the *Water Quality Improvement Plan for Casey Lake Tama County, Iowa: Total Maximum Daily Load for Algae and pH* in 2012. The TMDL was developed to address impairments in Casey Lake, located six miles north of Dysart in Tama County. The impaired uses addressed in the TMDL are primary contact recreation (Class A1) and aquatic life [Class B (LW)]. The primary contact recreation use was determined to be "not supported" due to aesthetically objectionable conditions caused by poor water transparency caused by algae blooms and violations of the Class A1 criteria for pH. The aquatic life use was determined to be "partially supported" due to violations of the Class B (LW) criterion for pH.

The TMDL found that excess algae blooms and subsequent chlorophyll-a concentrations and high pH levels were attributed to total phosphorus, therefore a target reduction in total phosphorus was developed. Cropland was identified as the major contributor (76 percent) of phosphorus to Casey Lake. An annual load reduction of 89.5 percent was established as a target for the lake.

Key Findings of the Casey Lake Algae and pH TMDL

A detailed implementation plan was developed as part of this TMDL that identified specific structural practices, watershed improvements and in-lake strategies for addressing total phosphorus loading to the lake.

The 89.5 percent target reduction in annual loading of total phosphorus established for this TMDL for the 748-acre drainage area to Casey Lake will require greater reductions than the overall goal established for the Wolf Creek HUC-12 subwatershed.

Cedar River Bacteria TMDL

EPA Region 7 developed the *Total Maximum Daily Load Cedar River Watershed, Iowa for Indicator Bacteria, Escherichia coli (E. coli)* in 2010. The TMDL covers the entire Cedar River watershed and includes four impaired reaches of the Cedar River within the MCW. Two additional reaches of the Cedar River downstream of the MCW are included in the TMDL, which is relevant because the entire MCW drains to these impaired reaches and is subject to the TMDL.

The primary contact recreation (Class A1) uses for each stream reach were determined to be impaired by the bacteria indicator *E. coli*. Based on a review of the flow and water quality data available throughout the watershed, it was determined that bacterial concentrations were primarily a function of flow. Therefore, a flow-variable daily load was selected to represent these TMDLs. The TMDL establishes the level of bacteria reductions over a range of flows that would be needed for each reach to meet State water quality standards.

The dominant source of bacteria to all nine reaches was open feedlots contributing over 80 percent of bacteria followed by manure application to cropland which contributed 10-16 percent of bacteria to each reach. Point sources discharged bacteria to some reaches more than others, contributing less than one percent in some reaches and up to eight percent at the Cedar River reach between Wolf Creek and Bridge Crossing in LaPorte City.

Key Findings of the Cedar River Bacteria TMDL

- Impaired Reaches within the Middle Cedar Watershed:
    - Cedar River from the Dam of Cedar Falls Impoundment to the Upper End of the Impoundment
    - Cedar River from Wolf Creek to Bridge Crossing in LaPorte City (IA 02-CED-0040_1)
    - Cedar River from McLoud Run to Confluence with Bear Creek (IA 02-CED-0030_2)
    - Cedar River from Prairie Creek to Confluence with McLoud Run (IA 02-CED-0030_1)
- Additional Impaired Reaches downstream of the Middle Cedar Watershed:
    - Cedar River from Highway 30 Bridge at Cedar Rapids to Confluence with Prairie Creek (IA 02-CED-0020_3)
    - Cedar River from Rock Run Creek to Highway 30 Bridge at Cedar Rapids (IA 02-CED-0020_2)

The TMDL includes an informational implementation plan. An implementation plan is not a requirement for a TMDL, but Region 7 developed a model (Hydrologic Simulation Program Fortran) to test potential scenarios. The model determined that the following scenario will result in the river reaches meeting the Iowa water quality standards. This scenario assumes that all wastewater treatment plants effluent and rivers entering Iowa will have bacteria concentrations less than or equal to the Iowa water quality standard.

- Unpermitted feedlots will control/capture the first one-half inch of rain.
- Cropland bacteria loading will be reduced by 40 percent through proper timing and application of animal waste.
- Cattle in streams will be reduced by 40 percent.
- Leaking septic systems will be eliminated.

Since the entire Middle Cedar Watershed is subject to this TMDL, the specific targets identified is used as the strategy for addressing bacterial pollution for all 68 HUC-12 Subwatersheds.

Black Hawk Creek Bacteria TMDL

The Iowa DNR approved the *Total Maximum Daily Load For Pathogen Indicators Black Hawk Creek, Iowa* in 2006. The TMDL was developed to address a reach of Black Hawk Creek that had been identified as being impaired due to excessive indicator bacteria (fecal coliform). The 11.4 mile impaired reach is defined as the Black Hawk Creek from its mouth at the Cedar River in S22,T89N, R13W to the stream crossing at Highway 58 in E 1/2, S27, T88N, R14W in Black Hawk County. Designated uses for the impaired reach included: primary contact recreation and aquatic life. The primary contact recreation (Class

A1) uses remain assessed as "not supported" due to consistently high levels of indicator bacteria. The aquatic life [Class B (WW-1)] uses were assessed as "fully supported/threatened." The applicable water quality standards for bacteria are a season geometric mean of 126/100ml for *E. coli* and a single maximum value of 235 counts/100 ml.

The TMDL was written as a phased TMDL, which is an iterative approach to managing water quality that becomes necessary when the origin, nature and sources of water quality impairments are not well understood. In this first phase of the Black Hawk Creek watershed improvement plan, specific and quantified targets for pathogen indicator concentrations were set for the stream and allowable loads for all sources were allocated. The TMDL states that a future Phase 2 will require the participation of the watershed stakeholders in the implementation of pollutant controls and continued water quality evaluation.

Key Findings of the Black Hawk Creek Bacteria TMDL

To achieve the *E. coli* water quality standard for this reach of Black Hawk Creek there must be an 85 percent reduction in rain driven surface runoff loads and a 98 percent reduction in continuous nonpoint source bacterial loads (e.g., septic systems, cattle in the stream).

This TMDL does not include an implementation plan but states that "analysis and modeling of the Black Hawk Creek watershed shows that controlling livestock manure runoff and cattle in streams would need to be a large part of a plan to reduce bacteria. Best management practices include feedlot runoff control; fencing off livestock from streams; alternative livestock watering supply; and buffer strips along the stream and tributary corridors to slow and divert runoff. In addition to these sources, failed septic tank systems need to be repaired and wastewater treatment plants need to control the bacteria in their effluent."

Middle Fork South Beaver Creek Sediment and Phosphorus TMDL

The Iowa DNR approved the *Water Quality Improvement Plan for Middle Fork South Beaver Creek Grundy County, Iowa: Total Maximum Daily Load for Sediment and Phosphorus* in 2007. The TMDL was developed to address an impaired reach of South Beaver Creek that had been identified as having a chronic biological impairment due to excessive sediment and phosphorus. The impaired reach is defined as the Middle Fork South Beaver Creek, from its mouth in Grundy Co. (N ½, S28, T89N, R17W) to its headwaters in Hardin County (NW1/4, S15, T89N, R19W). The impaired use addressed in the TMDL is warmwater aquatic life [Class B (WW-1)].

Iowa's water quality standards do not have numeric criteria for either sediment or phosphorus, therefore the decision criteria for water quality standards attainment in Middle Fork South Beaver Creek was based on meeting biological conditions typical of healthy reference streams for this ecoregion. Sediment loading criteria were based on siltation within the stream and phosphorus loading criteria were based on linkage to low dissolved oxygen.

Key Findings of the Middle Fork South Beaver Creek Sediment and Phosphorus TMDL

A detailed implementation plan was developed in this TMDL. The implementation plan identifies specific practices to address sediment and phosphorus loading to the impaired reach and prioritizes specific locations within the watershed for future action.

The targeted reductions for sediment (59 percent annual loading reduction) and total phosphorus (40 percent annual loading reduction) established in this TMDL will require greater reductions than what was applied to the HUC-12 subwatersheds that drain to this impaired reach of South Beaver Creek.

McLoud Run Thermal TMDL

The Iowa DNR approved the *Water Quality Improvement Plan for McLoud Run in Linn County, Iowa: Total Maximum Daily Load for Thermal Modifications* in 2007. The TMDL was developed for the entirety of McLoud Run in Cedar Rapids from its mouth at the Cedar River (SW ¼ S16, T83N, and R7W) to its headwaters (SW ¼ S5, T83N, R7W). The impaired use designation is warmwater aquatic life [Class B (WW-1)] and the TMDL was conducted due to McLoud Run having been identified as a high priority stream. The impairment was found to be caused by temperature (heat) delivered via surface runoff. State water quality standards for all Class B streams allow for a maximum increase of 1°C per hour.

Key Findings of the McLoud Run Thermal TMDL

The TMDL establishes heat load reductions for the impervious surfaces in the McLoud Run drainage area. The entire McLoud Run drainage area is covered by the NPDES (MS4) permits for the Cities of Cedar Rapids and Hiawatha. As such, the TMDL includes point source reductions for these areas and does not include an allocation or reduction for nonpoint source areas.

The heat reduction targets established within this TMDL should be noted for the Silver Creek – Cedar River HUC-12 but were not applied to the entire subwatershed since the target reduction only applies to point sources.

Dry Run Creek Biological Life TMDL

(Still Pending EPA Approval)

The Iowa DNR developed a Water Quality Improvement Plan which included a TMDL study for Dry Run Creek in 2011. The 2.83 mile impaired reach is defined as Dry Run Creek from its mouth at S18, T89N, and R13W to the confluence with unnamed tributary in S23, T89N, and R14W in Black Hawk County. Designated uses for the impaired reach included: primary contact recreation and warm-water Type 2 aquatic life. The primary contact recreation (Class A1) uses remain assessed as “partially supporting” due to levels of indicator bacteria that exceed state water quality criteria. The Class B (WW-2) aquatic life uses remain assessed (monitored) as "partially supported" (IR 5b-v) based on results of biological sampling in 2010, 2011 and 2013.

A stressor identification analysis determined that excess storm water runoff from Connected Impervious Surfaces (CIS) was the cause of the impairment. As such, the TMDL was developed using CIS as a surrogate for increased stormwater runoff and the array of pollutants associated with runoff derived from CIS. Multiple studies have shown that the quality of pollutant intolerant species (macroinvertebrate and/or fish species per site and fish IBI scores) sharply decline in watersheds with greater than 10 percent connected impervious surfaces.

To quantify the effects of CIS on stormwater flows, a Soil and Water Assessment Tool (SWAT) model was developed and ran for existing conditions and for the target of 10 percent CIS in subwatersheds with a higher percentage of CIS. The goal for Dry Run Creek is to decrease storm event runoff associated with

CIS, which is based on attaining CIS of less than 10 percent for each subbasin in the Dry Run Creek watershed.

Key Findings of the Dry Run Creek Biological Life TMDL

The TMDL target was set to the 24-hour water quality event of 1.25 in. (+/- 0.125 inches) for this region of Iowa. A review of existing streamflow rates and flow rate reductions resulting from the modeled decrease of CIS to 10 percent suggests an average streamflow rate reduction of 26.18 percent will occur for the 1.25-inch event.

To achieve the goal of reducing CIS to 10 percent, the implementation plan calls for a combination of green infrastructure best management practices will need to be retrofitted into the urban areas of the Dry Run Creek subwatershed to include green roofs, rain tanks and cisterns, permeable pavement, bioretention (rain-gardens), and dry-swales.

The subwatershed conservation practices plan for the Dry Creek Subwatershed include green infrastructure best management practices that will work mitigate the impacts of impervious surfaces in the subwatershed.

2.2.8. Watershed Hydrology

Before evaluating nutrient and pollutant concentrations and loads, it is important to understand the hydrology of the watershed. Five long-term USGS flow monitoring stations in the watershed provide a valuable dataset from which trends can be detected. The USGS station (05464500) located on the Cedar River at Cedar Rapids provides the most comprehensive dataset with stream flow data available from 1903-2017. The Hydrologic Assessment Section summarizes key findings from the University of Iowa IIHR-Hydroscience & Engineering Hydrologic Assessment performed for the MCW. Perhaps the most important finding from this assessment was that the water cycle in the MCW has changed due to land use changes as summarized in **Table 2-11**. Furthermore, heavy rainfall is increasing in intensity and frequency across the United States and globally and is expected to continue to increase over the next few decades.

Table 2-11. General Statewide Land Use Changes and Hydrologic Impacts (adapted from IIHR Hydrologic Assessment).

Timeline	Land use status, change, & interventions	Hydrologic effect(s)	Source
1830s–Prior	Native vegetation (tall-grass prairies and broad-leaved flowering plants) dominate the landscape	Baseflow dominated flows; slow response to precipitation events	Petersen (2010)
1830–1980	Continuous increase in agricultural production by replacement of perennial native vegetation with row crops 1940: <40% row crop (Raccoon) 1980: 75% row crop (statewide)	Elimination of water storage on the land; acceleration of the upland flow; expanded number of streams; increased stream velocity	Jones & Schilling (2011); Knox (2001)
1820–1930	Wetland drainage, stream channelization (straightening, deepening, relocation) leading to acceleration of the rate of change in channel positioning	Reduction of upland and in-stream water storage, acceleration of stream velocity	Winsor (1975); Thompson (2003); Urban & Rhoads (2003)
1890–1960 / 2000 – Present	Reduction of natural ponds, potholes, wetlands; development of large-scale artificial drainage system (tile drains)	Decrease of water storage capacity, groundwater level fluctuations, river widening	Burkart (2010); Schottler et al. (2013)
1940–1980	Construction of impoundments and levees in Upper Mississippi Valley	Increased storage upland	Sayre (2010);
1950 – Present	Modernization/intensification of the cropping systems	Increased streamflow, wider streams	Zhang & Schilling (2006); Schottler et al. (2013)
1970 – Present	Conservation practices implementation: Conservation Reserve Program (CRP); Conservation Reserve Enhancement Program (CREP); Wetland Reserve Program (WRP)	Reduction of runoff and flooding; increase of upland water storage	Castle (2010); Schilling (2000); Schilling et al. (2008);
2001– Present	62% of Iowa's land surface is intensively managed to grow crops (dominated by corn and soybeans up to 63% of total)	About 25% to 50% of precipitation converted to runoff (when tiling is present)	Burkart (2010)

Source: University of Iowa IIHR-Hydroscience & Engineering

Flooding

Reports on flood risk typically use probability statistics to assess the likelihood for a certain magnitude of flood to occur in any particular year. Flood risk is determined using a number of factors, including the amount of impervious surfaces, the diameter and length of storm sewers, the presence of natural detentions, the presence of drain tiles, changing weather patterns, and the existence of flood mitigation infrastructure. The ability to accurately assess the probability of a flood are aided by modeling methodology advancements and longer periods of record for the water body in question.

In 2015, the Department of Homeland Security, Federal Emergency Management Agency's (FEMA) Risk Mapping, Assessment, and Planning program developed a Flood Risk Report (FRR) for the MCW. The purpose of the FRR was to help local or tribal officials, floodplain managers, planners, emergency managers, and others better understand their flood risk, take steps to mitigate those risks, and communicate those risks to their citizens and local businesses.

A key component of the FRR was to develop a Flood Risk Map. The map provides stakeholders within the MCW with a visual resource that highlights key areas of risk based on potential losses and exposed facilities. The Flood Risk Map for the MCW is shown in **Figure 2-20.**

Identifying areas of the watershed with higher runoff potential is the first step in selecting mitigation project sites. High runoff areas offer the greatest opportunity for retaining more water from large rainstorms on the landscape and reducing downstream flood peaks. Landowner willingness to participate is essential. Locations may have existing conservation practices in place or areas such as timber that should not be disturbed. Stakeholder knowledge of places with repetitive loss of crops or roads/ road structures is also valuable in selecting locations. Lastly, the geology of the area may limit the effectiveness or even prohibit application of certain mitigation projects. (Iowa Flood Center and IIHR 2019).

Water levels of the Cedar River and its tributaries are monitored on an hourly basis. This stream gauge information is immediately uploaded to the Iowa Flood Information System (IFIS) in real-time, which is available to the public online at: http://ifis.iowafloodcenter.org/ifis/en/. The water level gauge information also includes updated flood stage information. This allows the user to observe the current water level and know the water level that would be considered a flood.

Furthermore, the Iowa DNR maintains Iowa Geodata (State of Iowa 2019) where GIS professionals can gain access to Flood Risk Products including the National Flood Hazard Layer (State of Iowa 2018) and the Flood Risk Boundaries of Iowa Layer (State of Iowa 2017) which depicts the boundaries for the 1-percent annual chance (100-yr) flood event, the 0.2 percent annual chance (500-yr) flood event, and areas of minimal flood risk; **Figure 2-21** shows the location of the 100-yr and 500-yr floodplain boundaries within the MCW. These boundaries, which are derived from the FEMA Flood Hazard and Flood Insurance Rate Maps, can be accessed at https://geodata.iowa.gov/dataset/flood-risk-areas. Additionally, the Iowa Flood Center has updated (but non-regulatory) statewide floodplains available at https://ifis.iowafloodcenter.org/ifis/app/.

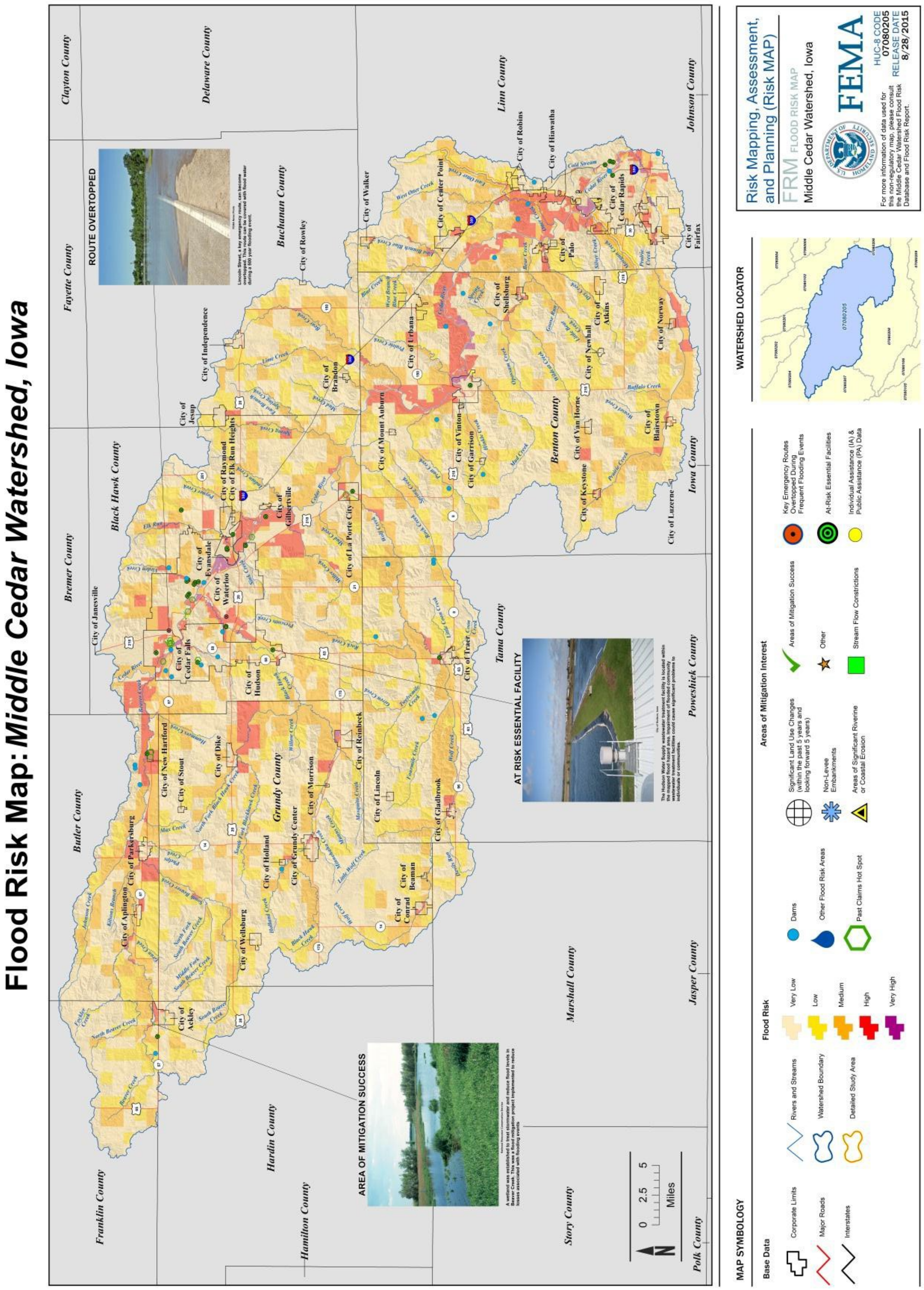

Figure 2-20. Middle Cedar Watershed—Flood Risk Map (FRM).

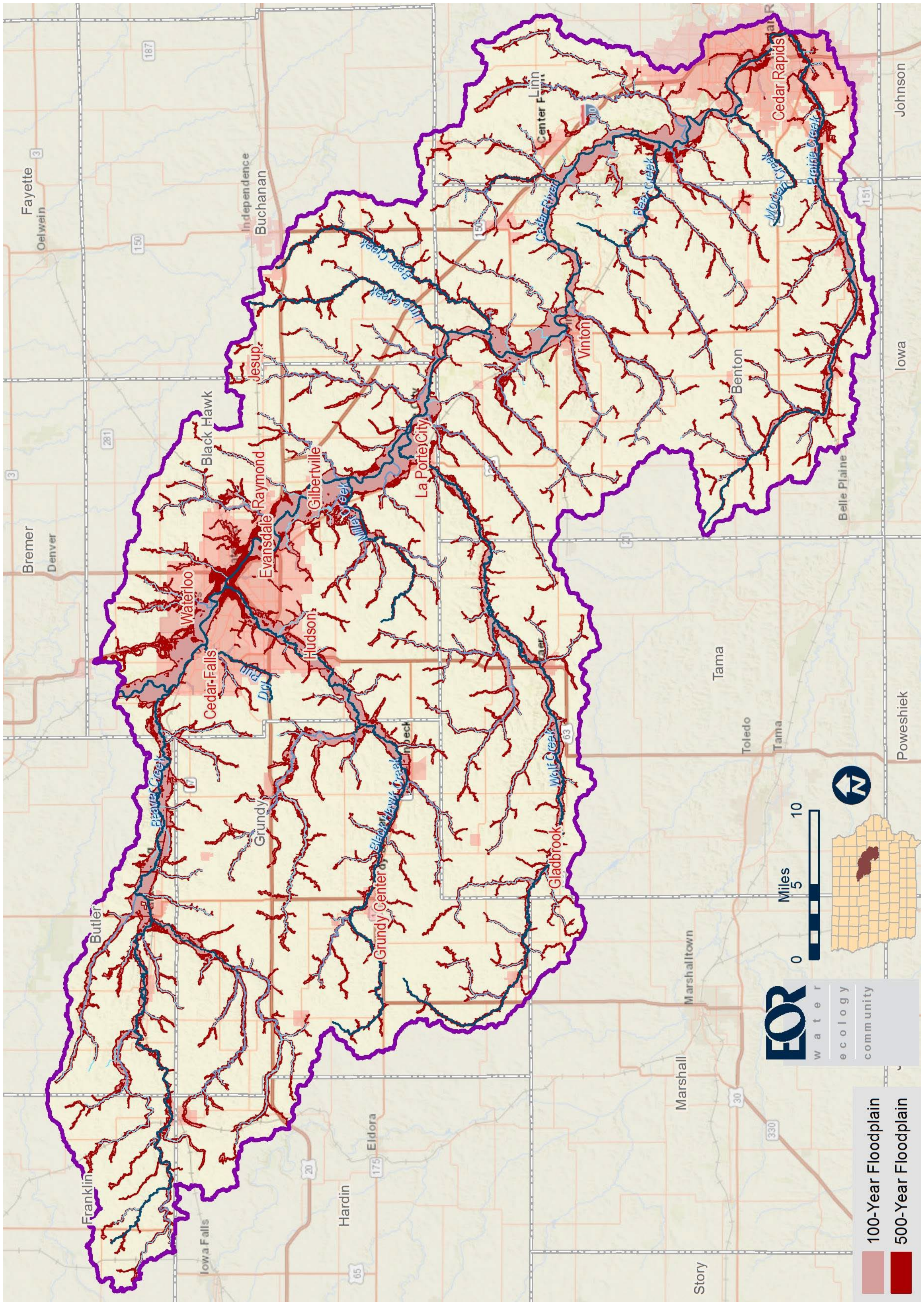

Figure 2-21. Middle Cedar Watershed—100-year and 500-year floodplain boundaries.

Average Annual Flows

The average annual flow of water recorded on the Cedar River at Cedar Rapids (USGS station 05464500) has increased at a rate of 34 cubic feet per second (cfs) per year from 1903-2017 with the most dramatic rise occurring since the 1950s. A 2013 study done by the USGS (Statistical Summaries of Selected Iowa Streamflow Data Through September 2013) reported that the average annual flow at this station for the entire period of record (1903 to 2013) was 3,980 cfs, but when looking at the most recent 30 years the average annual flow has been 5,520 cfs, an increase of nearly 40 percent. From 1984-2017, average annual flows exceeded the period of record annual flow average (3,980 cfs) in more than 70 percent of years (**Table 2-12**).

Additional USGS stations throughout the watershed show similar increases (**Table 2-13**). **Figure 2-22**, **Figure 2-23**, and **Figure 2-24** depict the annual mean discharge for Black Hawk Creek at Hudson, Beaver Creek at New Hartford, and Cedar River at Waterloo respectively for the entire period of record (1953-2013 for Black Hawk Creek, 1946-2013 for Beaver Creek, and 1941-2013 for Cedar River) versus 1984-2013. In addition to the arithmetic mean, the 50 percent (or median) flow rate and the harmonic mean flow rate (a different method of averaging that is useful for rates) are also displayed.

Table 2-12. Cedar River at Cedar Rapids Annual Mean Discharge by Percentile Comparison (1984-2017) versus Period of Record.

Annual average flows by percentile (1903-2017)		Annual average flows by percentile (1984-2017)	
Percentile	Average Annual Flow (cfs)	Percentile	Average Annual Flow (cfs)
10%	1,618	10%	2,739
30%	2,662	30%	4,078
50%	3,621	50%	5,326
75%	5,211	75%	7,059
90%	6,749	90%	9,116

Table 2-13. Annual Mean Discharge Comparison (1984-2017) versus Period of Record.

Name of Site	Period of Record	Annual Mean Discharge (cfs) Period of Record	Annual Mean Discharge (cfs) 1984-2013	Percent Increase
Black Hawk at Hudson	1953-2013	212	270	27%
Beaver Creek at New Hartford	1946-2013	246	308	25%
Cedar River at Cedar Rapids	1903-2013	3,980	5,520	39%
Cedar River at Waterloo	1941-2013	3,520	4,290	22%

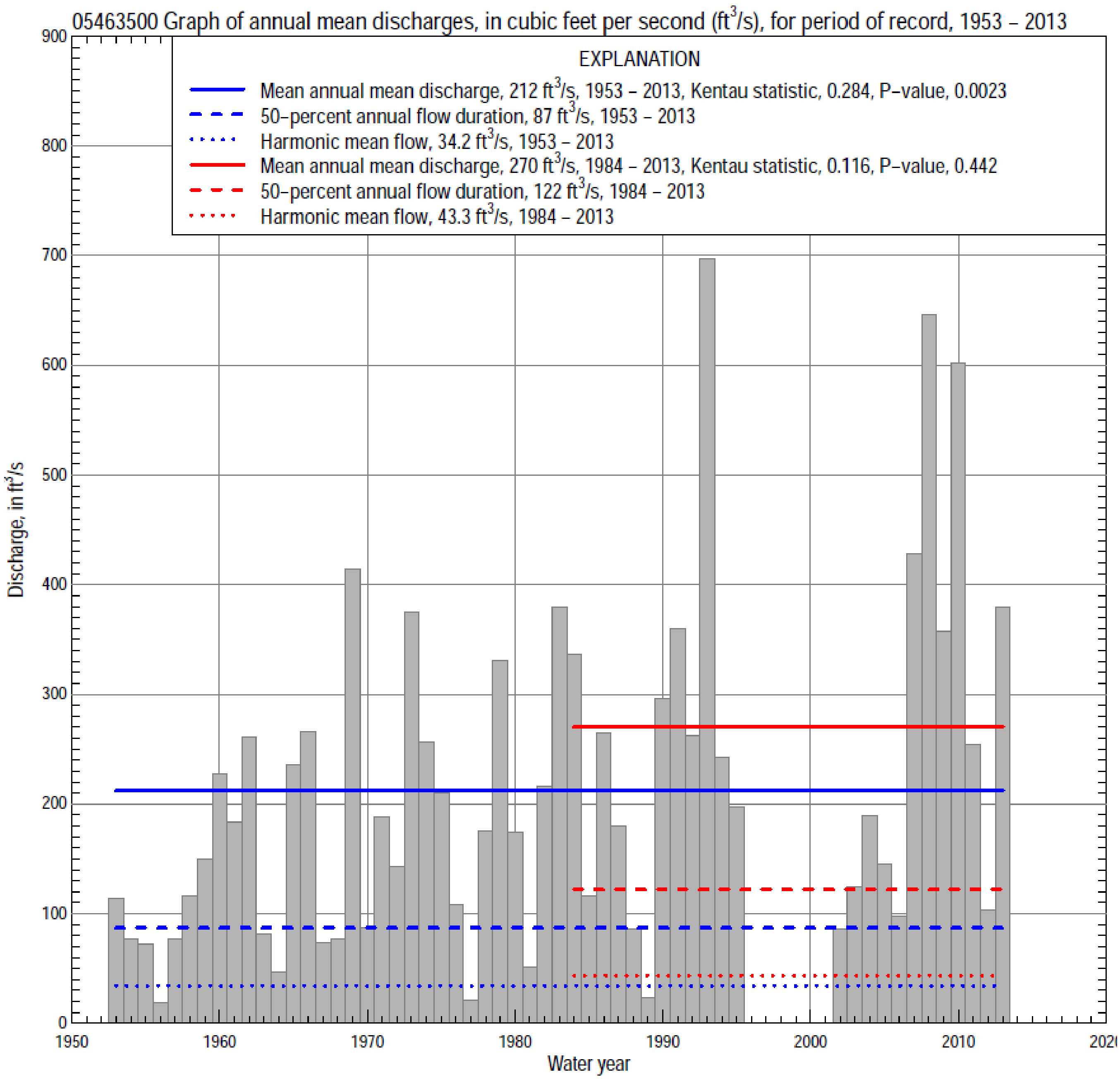

Figure 2-22. Black Hawk Creek at Hudson—Annual mean discharge for period of record (1953-2013) versus 1984-2013.

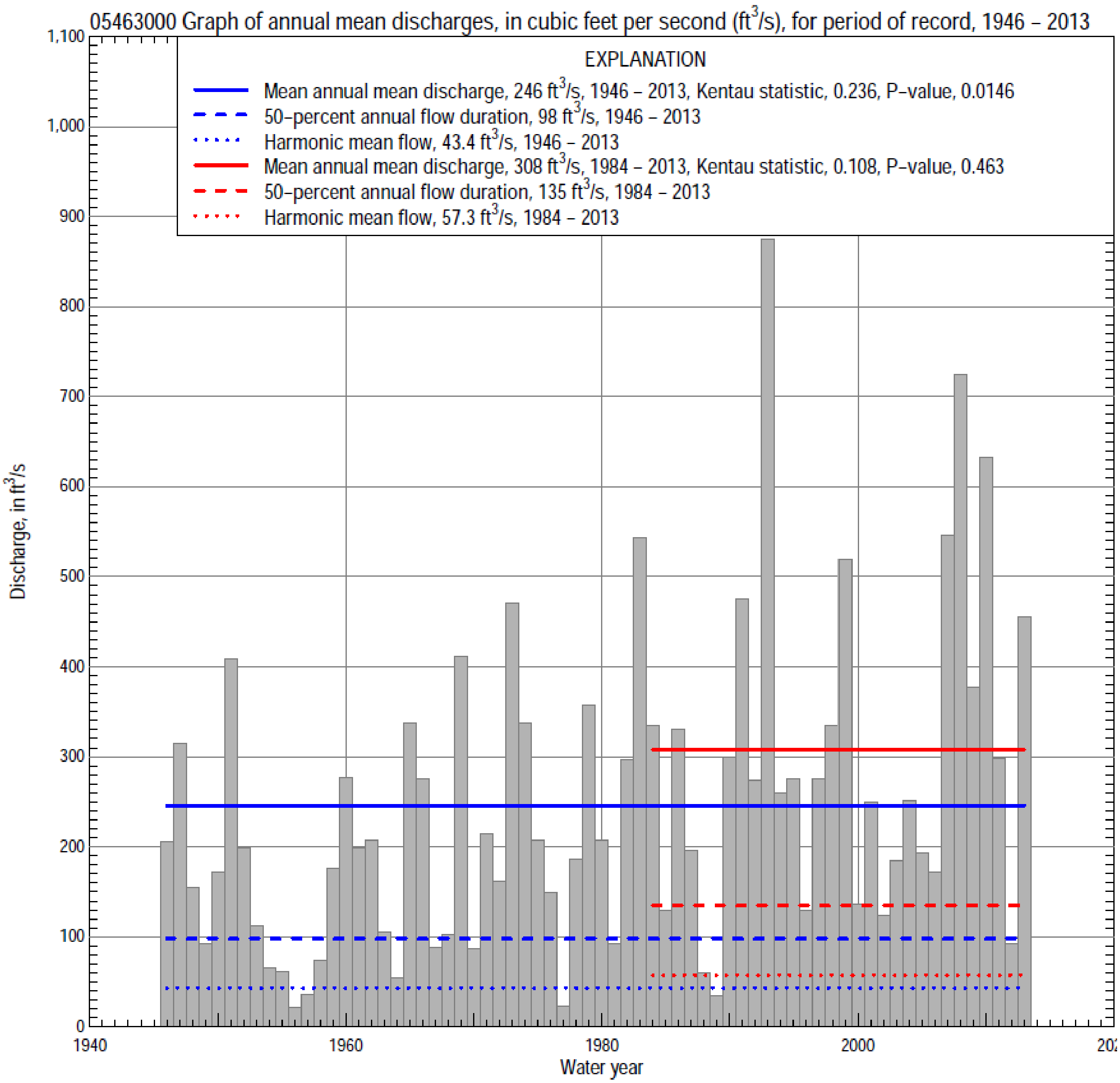

Figure 2-23. Beaver Creek at New Hartford—Annual mean discharge for period of record (1953-2013) versus 1984-2013.

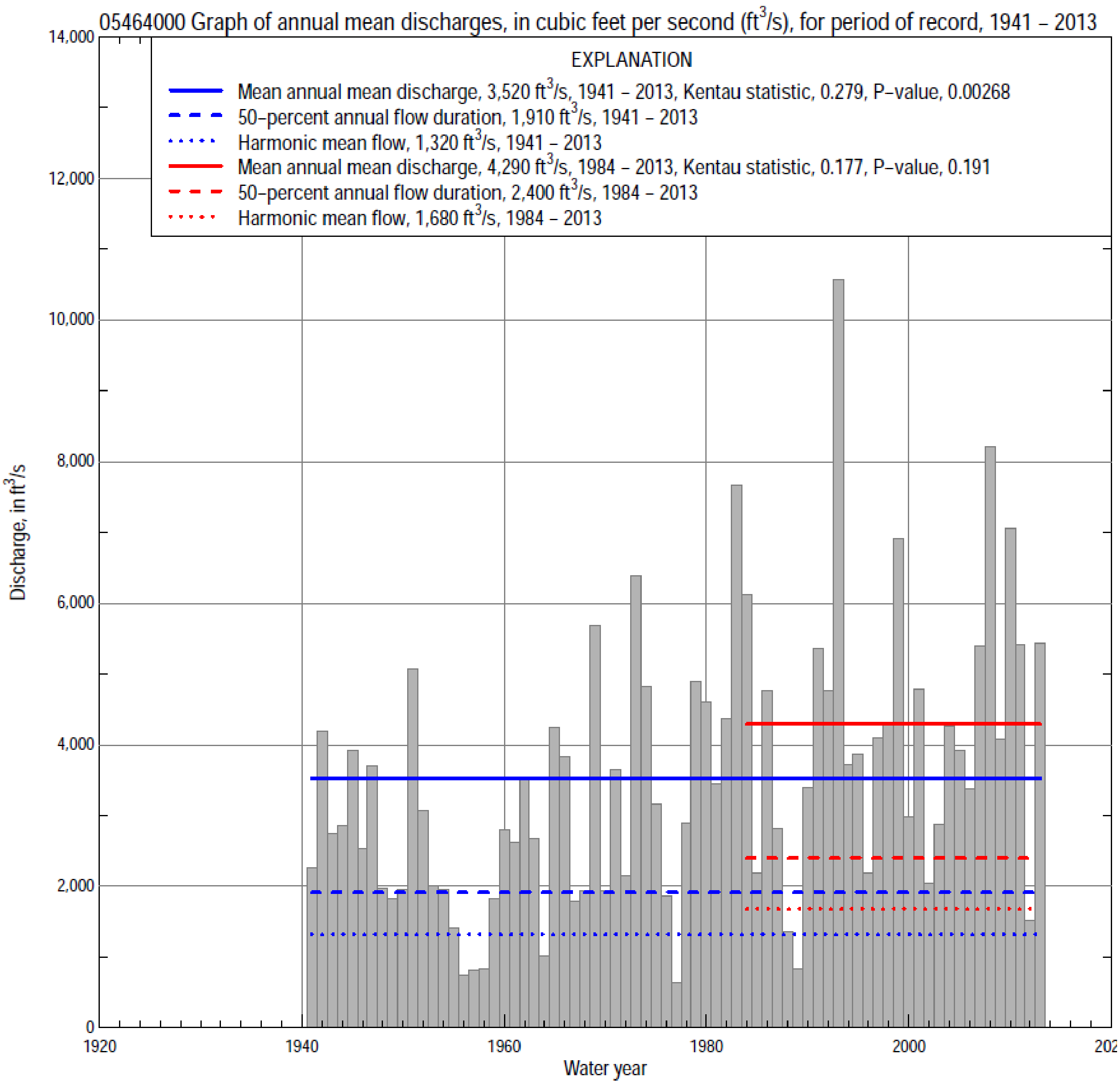

Figure 2-24. Cedar River at Waterloo - Annual mean discharge for period of record (1941-2013) versus 1984-2013.

Streamflow Variability (1983-2017)

In addition to annual increases in percent flow, the Cedar River at Cedar Rapids (USGS station 05464500) shows considerable variability as estimated by average annual flows from 1984 to 2017. During this time period, average annual flows varied from 996 cfs (1989) to 15,130 cfs (1993 Flood) with an overall annual median value of about 5,400 cfs (**Figure 2-25**).

Annual average flows show the considerable contrast of wet and dry years with 13 years having less than average flows and 4 years exceeding the median value by more than 150 percent (1.5 times the median value). Transitions appear abruptly shifting from dry to wet (1987-1990) and then from flood conditions noted in 1993 to much lower flow conditions of 1994-1997. The magnitude of the wet/dry shifts are of particular note as 1998/1999 experienced average annual low flows on the order of 996-1,729 cfs (or drier than about 95 percent of annual flows from 1984-2017) to the much higher flows of 1993, 2008, and 2016 which all had annual flows that exceeded 10,000 cfs. In this regard, wet and dry year flows differed by as much as a factor of 15 (1989 versus 1993).

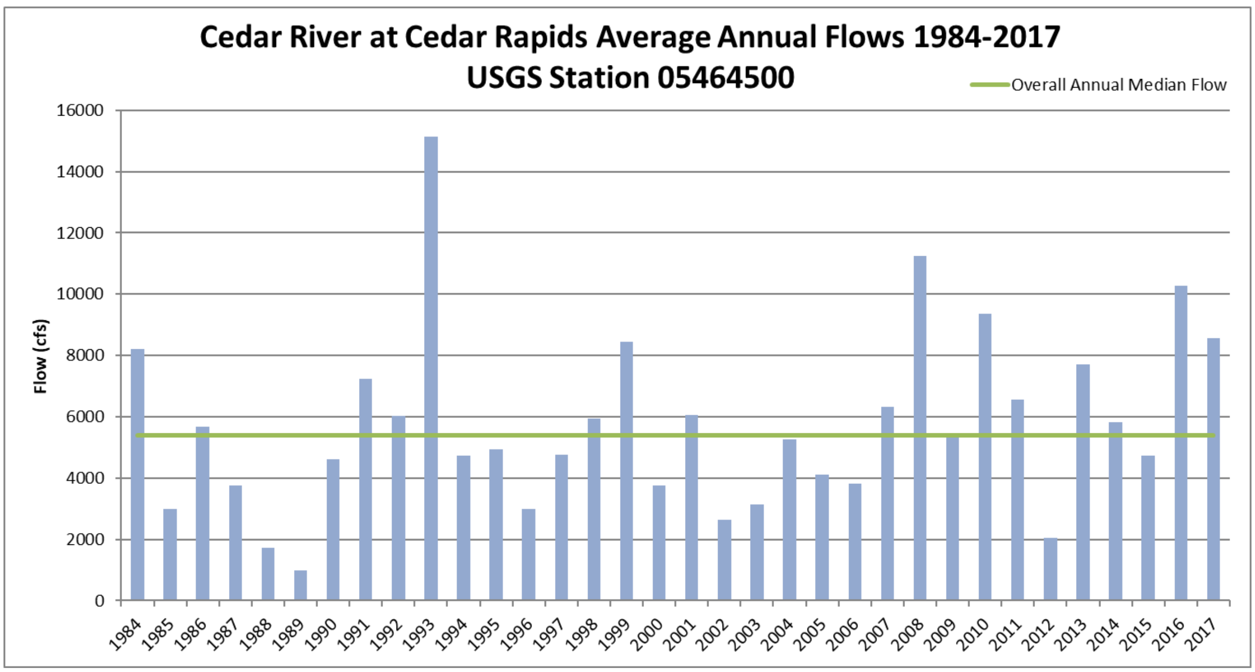

Figure 2-25. Cedar River at Cedar Rapids—Average Annual Flows (1984-2017)

Average Monthly Flows

Shifting to a closer examination of MCW flows, average monthly values monitored from 1903-2017, reflect the climate and precipitation patterns noted previously. Average monthly flows increase significantly from winter flows of approximately 2,000 cfs to typical peak flows of about 7,000 cfs noted from March-June (**Figure 2-26**). Sharp declines in average monthly flows were noted for the last half of the growing season (July-September) when peak evapotranspirational losses are expected.

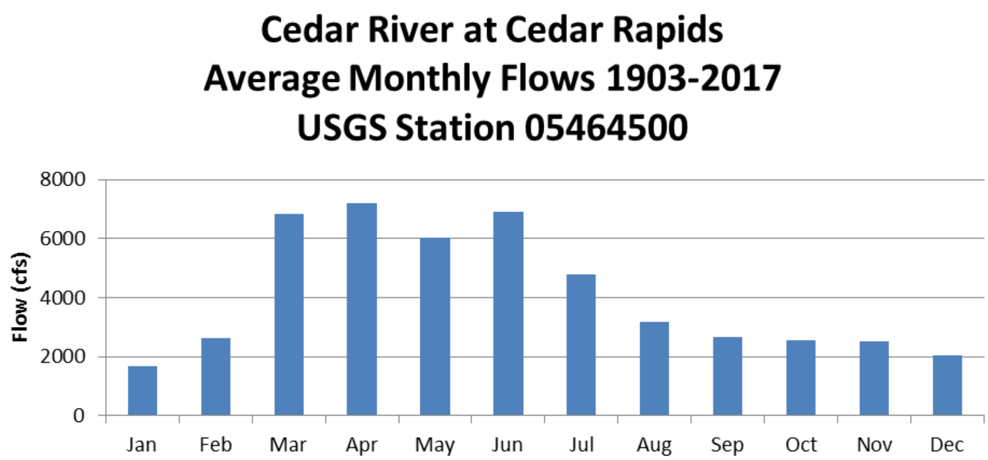

Figure 2-26. Cedar River at Cedar Rapids—Average Monthly Flows

Historical Peak Events

From a flooding perspective, instantaneous peak flows are of particular interest. Generally, instantaneous peak flows of the most recent 15 years (2001-2016) with available data were attributable to snow melt (2001, 2006, 2010 and 2011) or due to back-to-back storms of the preceding approximately 14 days with rainfall totals ranging from about two inches to eight inches (2002,2003, 2004, 2005, 2007, 2008, 2011, and 2013). The massive peak flow of June 13, 2008 was preceded by a very large amount of rainfall (about 9.5 inches) in the preceding approximately 14 days. **Back-to-back storms with total rainfalls of 2-6 inches appear to be a trigger for the large peak runoff events in the MCW.**

Cedar River's peak flows were further summarized from the USGS flow gauging station data at Cedar Rapids (Station 05464500) in **Figure 2-27** where dramatically increased peak events have occurred since approximately 1960. Peak events from 1918 through the 1920's and the 1950's were all less than approximately 60,000 cfs with the exception of one peak event in 1929. However, from 1961 to 2016, there were eight years with peak flows greater than 60,000 cfs. For perspective, flows greater than 60,000 cfs are approximately 10-15 times typical summer flows. **The range of peak to typical flows to intense rainfall events is indicative of the MCW as having substantially "flashy" or rapid runoff hydrology.**

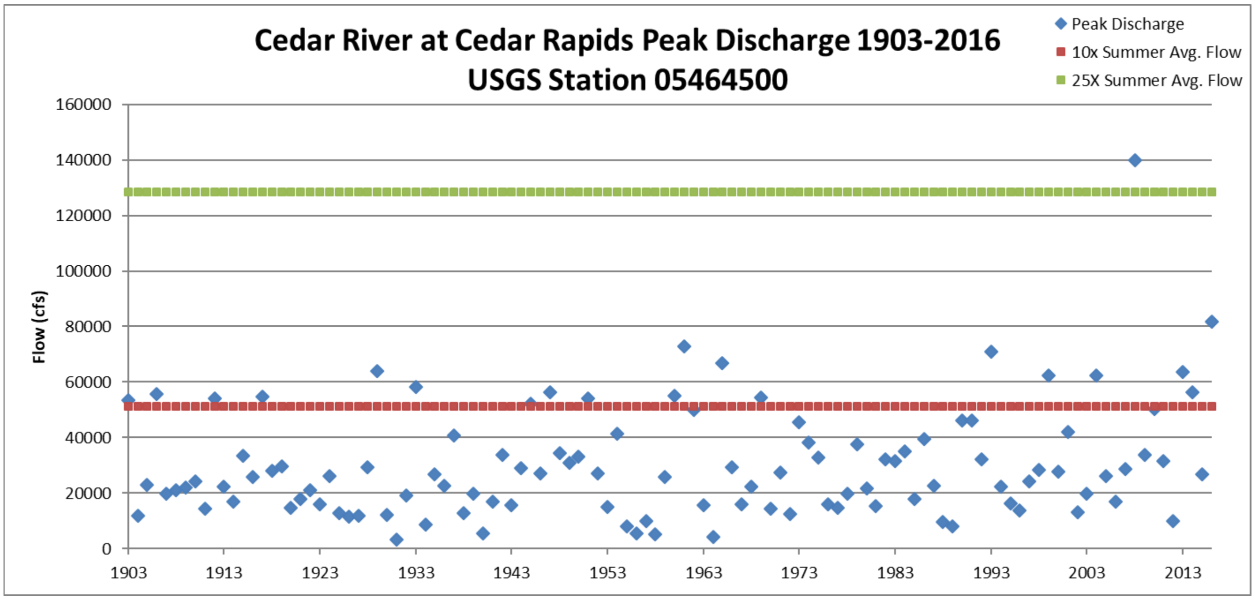

Figure 2-27. Cedar River at Cedar Rapids—Annual Peak Discharge 1903-2016.

2.2.9. Water Quality

Stream and lake monitoring provides information to compare monitored conditions to stream and lake standards and criteria, detect changes over time, and support future watershed rehabilitation efforts. The ability of a monitoring program to detect such changes and the reliability of the comparisons depend upon the nature and design of the monitoring program. In the MCW, stream monitoring data has been collected annually during the growing season (May-August) from 2012-2017 by Coe College and the City of Cedar Rapids on tributaries to the Cedar River and the Cedar River itself (**Figure 2-28**). A review of this information has yielded information regarding the long term average concentration of important environmental constituents including nitrogen, phosphorus and *E. coli* as well as distinct seasonal patterns in observed nutrient concentrations at tributaries.

Furthermore, the Iowa DNR has maintained water quality sampling stations on Beaver Creek, Black Hawk Creek, Wolf Creek, and the Cedar River from 2000-2017. While these two monitoring efforts have provided crucial information about water quality in the MCW, each study samples only a few select streams in the watershed and take a limited number of samples per year, leading to some data gaps. For a more complete understanding of the state of the watershed and water quality trends, monitoring over a larger extent of the watershed and more frequent sampling is necessary. A review of nitrogen, phosphorus, total suspended solids, and bacteria (*E. coli*) concentrations at each monitoring station is presented below.

Nitrogen

Nitrogen is an important measurement, particularly the dissolved forms, as it increases productivity on farm fields, urban lawns and streams/lakes. Nitrate (NO_3-N) is the dominant dissolved form with typically very small amounts of nitrite (NO_2-N) present (which can be quite ephemeral). Therefore, discussion will focus on nitrate. While nitrate is one of the primary forms of nitrogen used by plants for growth, excess amounts in groundwater and streams can cause human health concerns. At concentrations greater than 10 mg/L, it has been linked to methemoglobinemia ("blue baby syndrome") and some forms of cancer. The applicable water quality standard for nitrate is 10 milligrams per liter (mg/l). There are no numeric nitrate standards for aquatic life use.

Nonpoint sources are the dominant source of nitrogen in the MCW and throughout the state. According to the Iowa Geological Survey, point sources account for about eight percent of the stream nitrogen loads statewide, varying from one to 15 percent for individual watersheds (Libra et., al, 2004). Nonpoint sources account for the remainder. The primary source for surface water nitrate in Iowa is agriculture, specifically from the widespread use of anhydrous ammonia, application of livestock manure, legume fixation, and mineralization of soil nitrogen (Hallberg 1987; Goolsby et al. 1999). Previous studies have concluded that baseflow and agricultural tile drainage are the main conduits for nitrate to enter Iowa's streams (Hallberg 1987; 1989).

Unnamed tributary to Morgan Creek near Cedar Rapids Iowa(Photo Credit: EOR)

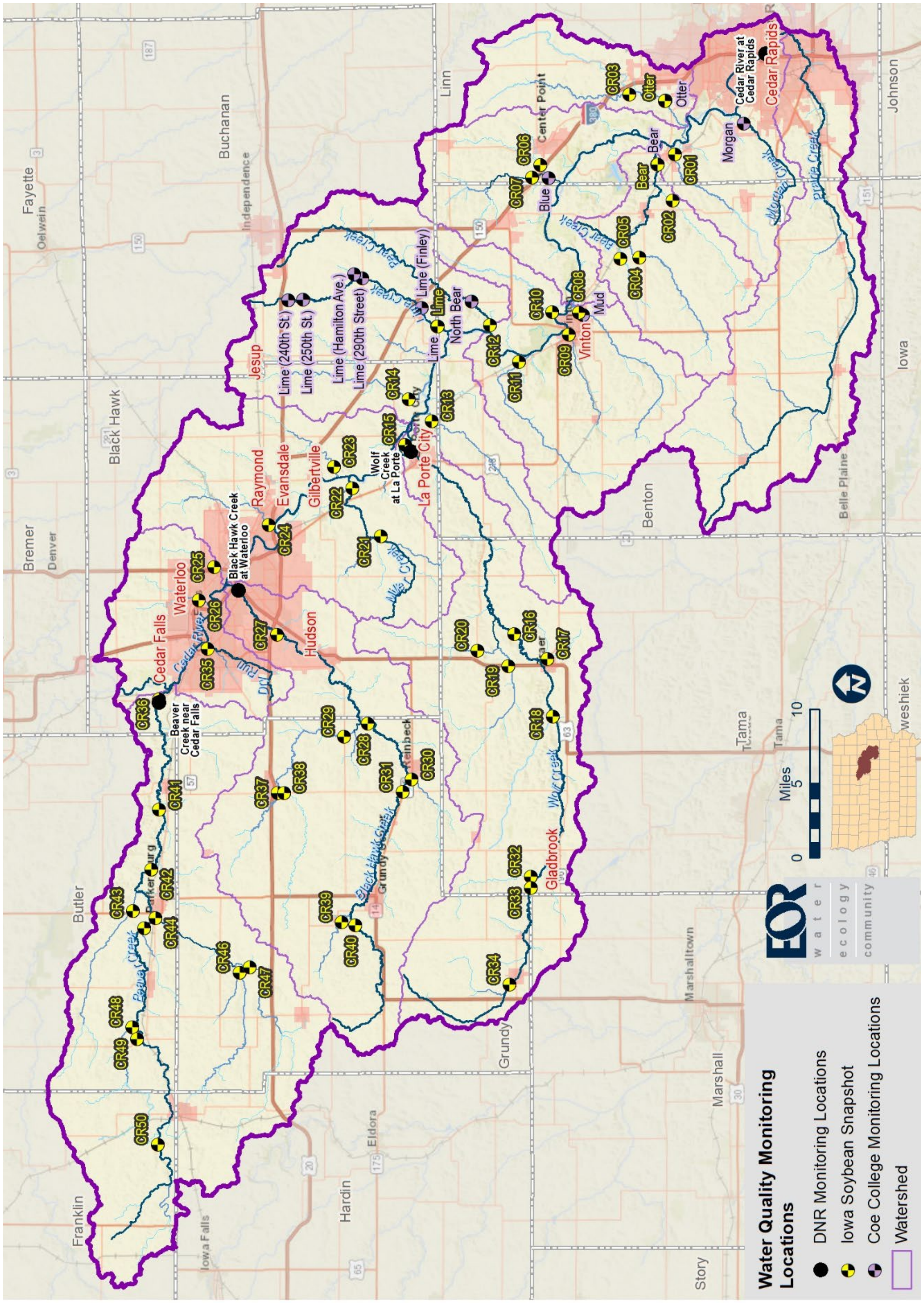

Figure 2-28. Middle Cedar Watershed—Water Quality Monitoring Locations

Coe College Monitoring Findings

Table 2-14 displays average annual growing season nitrate concentrations and the total number of samples collected by month at the Coe College monitoring stations from 2012-2016; average monthly nitrate concentrations are displayed as well. Observed average annual growing season nitrate concentrations ranged from a low of 7.6 mg/L (Blue Creek) to a high of 16.6 mg/L (Lime Creek – Hamilton Avenue).

Average monthly nitrate concentrations during the months of May and June exceeded the 10 mg/L standard along every stream reach with the exception of Blue Creek in May. In contrast, monthly concentrations during August were all below 10 mg/L. Observed seasonal changes in nitrate concentrations are reflective of a land use change from perennial grasslands to seasonal row crops which rely on subsurface tile drainage. Given tile drainage occurs mostly in the spring, it is not surpising to see elevated nitrate concentrations in the spring given that land use within the MCW is predominately (around 74 percent) agricultural. Similar seasonal patterns in nitrate concentrations have been observed throughout Iowa, including the Raccoon River Watershed in west Central Iowa (Schilling and Lutz 2004).

Table 2-14. Average Monthly Nitrate Concentrations (2012-2016) for Tributaries to the Cedar River – Source: Iowa Soybean Association/ Coe College.

Stream Reach Name	Average Monthly Nitrate Concentration (mg/L)								Average Nitrate (May-August) Concentration (mg/L)
	May		June		July		August		
	Avg.	# of Samples	Avg.	# of Samples	Avg.	# of Samples	Avg.	# of Samples	
Bear	10.5	14	10.3	23	7.8	22	5.0	5	8.4
Blue	9.8	14	10.2	23	6.2	22	4.1	7	7.6
Lime	15.7	30	15.0	44	10.6	44	6.9	16	12.1
Lime 240th Street	15.1	13	15.6	22	11.2	22	8.2	8	12.5
Lime 250th Street	14.8	13	15.3	22	10.6	22	7.7	8	12.1
Lime 290th Street	17.5	13	16.8	22	11.3	22	5.8	8	12.9
Lime Finley Avenue	15.9	13	16.0	22	10.8	22	6.8	8	12.4
Lime Hamilton Ave	18.8	13	19.7	22	14.5	22	9.6	8	15.6
Morgan	10.2	14	10.8	23	7.6	22	5.7	7	8.6
Mud	11.9	14	12.4	23	10.2	21	8.9	6	10.9
North Bear	14.6	14	13.5	23	10.6	22	8.4	7	11.8
Otter	10.0	14	10.1	23	7.1	22	5.1	7	8.1
Average	**13.7**	**15**	**13.8**	**24**	**9.9**	**24**	**6.9**	**8**	**11.1**

Iowa Department of Natural Resources (Iowa DNR) Monitoring - Annual Trends

The following paragraphs summarize trends in nitrate + nitrite concentrations at the four Iowa DNR monitoring sites within the MCW with the most complete (non-missing) dataset. This analysis is based on data downloaded from the EPA's Water Quality Portal (WQP). The four monitoring stations include Beaver Creek near Cedar Falls, Black Hawk Creek at Waterloo, Wolf Creek at La Porte City, and the Cedar River upstream of Cedar Rapids.

Observed annual average nitrate + nitrite concentrations were consistently low across all four monitored streams in the MCW in 2012 (**Figure 2-29**). The year 2012 was the driest year on record from 2000-2017 as shown in **Figure 2-30**. Average annual nitrate + nitrite concentrations were highest across all four streams in 2007 (**Figure 2-30**). Average annual flows in 2007 were higher than the preceding 7-year period from 2000-2006 indicating that 2007 may have represented a flushing event, releasing excess nitrogen that had built up in agricultural soils during periods of drought.

A similar pattern of low nitrate + nitrite concentrations in 2012 during periods of low precipitation followed by high concentrations in 2013 during periods of increased precipitation intensity was observed at all four monitoring points (**Figure 2-30**). Similarly low nitrate concentrations in 2012 and high concentrations in 2013 were observed at the 12 Coe College monitoring sites. Observed patterns in nitrate + nitrite concentrations in 2012 and 2013 are not unique to the MCW. According to the Water Footprint Calculator, "The highest nitrate concentrations in 2013 were in streams in Iowa, closely followed by southern Minnesota and central Illinois. Drought conditions in 2012 allowed excess nitrogen to build up in the soils until spring rains in 2013 flushed the nitrate into streams, leading to unusually high levels."

There is a significant amount of evidence available which suggests that this pattern of drought followed by intense rainfalls is going to increase. The substantial correlation between precipitation totals and observed nitrate + nitrite concentrations in the MCW across all four monitoring points suggests that nonpoint sources of pollution are the primary threat to the watershed's water resources. The EPA considers nonpoint sources of pollution to be the greatest threat to US waters, especially in watersheds like the MCW that are comprised largely of agricultural uses. Of the four monitored streams, Wolf Creek had the highest overall (all samples from 2000-2017 included) average nitrate + nitrite concentration at 8.54 mg/L. The Cedar River monitoring station had the lowest overall average concentration from 2000-2017 at 5.87 mg/L.

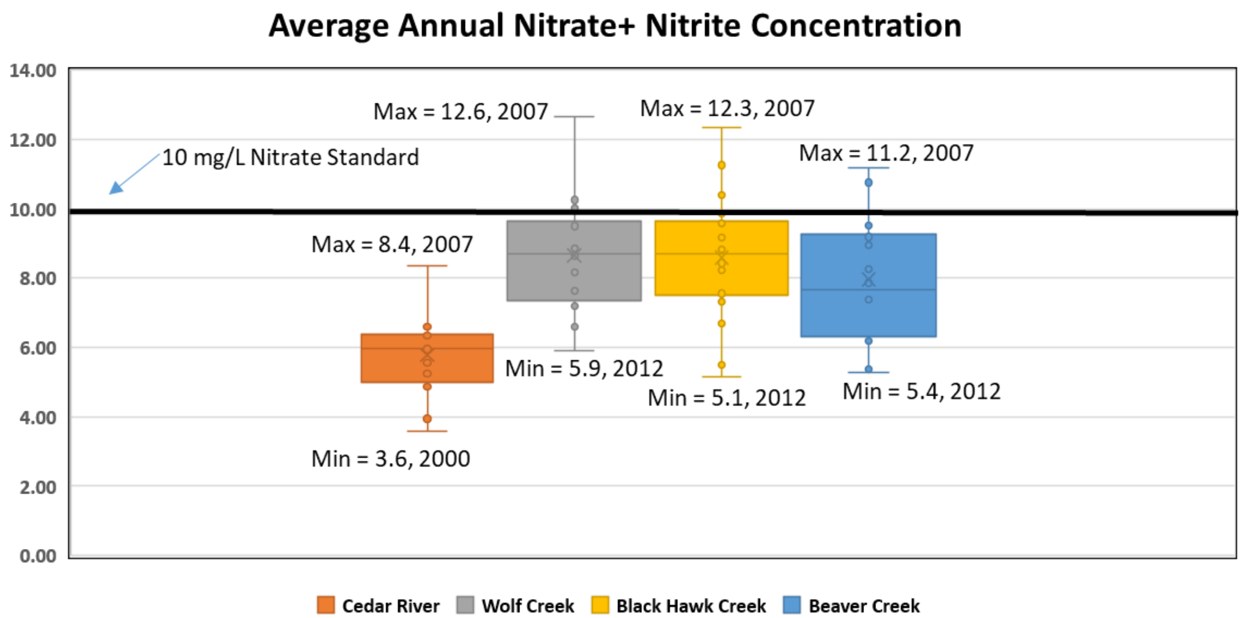

Figure 2-29. Average Annual Nitrate + Nitrite Concentrations.

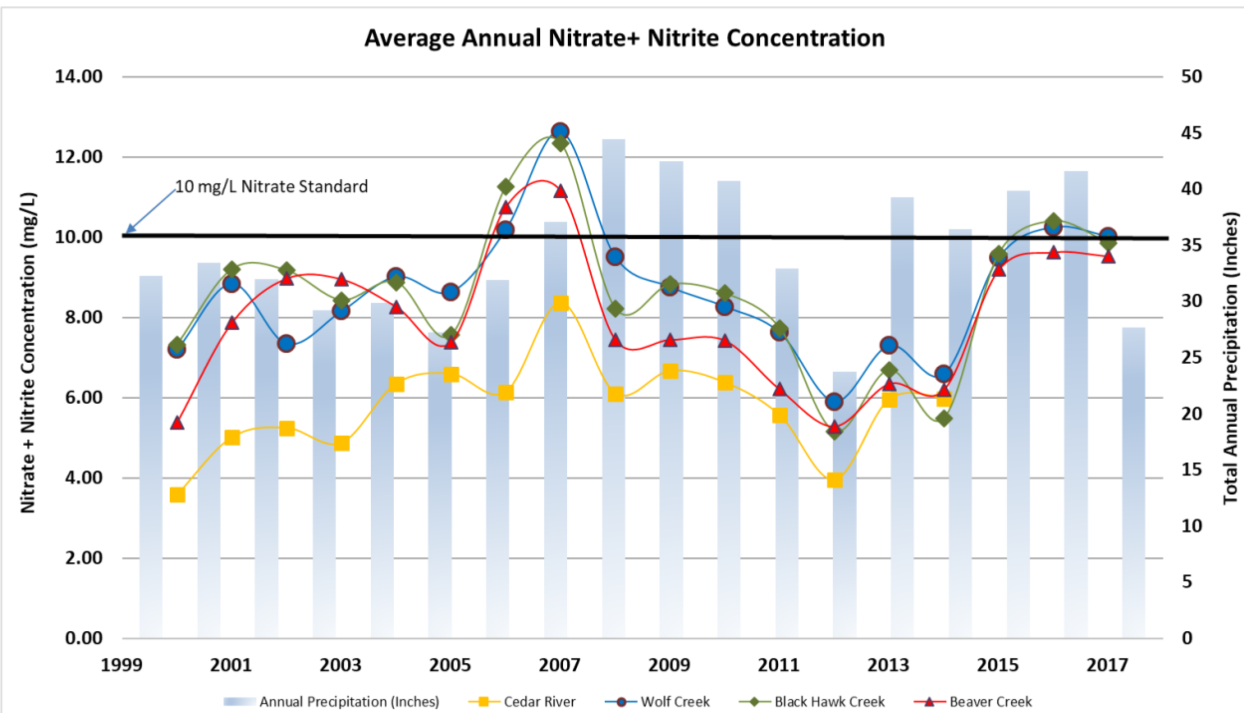

Figure 2-30. Average Annual Nitrate + Nitrite Concentrations with Annual Precipitation Totals.

Iowa Department of Natural Resources (Iowa DNR) Monitoring – Monthly Trends

Observed average monthly nitrate concentrations at the four DNR monitoring stations in the Cedar River were separated into three categories: good, moderate, or poor (**Figure 2-31**, **Figure 2-32**, **Figure 2-33**, and **Figure 2-34**). Each of these categories is associated with a water quality standard, for example the Iowa Drinking Water Standard for nitrate of 10 mg/L. Nitrate concentrations exceeding 10 mg/L are commonly accepted as posing a human health concern, therefore, nitrate observations exceeding this standard were categorized as "poor." Similarly, observed nitrate concentrations below the EPA's Western Corn Belt Ecoregion 25th percentile Nitrate concentration of 3.3 mg/L were categorized as "good." Subsequently, samples between 3.3 mg/L and 10 mg/L were categorized as "moderate."

Beaver Creek

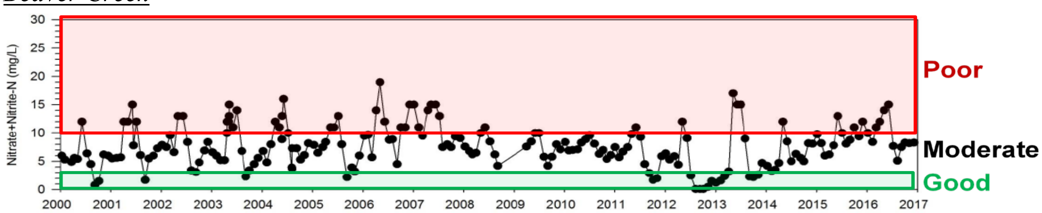

Figure 2-31. Beaver Creek—Observed average monthly Nitrate + Nitrite Concentration 2000-2017.

Black Hawk Creek

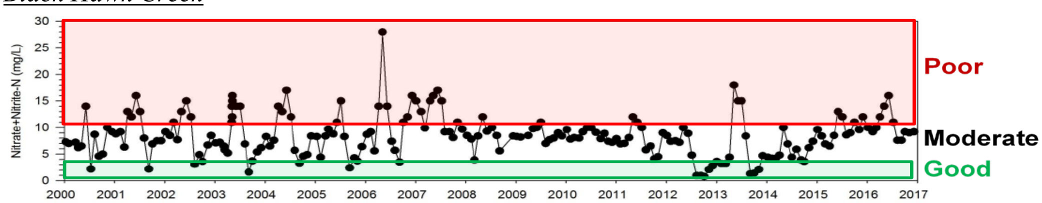

Figure 2-32. Black Hawk Creek—Observed average monthly Nitrate + Nitrite Concentration 2000-2017.

Wolf Creek

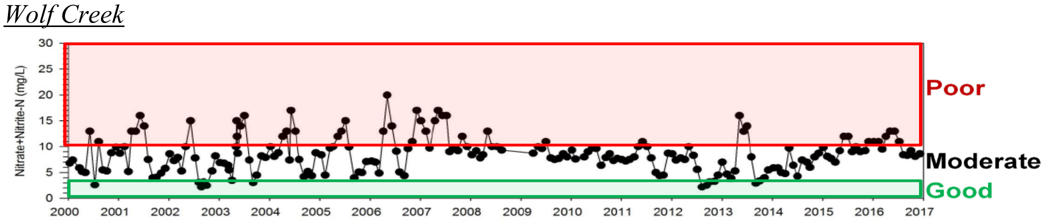

Figure 2-33. Wolf Creek—Observed average monthly Nitrate + Nitrite Concentration 2000-2017.

Cedar River

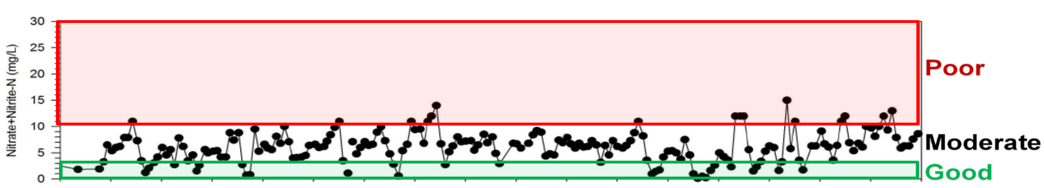

Figure 2-34. Cedar River—Observed average monthly Nitrate + Nitrite Concentration 2000-2017.

Phosphorus

Phosphorus is typically monitored in two forms: dissolved phosphorus (forms most readily used by crops as well as algae and aquatic plants, resulting in increased productivity); and total phosphorus (TP), which is found in both dissolved and particulate forms. Nonpoint sources are the dominant source of phosphorus in the MCW.

Table 2-15 displays the estimated phosphorus inputs (sources) and outputs for Iowa by category (Libra et., al, 2004). Phosphorus inputs are dominated almost entirely by fertilizer (53 percent) and manure (45 percent) whereas point source discharges from human and industrial wastewaters are less than two percent of the total. Harvest and grazing account for an estimated 96 percent of phosphorus outputs (loss). Streams account for only about four percent of total phosphorus outputs.

Table 2-15. Estimated phosphorus inputs and outputs for Iowa. Source – Nitrogen and Phosphorus Budgets for Iowa and Iowa Watersheds (Libra et., al, 2004).

Phosphorus Inputs	Tons	Phosphorus Outputs	Tons
Fertilizer	126,954	Harvest	243,197
Manure	109,214	Grazing	22,545
Human	3,600	Streams	10,844
Industry	650		
Total	**240,418**	**Total**	**276,586**

Coe College Monitoring Findings

Table 2-16 displays average annual Dissolved Reactive Phosphorus (DRP) concentrations and average monthly DRP concentrations for the growing season for each station monitored by Coe College from 2012-2016. Average annual growing season DRP concentrations range from a low of 0.12 mg/L (Lime Creek – Hamilton Avenue) to a high of 0.33 mg/L (Mud Creek).

Phosphorus concentration in water is a primary focus of applied watershed management as this element drives a wide array of river, stream and lake biological responses affecting beneficial uses. Excess phosphorus concentrations lead to increased algae that float in the stream or are attached to rocks and substrates, increased organic matter, increased bacteria that lead to boom-bust daily oxygen concentration cycles that limit aquatic life. In severe cases, massive algal mats and scums can be generated by blue-green algae that also can produce toxins such as microcystin that can affect recreation, drinking water supplies, and wildlife habitat. Because DRP is in an inorganic form, it is readily assimilated by aquatic plants and algae. Even low concentrations of DRP can therefore have a dramatic impact on streams.

The EPA has developed national nutrient criteria recommendations by ecoregion based on nutrient data from a large number of the nation's lakes and rivers (US EPA 2000). Ecoregions are defined as areas of similar ecosystem and geography. The 25th percentile total TP concentration for streams in the Western Corn Belt Plains ecoregion is 0.118 mg/L (the EPA associates the 25th percentile of a whole population of streams in an ecoregion with minimally impacted conditions.) When comparing the values in **Table 2-16** to this ecoregion criteria, it is important to note that DRP represents only a small portion of the total amount of phosphorus present in a stream. The observation that the average annual and monthly DRP concentration consistantly exceeded the EPA 25th percentile TP criteria, suggests the tributaries of the MCW are significantly impaired due to excessive nutrient contributions from the watershed.

Table 2-16. Average Monthly and Annual Dissolved Reactive Phosphorus Concentrations for Tributaries to the Cedar River from 2012-2016 – Source: Iowa Soybean Association/ Coe College.

Stream Reach Name	Average Monthly Dissolved Reactive Phosphorus Concentration (mg/L)								Annual Growing Season Average Dissolved Reactive Concentration (mg/L)
	May		June		July		August		
	Avg.	#of Samples	Avg.	#of Samples	Avg.	#of Samples	Avg.	#of Samples	
Bear	0.19	14	0.32	23	0.19	22	0.19	5	0.22
Blue	0.13	14	0.20	23	0.11	22	0.11	7	0.14
Lime	0.10	30	0.26	44	0.21	44	0.19	16	0.19
Lime 240th Street	0.07	13	0.20	22	0.15	22	0.48	8	0.22
Lime 250th Street	0.08	13	0.19	22	0.15	22	0.20	8	0.15
Lime 290th Street	0.08	13	0.23	22	0.15	22	0.17	8	0.15
Lime Finley Avenue	0.08	13	0.23	22	0.19	22	0.20	8	0.17
Lime Hamilton Ave	0.06	13	0.17	22	0.13	22	0.13	8	0.12
Morgan	0.25	14	0.24	23	0.14	22	0.12	7	0.19
Mud	0.26	14	0.37	23	0.32	21	0.36	6	0.33
North Bear	0.08	14	0.22	23	0.16	22	0.12	7	0.14
Otter	0.21	14	0.26	23	0.23	22	0.16	7	0.21
Average	**0.17**	**15**	**0.21**	**24**	**0.11**	**24**	**0.19**	**8**	**0.19**

Iowa Department of Natural Resources (Iowa DNR) Monitoring - Annual Trends

The following paragraphs summarize trends in TP concentrations at the four Iowa DNR monitoring sites within the MCW with the most complete (non-missing) dataset.

Observed annual average TP concentrations were lowest in 2010 on Beaver Creek, Black Hawk Creek and the Cedar River and in 2012 on Wolf Creek (**Figure 2-35**). The year 2012 was the driest year on record from 2000-2017 (**Figure 2-36**). The low average TP concentration observed in Wolf Creek during 2012 suggests a correlation with nonpoint sources. In contrast, the 2010 calendar year produced above-normal annual rainfall levels including a large spring-time event on March 17th, 2010; however average annual phosphorus concentrations remained low in Beaver Creek, Black Hawk Creek, and the Cedar River. This observation may be the result of previous flushing events which occurred in 2008 and 2009, thus a significant amount of phosphorus had not previously accumulated in the watershed's soils.

Average annual TP concentrations were highest in 2004 on Beaver Creek and Wolf Creek (**Figure 2-36**). Although annual flow totals for 2004 were near-normal, a large late-spring precipitation event on May 26th and 27th, 2004 produced a large amount of runoff immediately following drought conditions resulting from two years of below-average rainfall in 2002 and 2003. Therefore, it appears that storm events which are preceded by periods of drought are the major driver in the export of phosphorus within the watershed. Observed TP concentrations at the Beaver Creek monitoring station were highest in 2008; 2008 was an extremely wet year with high average annual rainfall and intense rainfall events.

Observed annual average TP concentrations at the Cedar River monitoring station were highest in 2014. Two data points collected within a three-week window in 2014 (March 11th, 2014, April 2nd, 2014) were amongst the top six highest TP concentrations observed throughout the entire 17-year monitoring period.

Of the four monitored streams, Wolf Creek had the highest overall average TP concentration from 2000-2017 at 0.249 mg/L, more than twice the EPA's 25th percentile value for the Western Corn Belt Ecoregion of 0.118 mg/L. The Beaver Creek monitoring station had the lowest overall average TP concentration from 2000-2017 at 0.175 mg/L.

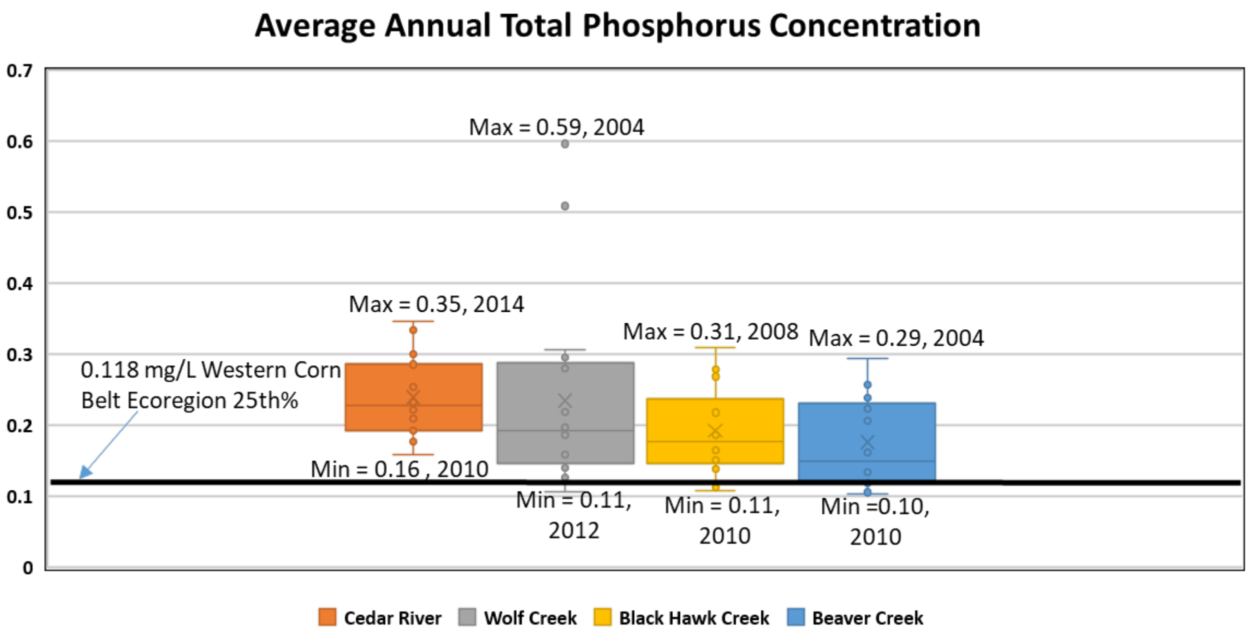

Figure 2-35. Cedar River, Wolf Creek, Black Hawk Creek, and Beaver Creek—Average Annual Total Phosphorus Concentrations.

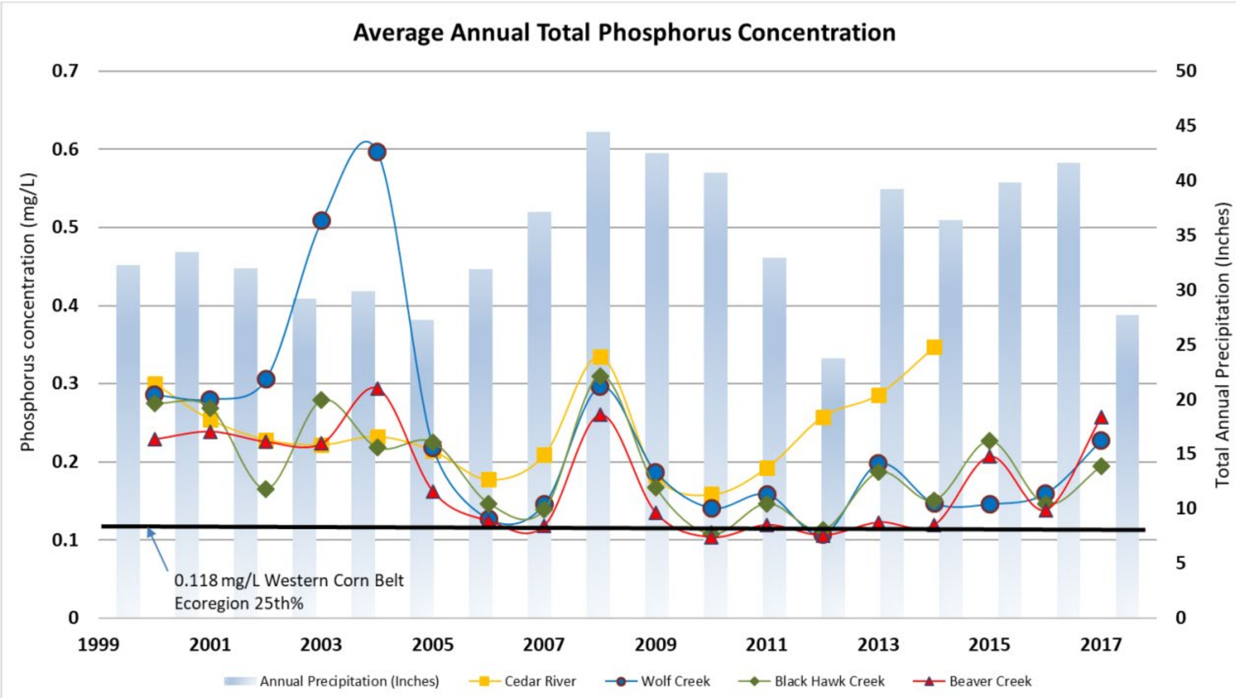

Figure 2-36. Cedar River, Wolf Creek, Black Hawk Creek, and Beaver Creek—Average Annual Total Phosphorus Concentrations with Annual Precipitation Totals.

Iowa Department of Natural Resources (Iowa DNR) Monitoring - Monthly Trends

Observed average monthly TP concentrations at DNR monitoring stations in the Cedar River were separated into three categories: good, moderate, or poor (**Figure 2-37**, **Figure 2-38**, **Figure 2-39**, and **Figure 2-40**). The EPA's TP 25th percentile of 0.118 mg/L for the Western Corn Belt Ecoregion was used as a boundary for identifying "Poor" samples. Observed TP concentrations below 0.060 mg/L (60 ug/L) were categorized as "Good".

Beaver Creek

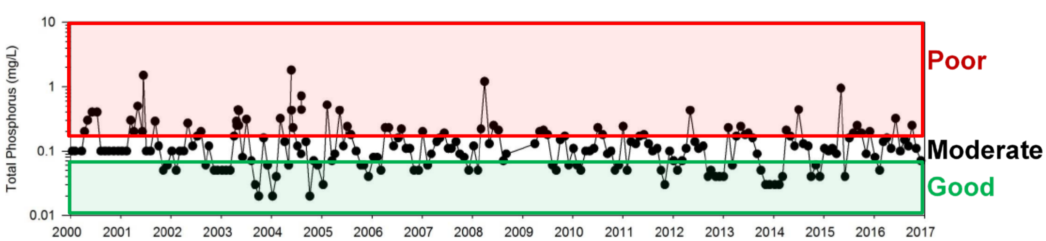

Figure 2-37. Beaver Creek—Observed *Average Monthly* Total Phosphorus Concentration 2000-2017.

Black Hawk Creek

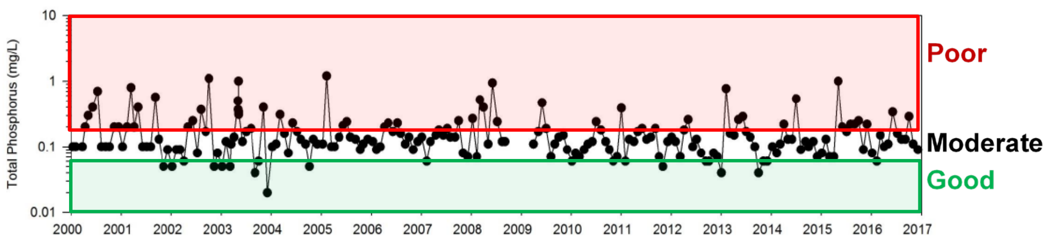

Figure 2-38. Black Hawk Creek—Observed *Average Monthly* Total Phosphorus Concentration 2000-2017.

Wolf Creek

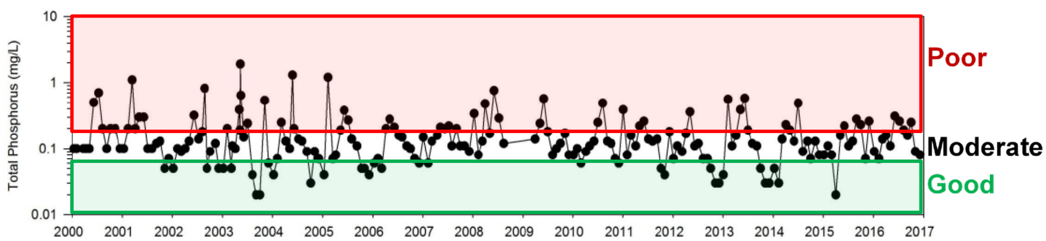

Figure 2-39. Wolf Creek—Observed *Average Monthly* Total Phosphorus Concentration 2000-2017.

Cedar River

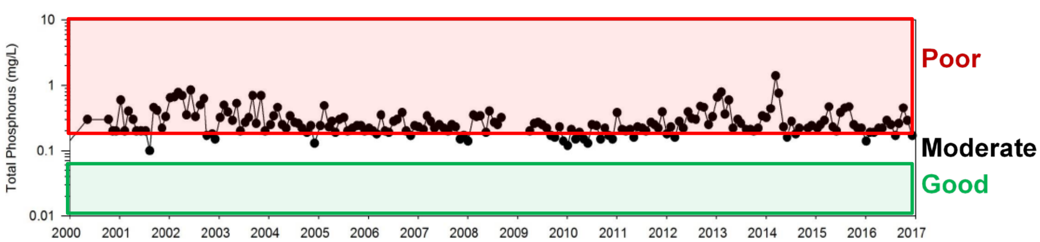

Figure 2-40. Cedar River—Observed Average Monthly Total Phosphorus Concentration 2000-2017.

Total Suspended Solids

Total Suspended Solids (TSS) is an important measurement of the amount of material suspended in a waterbody, which is sometimes referred to as turbidity. As more material is suspended, less light can pass through, making it less transparent. Suspended materials may include soil, algae, plankton, and microbes.

Excess turbidity can significantly degrade the aesthetic qualities of waterbodies. People are less likely to recreate in waters degraded by excess turbidity. Also, turbidity can make the water more expensive to treat for drinking or food processing uses. Excess turbidity can also harm aquatic life, aquatic organisms may have trouble finding food, gill function may be affected, and spawning beds may be buried.

Coe College Monitoring Findings

Table 2-17 displays average annual growing season TSS concentrations and average monthly TSS concentrations for the growing season for each station monitored by Coe College from 2012-2016. Monthly TSS concentrations were highest during the months of May and June, which correspond to the period of the year where row crops have not yet become established. In these periods of year, bare soil from agricultural fields is more likely to become detached during precipitation events given the rate and magnitude of water erosion is usually greatest during short-duration, high-intensity thunderstorms; during snowmelt; when soils have high moisture content; and when vegetative cover is minimal. Also, at this time of year, stream flow levels are high leading to increased streambank and streambed erosion, releasing sediment into the water.

Table 2-17. Average Monthly and Annual Total Suspended Solids Concentrations for Tributaries to the Cedar River from 2012-2016 – Source: Iowa Soybean Association/ Coe College.

Stream Reach Name	Average Monthly Total Suspended Solids Concentration (mg/L)								Annual Growing Season Average Total Suspended Solids Concentration (mg/L)
	May		June		July		August		
	Avg.	#of Samples	Avg.	#of Samples	Avg.	#of Samples	Avg.	#of Samples	
Bear	35.6	14	67.2	23	14.0	22	8.5	5	31.3
Blue	15.1	14	32.0	23	9.5	22	9.0	7	16.4
Lime	4.0	30	19.2	44	8.1	44	5.7	16	9.2
Lime 240th Street	3.4	13	13.6	22	9.7	22	11.9	8	9.7
Lime 250th Street	8.1	13	15.8	22	11.5	22	9.4	8	11.2
Lime 290th Street	4.3	13	23.3	22	15.4	22	8.9	8	13.0
Lime Finley Avenue	6.5	13	16.8	22	7.2	22	4.8	8	8.8
Lime Hamilton Ave	6.1	13	15.4	22	15.5	22	18.7	8	13.9
Morgan	74.4	14	33.2	23	12.4	22	9.4	7	32.4
Mud	13.6	14	47.9	23	16.8	21	8.4	6	21.7
North Bear	8.9	14	22.9	23	7.4	22	4.2	7	10.8
Otter	40.8	14	35.3	23	13.3	22	5.3	7	23.7
Average	**18.4**	**15**	**28.6**	**24**	**11.7**	**24**	**8.7**	**8**	**16.8**

Iowa Department of Natural Resources (Iowa DNR) Monitoring - Annual Trends

The following paragraphs summarize trends in TSS concentrations at the four Iowa DNR monitoring sites within the MCW with the most complete (non-missing) dataset.

Similar to observed TP concentrations, observed annual average TSS concentrations were lowest in 2010 on Beaver Creek and the Cedar River despite above average rainfall (**Figure 2-41**). Observed annual TSS concentrations were lowest in 2005 on Black Hawk Creek and in 2014 in Wolf Creek (**Figure 2-42**). Observed annual average TSS concentrations were highest in Beaver Creek and Wolf Creek in 2004, again this is reflective of observed TP patterns. The combination of high TSS loading with high TP loading in 2004 provides evidence to suggest that the majority of the TP load from 2004 was from sediment bound phosphorus. Observed TSS concentrations at the Cedar River monitoring station were highest in 2008, an extremely wet year with high average annual rainfall and intense rainfall events. Of the four monitored streams, Wolf Creek had the highest overall (all samples from 2000-2017 included) average TSS concentration at 122 mg/L. The Beaver Creek monitoring station had the lowest overall average TSS concentration from 2000-2017 at 44 mg/L.

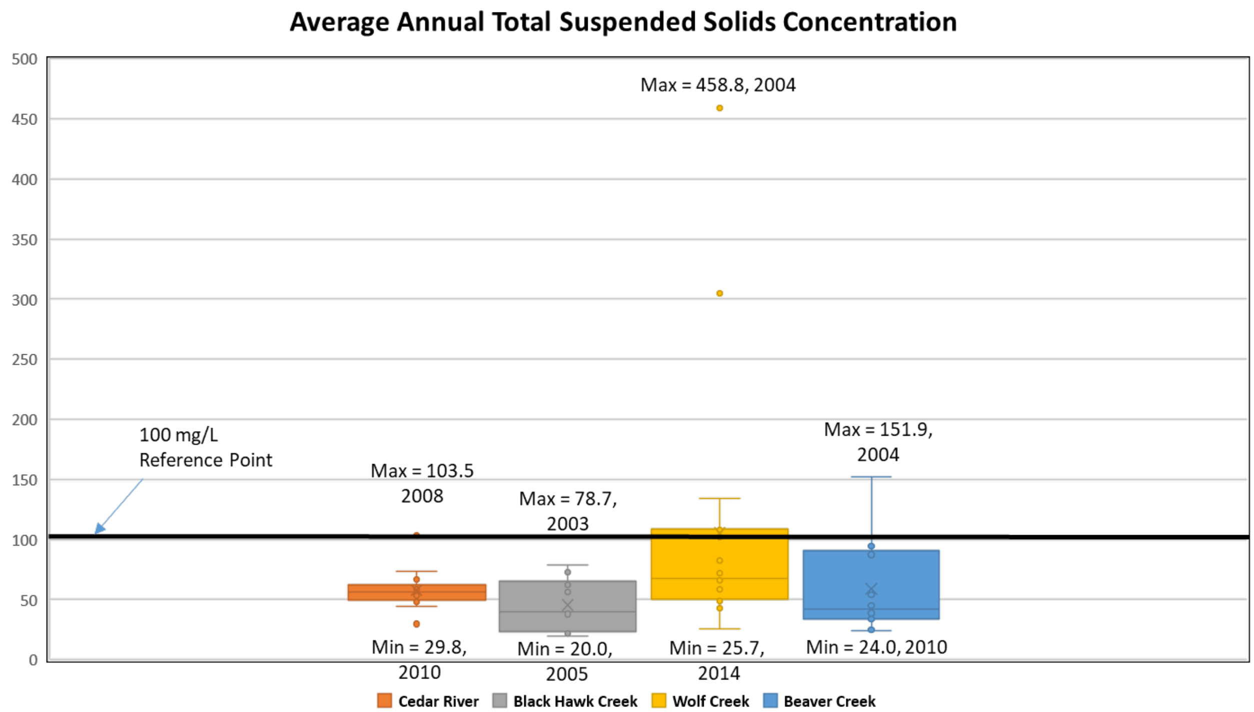

Figure 2-41. Cedar River, Black Hawk Creek, Wolf Creek, and Beaver Creek—Average annual TSS concentration.

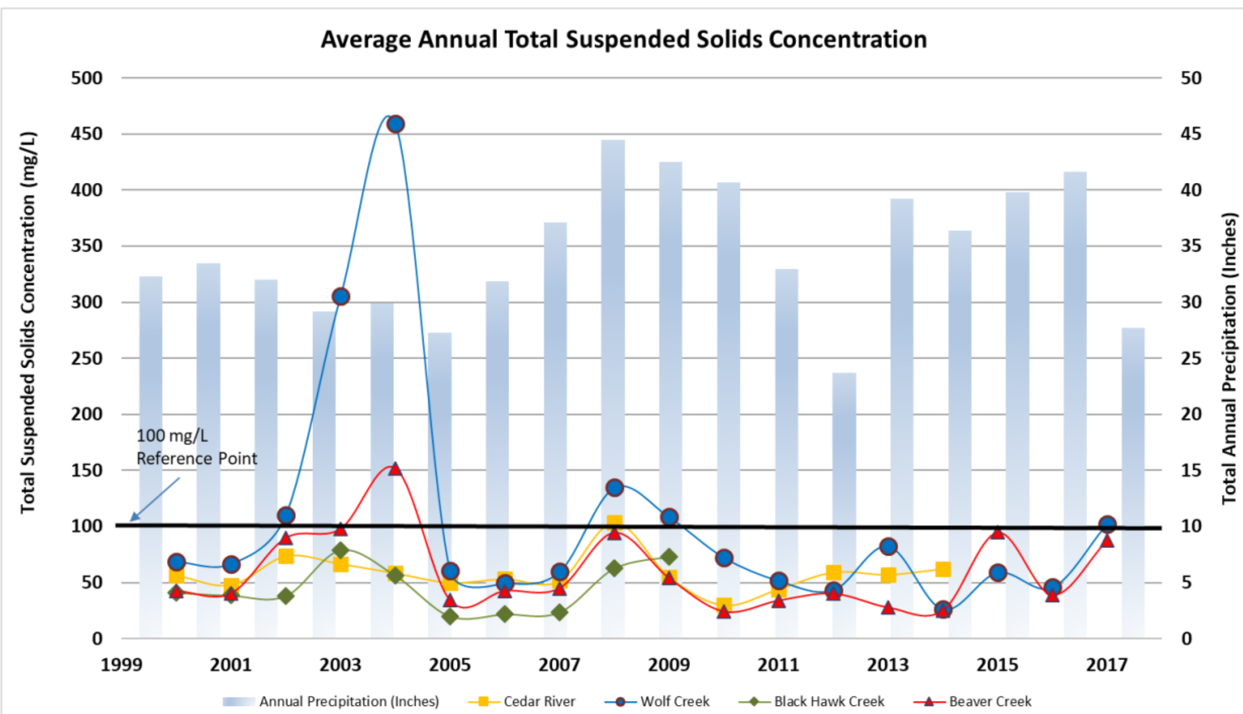

Figure 2-42. Cedar River, Wolf Creek, Black Hawk Creek, and Beaver Creek—Average Annual TSS Concentration with Annual Precipitation Totals.

Iowa Department of Natural Resources (Iowa DNR) Monitoring - Monthly Trends

Observed average monthly TSS concentrations at DNR monitoring stations in the Cedar River were separated into three categories: good, moderate, or poor (**Figure 2-43**, **Figure 2-44**, **Figure 2-45**, and **Figure 2-46**). A value of 100 mg/L was used as the cutoff for identifying poor water quality based on observations made in southern Minnesota streams as outlined in the *Aquatic Life Water Quality Standards Draft Technical Support Document for Total Suspended Solids* (Markus 2011). Values below 66 mg/L were classified "good." Values between 100 and 66 mg/L were classified "moderate."

Beaver Creek

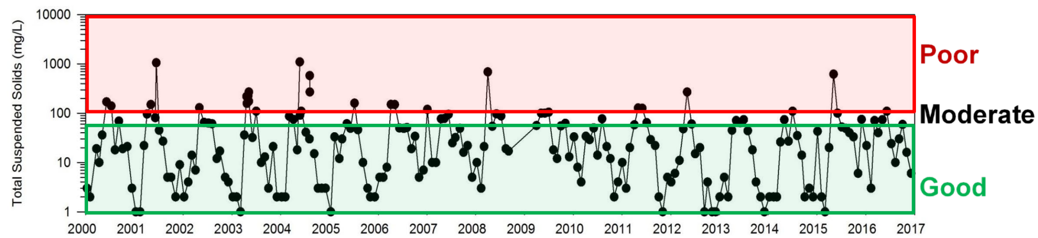

Figure 2-43. Beaver Creek—Observed Average Monthly TSS Concentration 2000-2017.

Black Hawk Creek

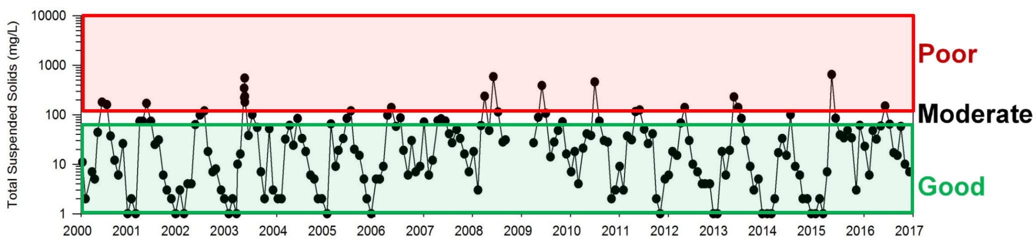

Figure 2-44. Black Hawk Creek—Observed Average Monthly TSS Concentration 2000-2017.

Wolf Creek

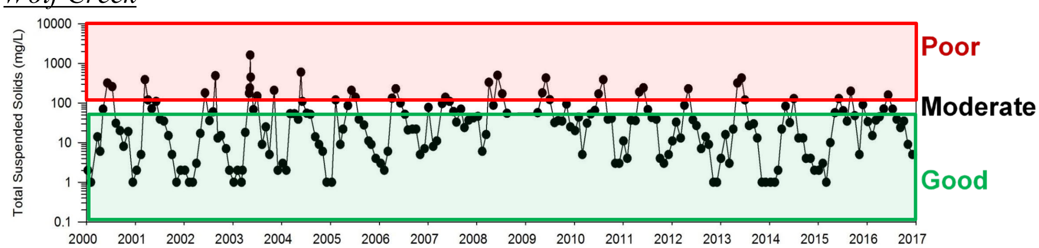

Figure 2-45. Wolf Creel—Observed Average Monthly TSS Concentration 2000-2017.

Cedar River

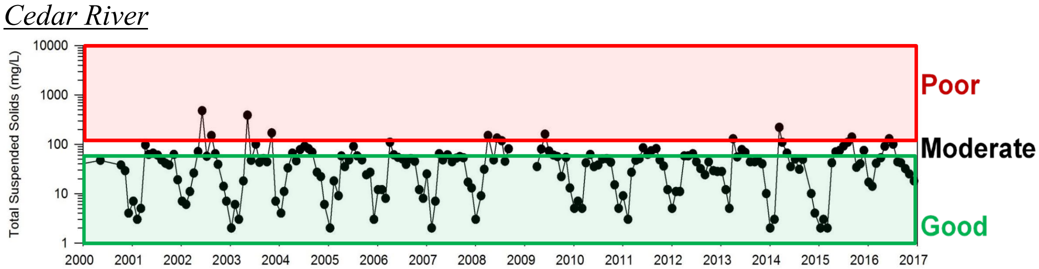

Figure 2-46. Cedar River—Observed Average Monthly TSS Concentration 2000-2017.

Bacteria (*E. coli*)

Humans, pets, livestock, and wildlife all contribute bacteria to the environment. These bacteria, after appearing in animal waste, are dispersed throughout the environment by an array of mechanisms (LeFevre et. al., 2014). Bacteria fate and transport is affected by sewage disposal and treatment mechanisms, methods of manure reuse, imperviousness of land surfaces, and natural decay and die-off due to environmental factors such as ultraviolet (UV) exposure and detention time in the landscape (LeFevre et. al., 2014). The following discussion highlights sources of bacteria in the environment and mechanisms that drive the delivery of bacteria to surface waters.

Coe College Monitoring Findings

Table 2-18 displays average annual geometric mean bacteria (*E. coli*) concentrations for each station monitored by Coe College from 2012-2016. Annual geometric mean *E. coli* concentrations ranged from a high of 3003 Most Probable Number (MPN/100 ml) on Mud Creek in 2014 to a low of 352 (MPN/100 ml) on Blue Creek in 2012. The Iowa State Standard geometric mean MPN/100ml *E. coli* concentration is 126 MPN/100ml. Comparing observed data collected in the MCW with the 126 MPN/100ml State Standards suggests all tributaries are significantly impaired due to excessive bacteria contributions from the watershed.

Based on data collected to date, there are likely additional stream bacteria impairments in the watershed. Many of the smaller streams and tributaries have an insufficient amount of monitoring information to be fully assessed for compliance with water quality standards. Additional monitoring, with an emphasis on bacteria data collection is needed on these unmonitored tributaries for comparison to water quality standards and criteria.

Table 2-18. Annual Geometric Mean *E. coli.* Concentration for Tributaries to the Cedar River -Source: Iowa Soybean Association/ Coe College.

Stream Reach Name	Annual Geometric Mean *E. Coli* Concentration (organisms/100 ml)					Annual Geometric Mean *E. Coli* Concentration (organisms/100 ml)
	2012	2013	2014	2015	2016	
Bear	717	742	1,676	1,160	782	1,015
Blue	352	574	879	789	579	635
Lime	529	742	1,236	966	864	867
Lime 240th Street	511	438	514	439	758	532
Lime 250th Street	771	608	587	450	736	630
Lime 290th Street	1,018	1,044	1,484	758	1,405	1,142
Lime Finley Avenue	872	1,316	1,568	1,318	1,880	1,391
Lime Hamilton Ave	2,156	1,181	1,989	1,454	557	1,467
Morgan	391	416	902	982	820	702
Mud	453	588	3,003	1,103	700	1,169
North Bear	539	756	685	705	779	693
Otter	407	713	1,069	1,123	868	836
Average	726	760	1,299	937	894	923

Iowa Department of Natural Resources (Iowa DNR) Monitoring - Annual Trends

The following paragraphs summarize annual and monthly trends in TSS concentrations at the four Iowa DNR monitoring sites within the MCW with the most complete (non-missing) dataset.

Observed annual average *E. coli* concentrations were lowest in 2010 on the Cedar River despite above average rainfall (**Figure 2-47**). Observed annual *E. coli* concentrations were lowest in 2014 on Black Hawk Creek, Wolf Creek and Beaver Creek. Observed annual average *E. coli* concentrations were highest in Wolf Creek and Beaver Creek in 2003 (**Figure 2-48**). Observed *E. coli* concentrations at the Cedar River monitoring station were highest in 2007. Of the four monitored streams, Wolf Creek had the highest overall (all samples from 2000-2017 included) average TSS concentration at 122 mg/L. The Cedar River monitoring station had the lowest geometric mean concentration from 2000-2017.

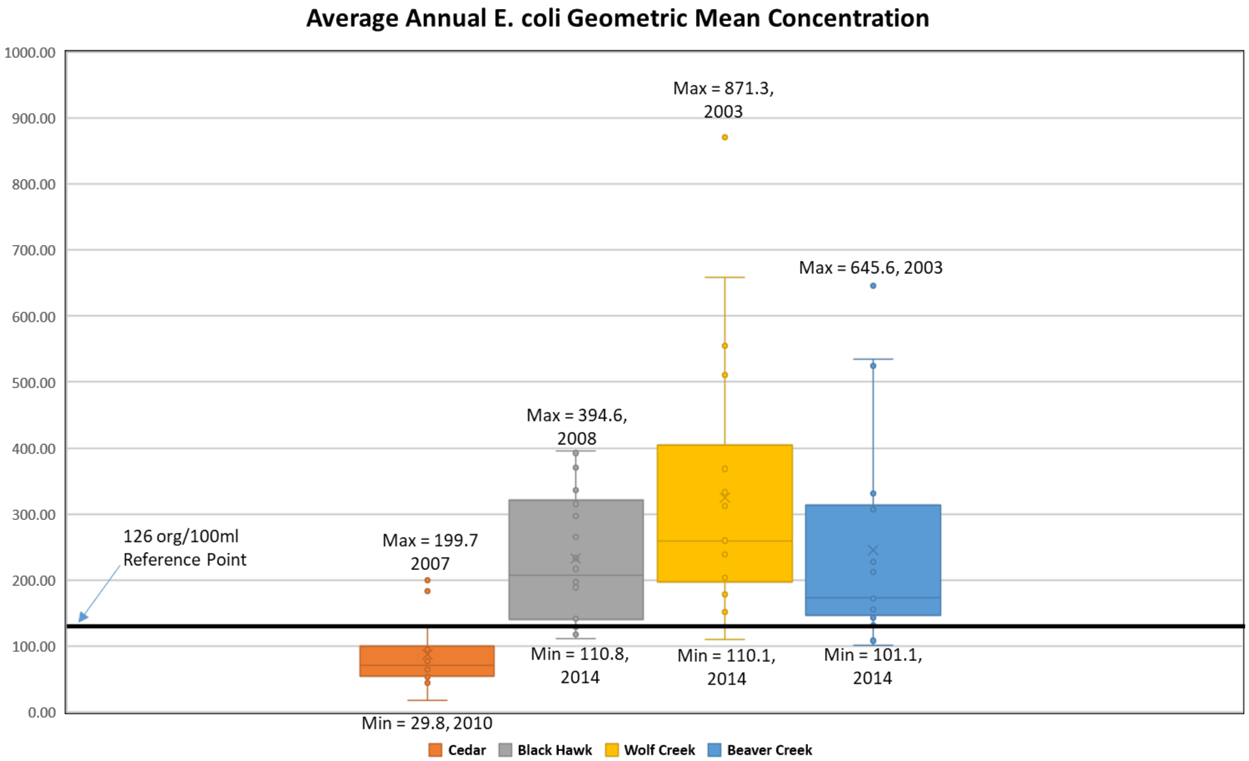

Figure 2-47. Cedar River, Wolf Creek, Black Hawk Creek, and Beaver Creek—Average annual *E. coli* geometric mean concentrations.

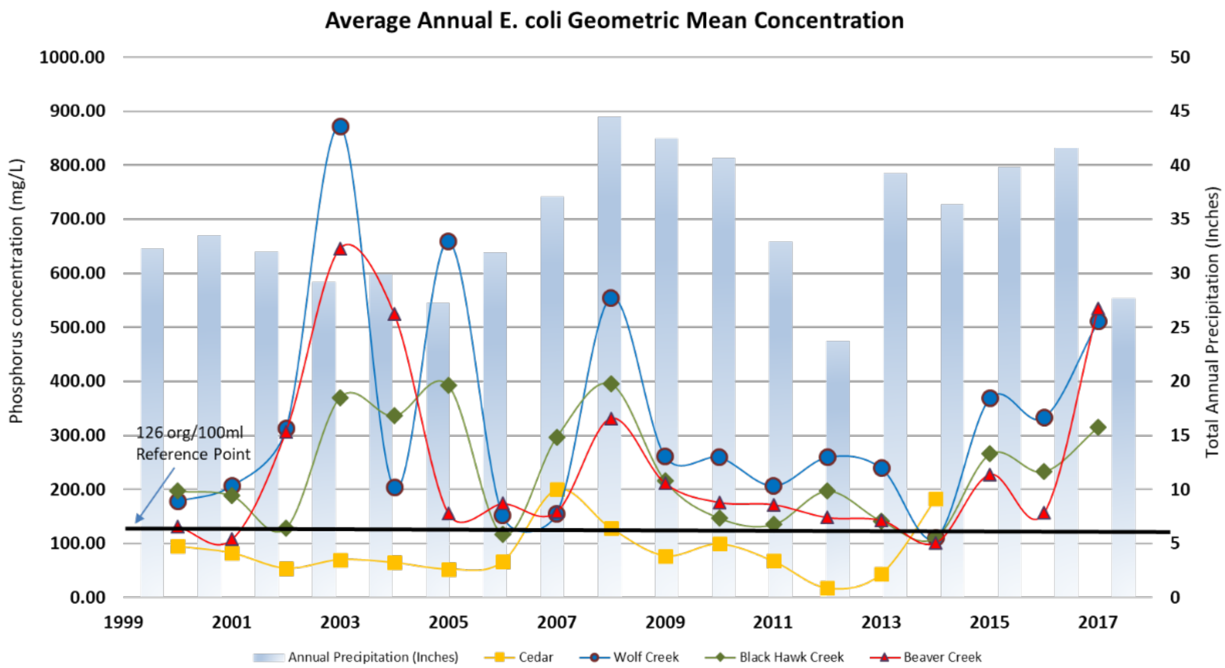

Figure 2-48. Cedar River, Wolf Creek, Black Hawk Creek, and Beaver Creek—Average Annual *E. coli* Geometric Mean Concentrations with Annual Precipitation Totals (Inches).

Iowa Department of Natural Resources (Iowa DNR) Monitoring - Monthly Trends

Observed bacteria (*E. coli)* concentrations at DNR monitoring stations in the Cedar River were separated into three categories: good, moderate, or poor (**Figure 2-49**, **Figure 2-50**, **Figure 2-51** and **Figure 2-52**). For a point of reference, the Iowa State Geometric Mean Standard of 126 org/100ml was used as a boundary for identifying "poor" samples. Observed *E. coli* concentrations below 20 org/100ml were categorized as "good". Seasonal patterns in bacteria concentrations show elevated concentrations exceeding 126 org/100 ml from May through October. The lowest observed bacteria concentrations occur from November through April.

<u>*Beaver Creek*</u>

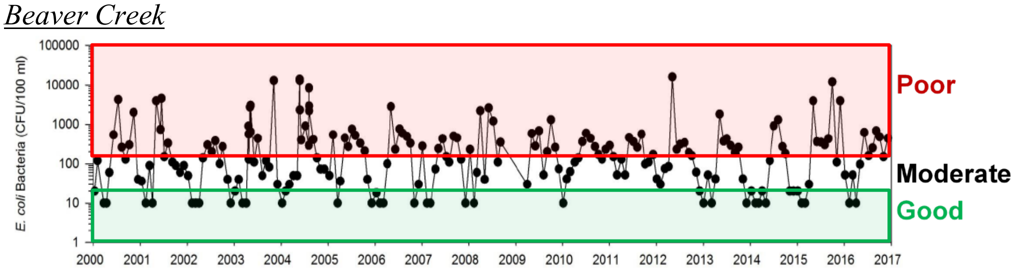

Figure 2-49. Beaver Creek—Observed Bacteria (E. coli) Concentration 2000-2017.

Black Hawk Creek

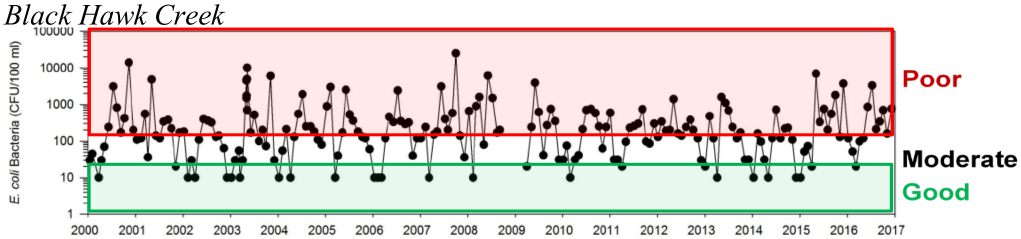

Figure 2-50. Black Hawk Creek—Observed Bacteria (E. coli) Concentration 2000-2017.

Wolf Creek

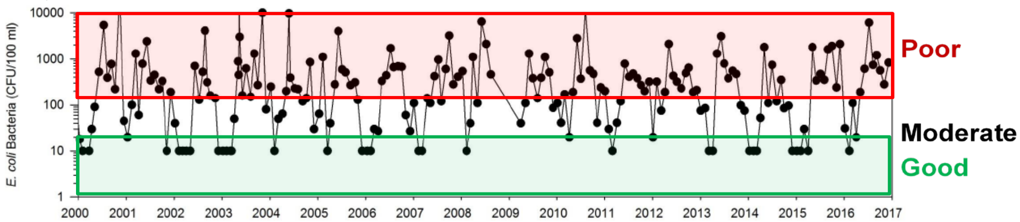

Figure 2-51. Wolf Creek—Observed Bacteria (E. coli) Concentration 2000-2017.

Cedar River

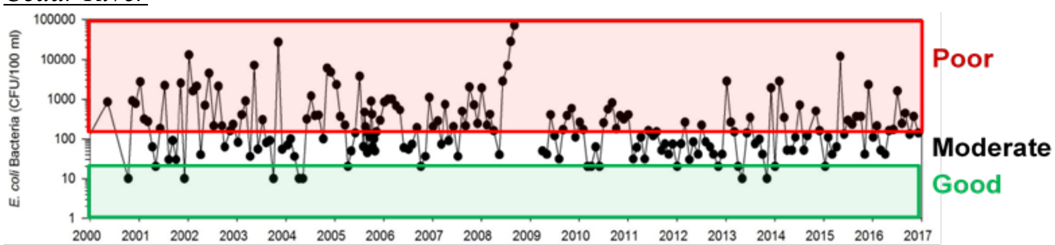

Figure 2-52. Cedar River—Observed Bacteria (E. coli) Concentration 2000-2017.

Fish and Benthic Macroinvertebrate Evaluation

From 1994 to 2016, the Iowa DNR conducted biological assessments on 81 stream reaches within the MCW. These 81 stream reaches were distributed over 29 of the 68 HUC-12 watersheds (43 percent). Biological assessment (bioassessment) is a key component of the DNR's water quality monitoring and assessment functions, including: problem investigation, project evaluation, status/trend monitoring, and TMDL development. Biological data collected at each of the 81 sampling sites was used to calculate the Fish Index of Biotic Integrity (FIBI) and Benthic Macroinvertebrate Index of Biotic Integrity (BMIBI).

Both the FIBI and BMIBI are composite indexes in which twelve individual metrics (**Table 2-19**) are combined to provide a community-level assessment of stream biological conditions. Both indices were developed from a database of stream reference sites and test sites located in the eight ecological regions of Iowa. Reference sites were chosen to represent least impacted stream habitats in the ecoregions in which they are located. Test sites were chosen to represent common types of stream impacts (e.g., point source discharge; riparian livestock grazing), or they were chosen as part of a watershed assessment project.

The FIBI and BMIBI both have a possible scoring range from 0-100. **Figure 2-53** and **Figure 2-54** provide a general framework for relating FIBI/BMIBI scores to fish/macroinvertebrate assemblage observed. This framework is largely based on the biological criteria program of the U.S. EPA, the EPA has endorsed the adaptation of a multitiered biological condition gradient (Davies 2003; Jackson 2003). The gradient captures various levels of biological condition from natural (biological integrity) to highly impaired (i.e., not meeting Section 101(a) (2) Clean Water Act (CWA) “fishable” interim use goal). The biocondition gradient establishes a consistent framework for conveying biological information to resource managers and the public, and it can also serve as a template for refining water quality standards and aquatic life use designations.

Figure 2-55 shows the observed FIBI scores for the evaluated stream reaches of the MCW. Twenty-six of 81 (32 percent) stream reaches contained fish communities with FIBI scores that would be considered excellent (FIBI exceeding 71). These excellent-rated stream reaches represent portions of Beaver Creek, Bear Creek, Dry Run Creek, Lime Creek, and West Otter Creek. No “poor” (FIBI below 25) fish communities were observed in the stretches of sampled streams in the MCW.

Figure 2-56 shows the observed BMIBI scores for the evaluated stream reaches of the MCW. Thirteen of 81 (16 percent) stream reaches contained benthic macroinvertebrate communities with BMIBI scores that would be considered excellent (BMIBI exceeding 76). These excellent stream reaches represent portions of Beaver Creek, Bear Creek, Lime Creek, and West Otter Creek. Five “poor” (FIBI below 25) macroinvertebrate communities were observed in the stretches of sampled streams in the MCW. These poor-rated stream reaches represent portions of the Middle Fork South Beaver Creek, an unnamed tributary to the West Branch of Blue Creek, Miller Creek, and two unnamed tributaries to Lime Creek.

Table 2-19. Data metrics of the Benthic Macroinvertebrate Index of Biotic Integrity (BMIBI) and the Fish Index of Biotic Integrity (FIBI) – Source: Iowa DNR Biological Assessment of Iowa’s Wadeable Streams.

Benthic Macroinvertebrate Index of Biotic Integrity (BMIBI)	Fish Index of Biotic Integrity (FIBI)
1. MH*-taxa richness	1. # native fish species
2. SH*-taxa richness	2. # sucker species
3. MH-EPT richness	3. # sensitive species
4. SH-EPT richness	4. # benthic invertivore species
5. MH-sensitive taxa	5. % 3-dominant fish species
6. % 3-dominant taxa (SH)	6. % benthic invertivores
7. Biotic index (SH)	7. % omnivores
8. % EPT (SH)	8. % top carnivores
9. % Chironomidae (SH)	9. % simple lithophil spawners
10. % Ephemeroptera (SH)	10. fish assemblage tolerance index
11. % Scrapers (SH)	11. adjusted catch per unit effort
12. % Dom. functional feeding group (SH)	12. % fish with DELTs

* MH, Multi-habitat sample; SH, Standard-habitat sample.

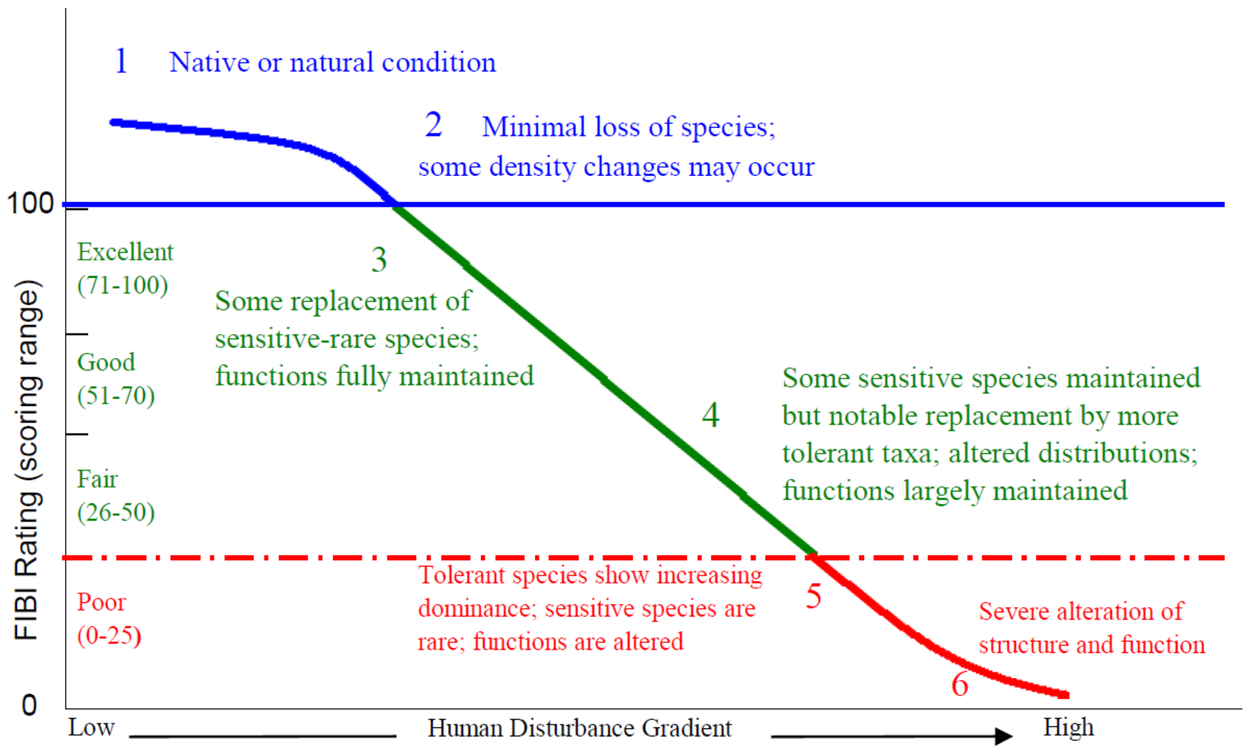

Figure 2-53. Fish Index of Biotic Integrity (FIBI) qualitative scoring ranges (excellent, good, fair, and poor) in relation to a conceptual tiered biological condition gradient (Adapted from Davies and Jackson 2006).

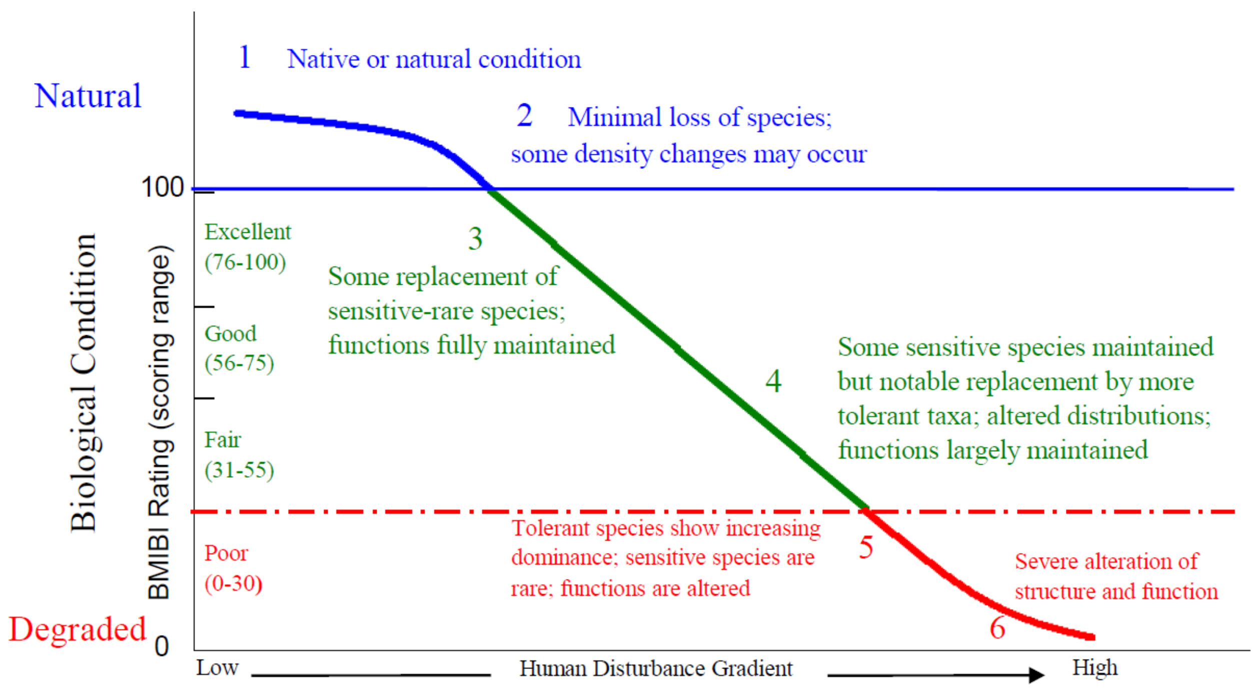

Figure 2-54. Benthic Macroinvertebrate Index of Biotic Integrity (BMIBI) qualitative scoring ranges (excellent, good, fair, and poor) in relation to a conceptual tiered biological condition gradient (Adapted from Davies and Jackson 2006).

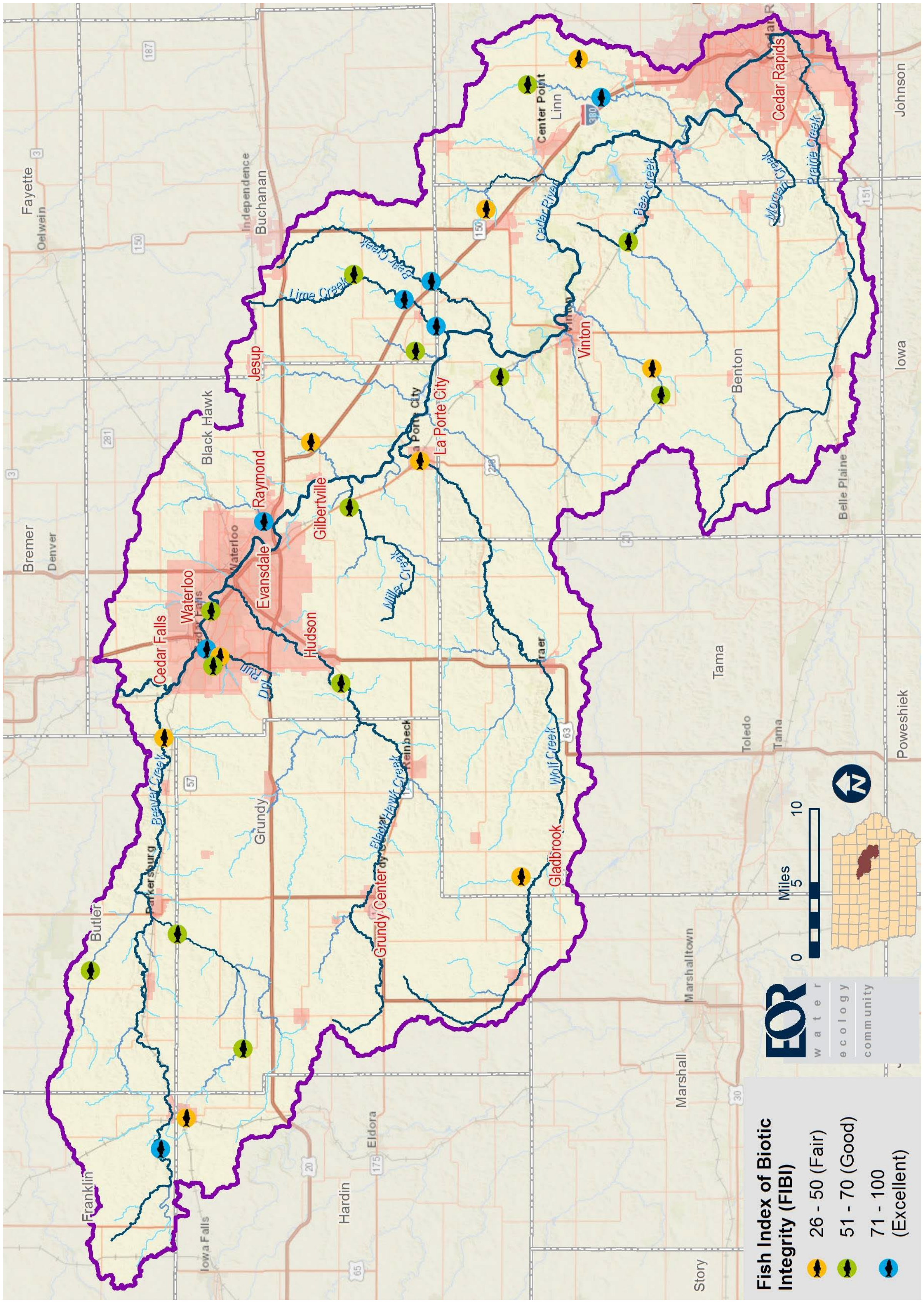

Figure 2-55. Middle Cedar Watershed—Fish Index of Biotic Integrity (FIBI) Scores –1994-2016.

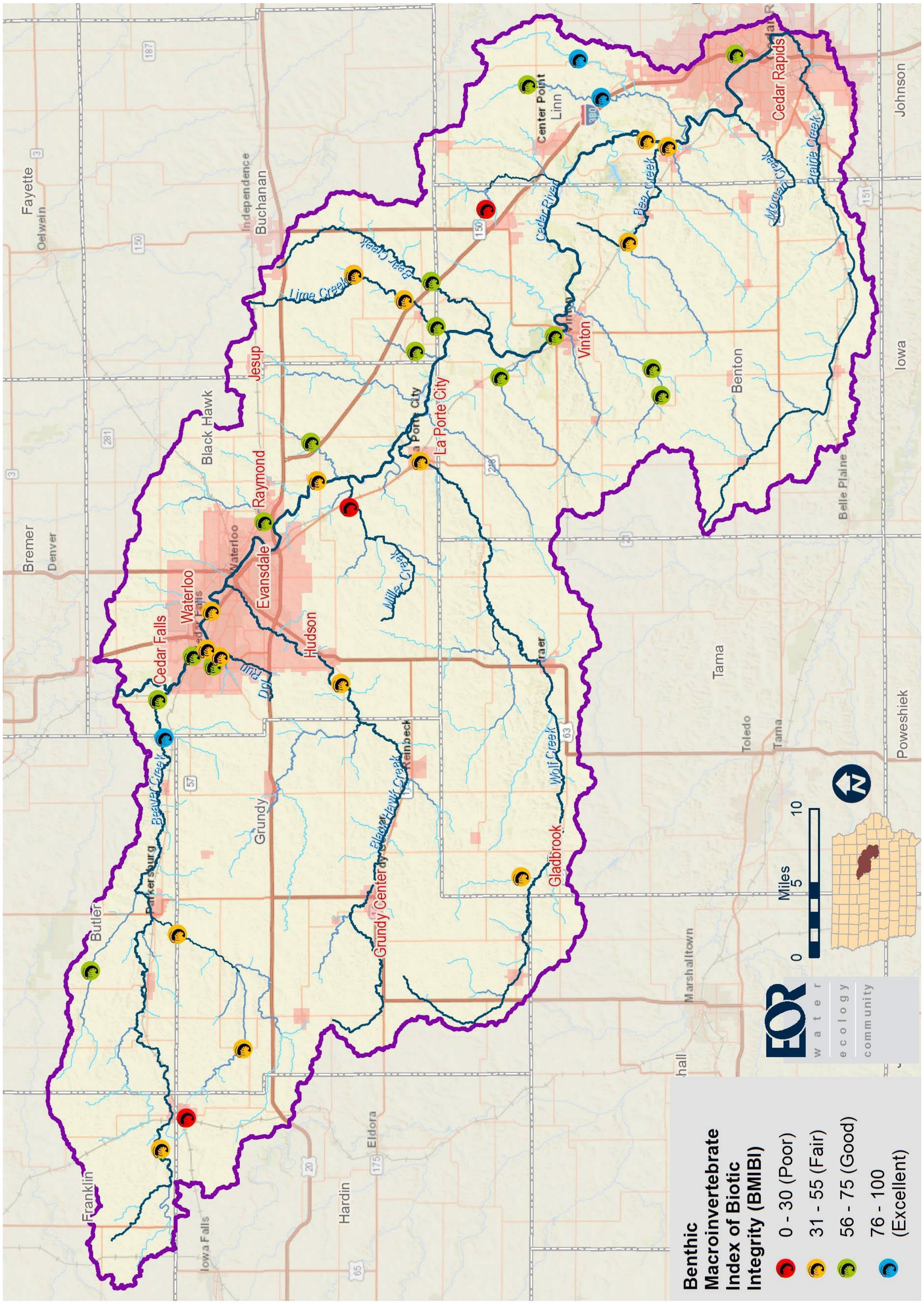

Figure 2-56. Middle Cedar Watershed—Benthic Macroinvertabrate Index of Biotic Integrity (BMIBI) Scores –1994-2016.

Iowa Soybean Association Snapshot Monitoring

The Iowa Soybean Association (ISA) and Coe College have collaborated to collect more than 400 stream water samples from 60 locations in the MCW beginning in April of 2017. The objective of this monitoring effort was to execute a water quality monitoring snapshot of HUC-12s in the MCW to characterize the water quality conditions in subwatersheds in the MCW. The rationale is to collect data to inform watershed planning in the MCW and prioritization of HUC-12s for additional planning and implementation. Water quality sampling events in 2017 were limited to two sampling events, one in late April and a second event in June. In 2018, the intensity and frequency of sampling efforts increased to include the collection of samples over two consecutive days in each month from May through September.

The results of the snapshot monitoring were provided to the City of Cedar Rapids. More information about the Middle Cedar Watershed Water Quality Snapshot program (Iowa Soybean Association 2017) is available on the ISA website. This monitoring program has helped to develop an understanding of the conditions of streams in the MCW and will be instrumental in the future as the program expands. With this program, the ISA has been able to gather large numbers of people to cover the whole watershed. Frequent sampling events over many years covering a broad extent of the watershed is the best way to assess the state of the watershed and measure the progress of Middle Cedar Watershed Management Authority's (MCWMA) initiatives. More information, including results from the 2018 monitoring season can be found by visiting the Middle Cedar Watershed 2018 Tributary Monitoring Results Story Map.

2.2.10. Pollutant Source Assessment

Hydrologic Assessment

As discussed in Section 1.1.1, a Hydrologic Assessment was performed by the University of Iowa IIHR-Hydroscience & Engineering/Iowa Flood Center for the MCW. Key findings from this assessment are highlighted in the succeeding paragraphs.

<u>Water Balance</u>

Average annual precipitation for the MCW is approximately 36.0 inches. Of this precipitation amount, roughly 70 percent (25 inches) evaporates back into the atmosphere and the remaining 30 percent (11 inches) runs off the landscape into the streams and rivers. The majority of the runoff amount is baseflow (70 percent or 7.7 inches), and the rest is surface flow (30 percent or 3.3 inches). The soil distribution of the MCW shows that the watershed consists primarily of HSG B type soils (65.6 percent), which have a moderate runoff potential when saturated. Components of type B/D (27.1 percent) soils are present as well. Average monthly streamflow peaks in June and decreases slowly through the summer growing season. In most years, the largest discharge observed during the year occurs in May or June, associated with heavy spring/summer rainfall events.

<u>Water Balance Changes</u>

The water cycle in the MCW has changed due to land use and climate changes. Since the 1970s, Iowa has seen increases in precipitation, changes in timing of precipitation, and changes in the frequency of intense rain events. Streamflow records in Iowa (including those for the MCW) suggest that average flows, low flows, and perhaps high flows have all increased and become more variable since the late 1960s or 1970s; however, the relative contributions of land use and climate changes are difficult to sort out. Using land cover information obtained from well documented studies in 1859, 1875, and 2001, Wehmeyer et al. (2011) estimated that the increase in runoff potential in the first 30 years of settlement represents the majority of predicted change in the 1832 to 2001 study period. The study also outlines hydrologic alterations induced by climate change based on evidence provided in the recently released *The Climate Science Special Report* (USGCRP 2017). This study found that heavy rainfall is increasing in intensity and frequency across the U.S. (**Figure 2-45**) and is expected to increase over the next few decades.

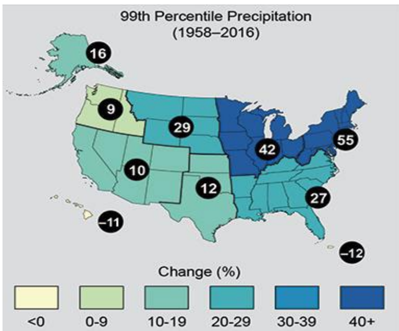

Figure 2-57. Observed change in heavy precipitation (the heaviest one percent) between 1958 and 2016. Figure taken from The Climate Science Special Report (USGCRP 2017)

Generic Hydrologic Overland Subsurface Toolkit GHOST Model Results

To prioritize where practice implementation efforts are most needed, the University of Iowa's Hydroscience and Engineering Center used the Generic Hydrologic Overland Subsurface Toolkit (GHOST) to better understand high runoff potential areas and to evaluate potential flood mitigation strategies that can help to offset changes in the water cycle resulting from both land use and climate changes. Model results suggested that the eastern part of the watershed, with runoff coefficients of up to 47 percent (from 0 for no runoff to 100 percent when all rainfall is converted to runoff), had the highest runoff potential. Agricultural land use dominates the eastern areas of the watershed. To evaluate the impact of flood mitigation strategies on reducing the runoff potential within these high runoff potential areas and ultimately reduce downstream peak flood discharges, the following three scenarios were run within the GHOST model:

1. Conversion of 100 percent of the row crop acres to native vegetation.
2. Adoption of both no-till and cover crops in 100 percent of the row crop acres.
3. A distributed storage system built with ponds (684) located in the headwater catchments.

Figure 2-58 summarizes the modeled results from each flood mitigation strategy in terms of the strategy's capacity to reduce peak discharges relative to other mitigation strategies at two different index points within the MCW using both historic precipitation totals and increased precipitation totals associated with plausible future climate scenarios. The restoration of all agricultural lands to tallgrass prairie had the greatest flood reduction impact while distributed storage (implanting 684 ponds) had the lowest impact for both streams under both historic and future precipitation totals.

While it is unlikely that all row crops in the MCW will ever be converted to native grasslands, implementation of cover crops/no-till is a feasible management practice that when implemented throughout agricultural watersheds shows potential to lead to important flood reduction benefits. Based on the MCW model results, this practice shows average peak flood reductions of 40 percent with historic rain and 30 percent with increased precipitation at Wolf Creek near Dysart.

Interestingly, while the 684 ponds associated with the distributed storage system scenario provide peak flow reductions of up to 15 percent in the tributaries with historic rain, when increased precipitation conditions were simulated model results show higher peak flows than those of the baseline condition (with historic rain). **This result suggests that more emphasis must be placed on practices that promote increases in infiltration that treat rainfall onsite rather than at downstream locations (i.e., stormwater ponds).**

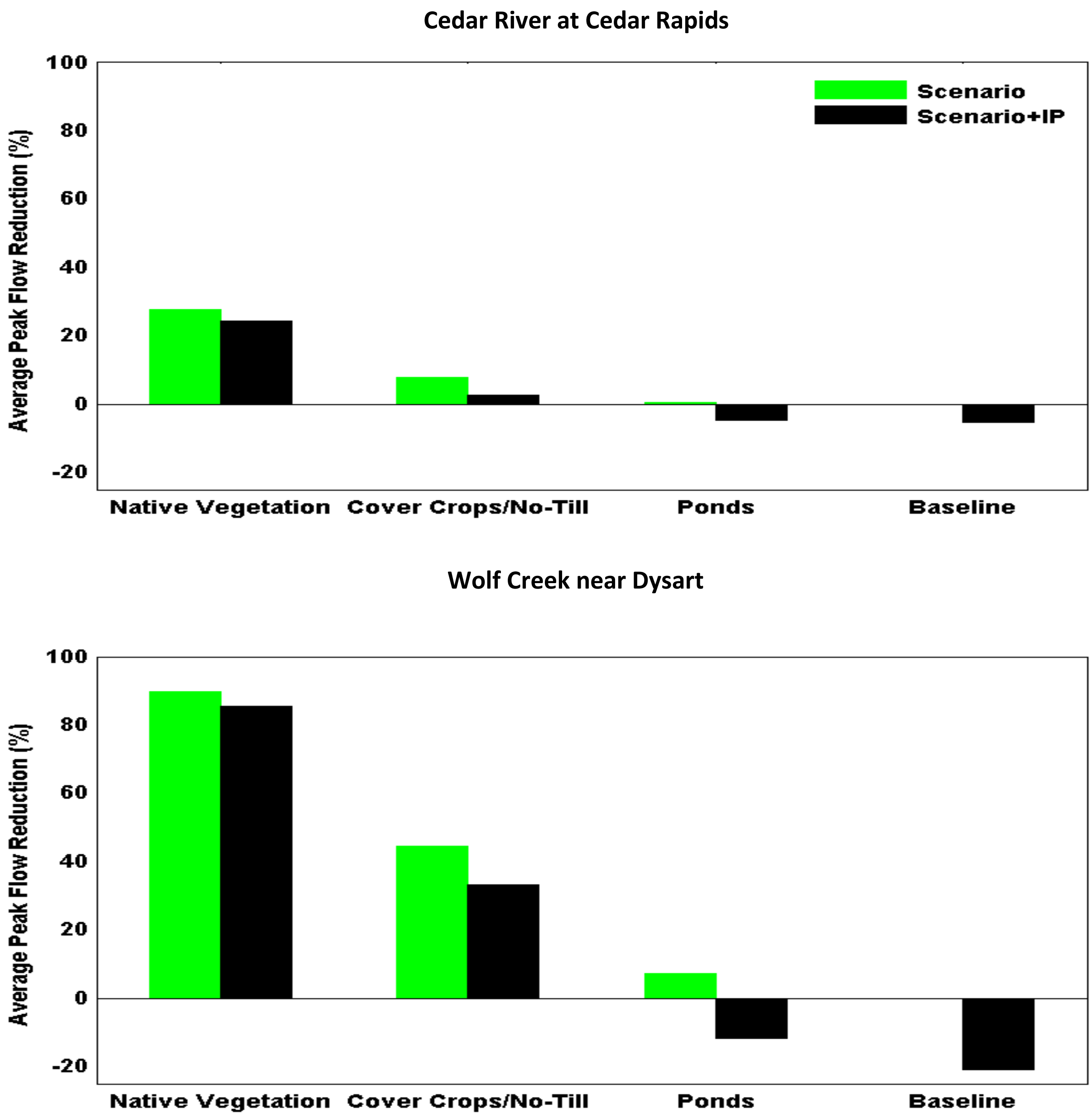

Figure 2-58. Average peak flow reductions for all the simulations at two different index points. Top: Cedar River at Cedar Rapids and bottom: Wolf Creek near Dysart. IP stands for increased precipitation associated with future predicted climate scenarios.(USGCRP 2017).

Soil and Water Assessment Tool (SWAT) Model

The Nature Conservancy, University of Minnesota, and World Wildlife Fund partnered in 2014 to conduct Soil and Water Assessment Tool (SWAT) modeling and optimization at multiple scales in the MCW. This work began with the development of a fine resolution SWAT model for 14 MCW HUC-12 priority watersheds and a coarse resolution SWAT model for the entire MCW. The ultimate purpose was to develop an optimization tool that combines SWAT model (nutrient, sediment loads and crop yields) with an agricultural profit model to evaluate tradeoffs between environmental outcomes and agricultural revenue.

Since 2017, the team has worked to refine the model resolution for the entire MCW including full hydrologic response unit coverage with Soil Survey Geographic Database information. The modeling work is largely being led by the University of Minnesota and the World Wildlife Fund while The Nature Conservancy plays a facilitator role between the MCWMA and stakeholders in the watershed (Longbucco 2017).

Currently, the modeling team is working to improve wetland representation in the SWAT model by incorporating local hydrology and nutrient transformation. Additional future model improvements include:

- Incorporate additional BMPs such as saturated buffers.
- Incorporate switchgrass and alfalfa plantings.
- Improve economic models and valuations of ecosystem service benefits resulting from BMP implementation (water quality, air quality, climate change mitigation, etc.).
- User interface improvements of decision tool:
    - Improve tool visualization or results to enhance usability by stakeholders.
    - Incorporate commodity price and input uncertainty.

Existing results from the SWAT model have been integrated into this water management plan and were used to develop maps, which helped to visualize and prioritize future implementation efforts at the HUC-12 scale based on modeled nitrogen load (**Figure 2-59**), tile nitrate load (**Figure 2-60**), TP load (**Figure 2-61**), sediment load (**Figure 2-62**), and average annual water yield (**Figure 2-63**).

Modeled TP loading rates as shown in **Figure 2-61** were higher than reported in a review of typical phosphorus loading from literature values. The review included MPCA's 2004 Detailed Assessment of Phosphorus Sources to Minnesota Watersheds, and a technical memorandum to the Minnesota Board of Water and Soil Resources regarding the PTMApp toolset.

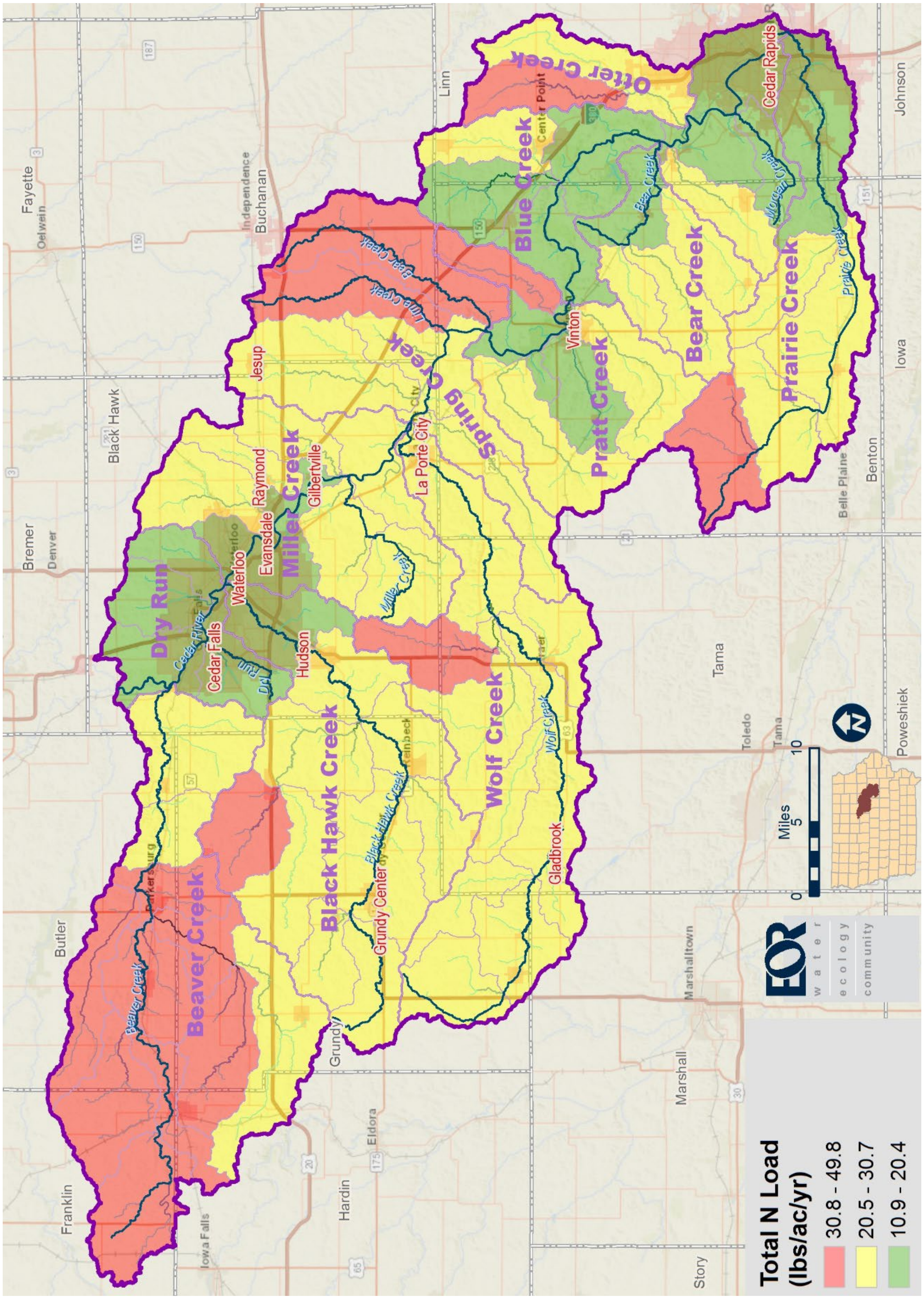

Figure 2-59. Middle Cedar Watershed—Average Annual Total Nitrogen Load (SWAT Model).

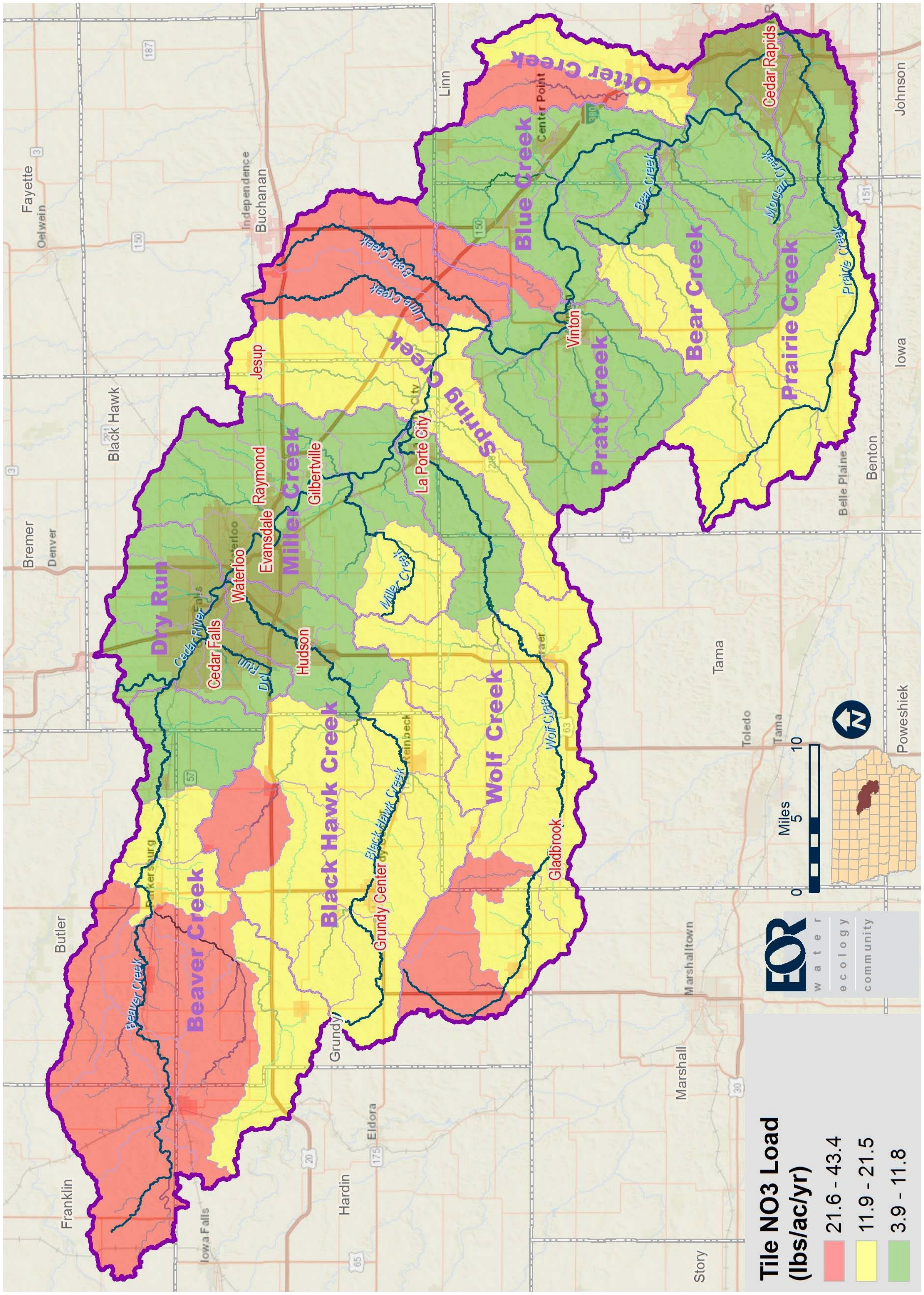

Figure 2-60. Middle Cedar Watershed—Average Annual Tile Nitrate Load (SWAT Model).

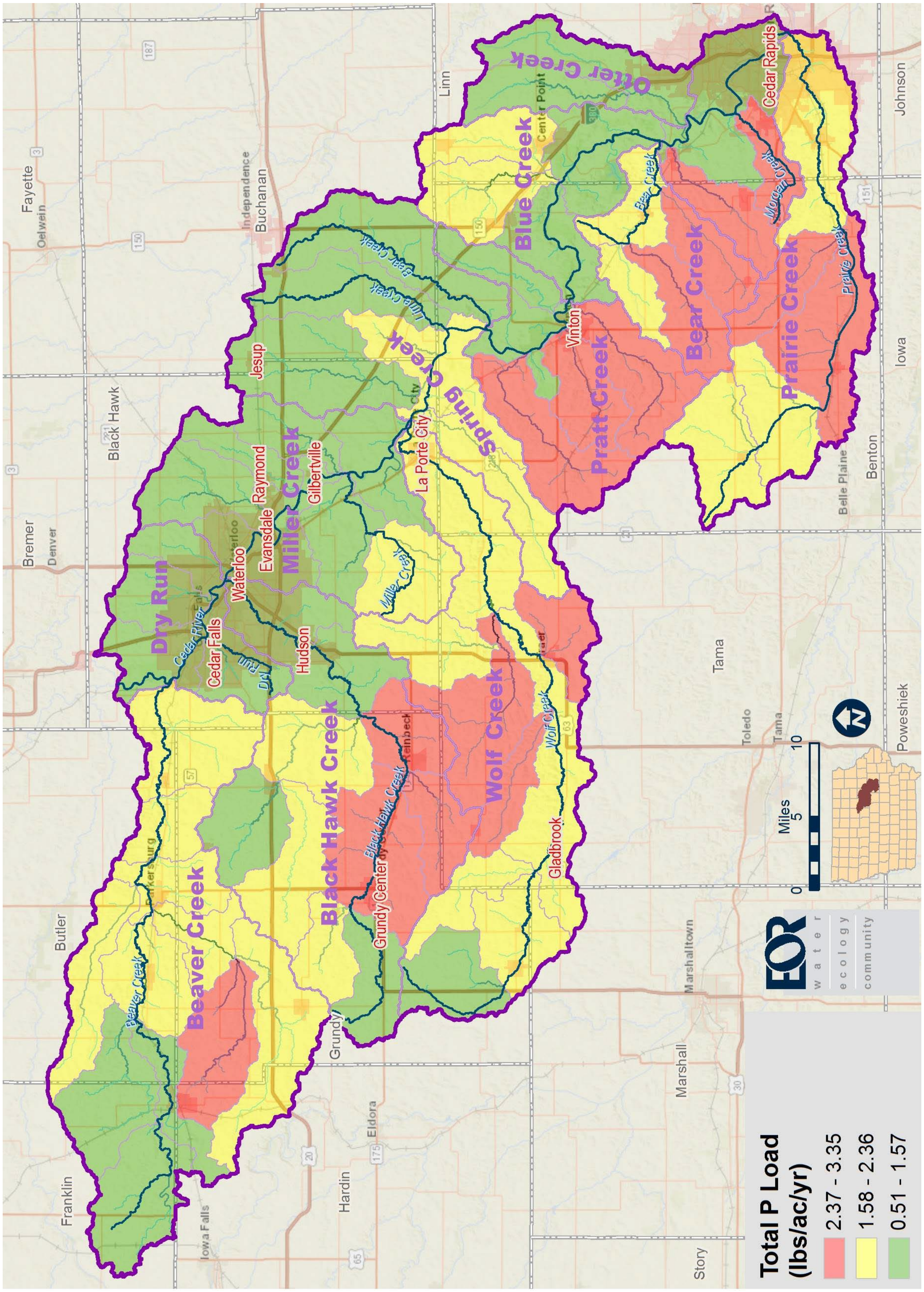

Figure 2-61. Middle Cedar Watershed—Average Annual TP Load (SWAT Model).

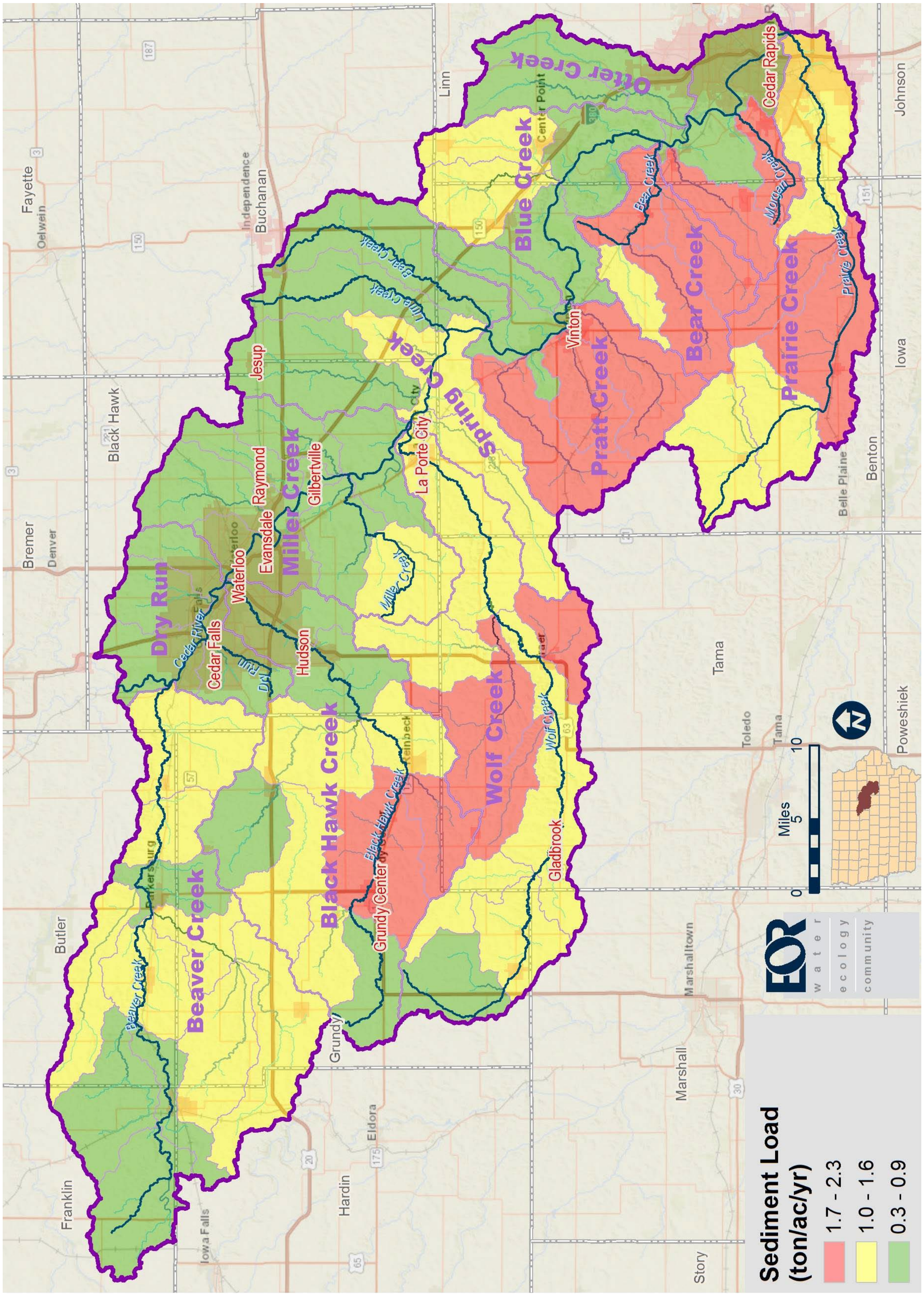

Figure 2-62. Middle Cedar Watershed—Average Annual Sediment Load (SWAT Model)

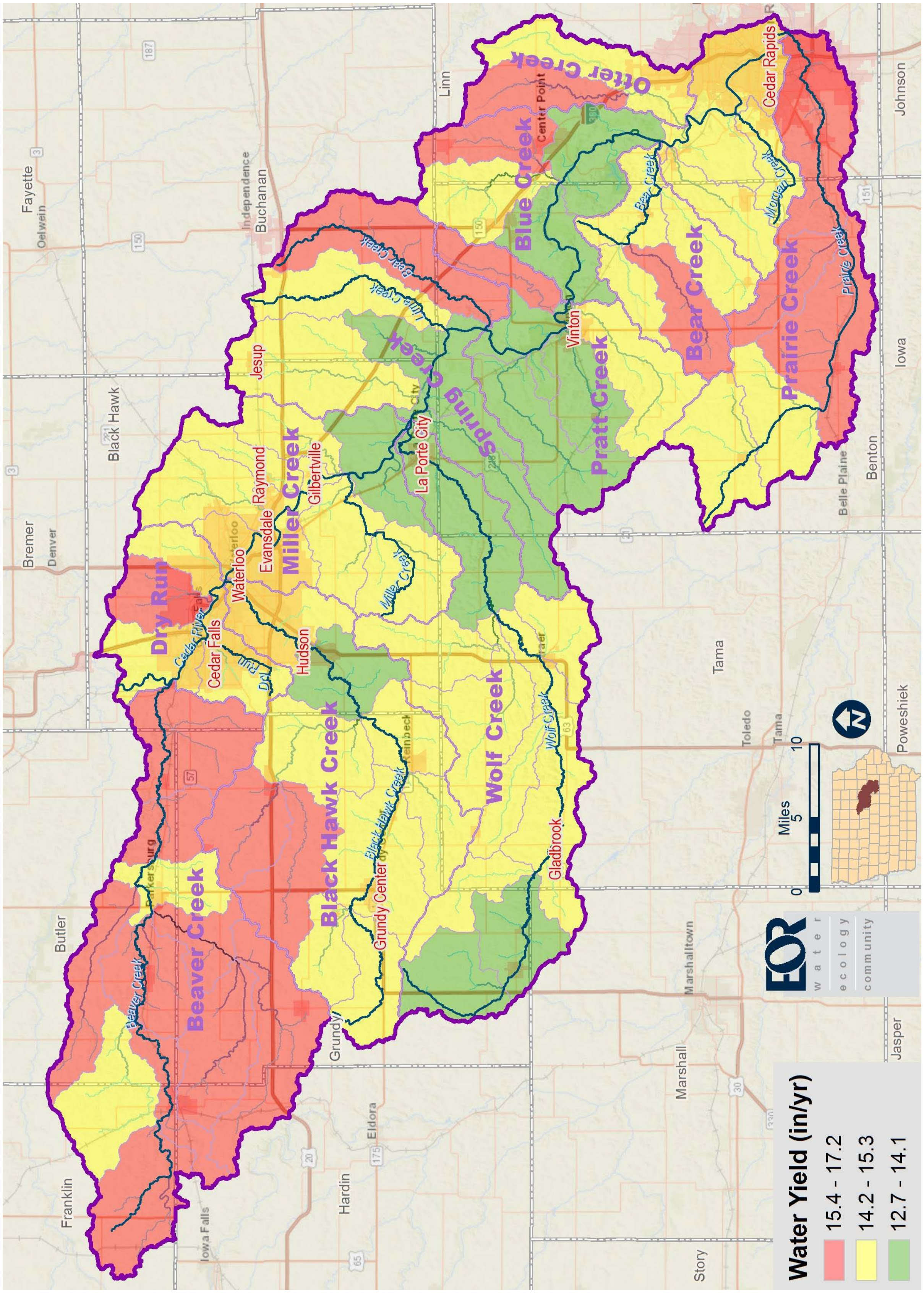

Figure 2-63. Middle Cedar Watershed—Average Annual Water Yield (SWAT Model)

Daily Erosion Project

The Daily Erosion Project (DEP) is a free online tool that allows users to understand how fast soil is being lost off the land. The tool arms farmers and conservation planner with the information needed to make effective decisions regarding resources. The tool takes precipitation data provided by the Next Generation Weather Radar (NEXRAD) and estimates the amount of soil erosion taking place on the land based on soil type, vegetative cover and slope on a daily basis. The tool also estimates Hillslope Soil Loss using the Water Erosion Prediction Project (WEPP) Model. The DEP addresses sheet and rill erosion but does not account for gully erosion, which may lead to an underestimation of erosion using this model. Further documentation of the Daily Erosion Project can be found on the project website (Iowa State University 2019).

DEP users can either view data for a single day or choose to enter a specific date range of interest. Data can be viewed for the entire State of Iowa (and beyond) or at the very local, HUC-12 subwatershed scale. An example of the DEP output for a single day is shown in **Figure 2-64.** It was run for the 68 HUC-12 subwatersheds in the MCW for the 10-year period 2008-2017. The results were used to determine the average annual soil detachment (**Figure 2-65)** and average annual hillslope soil loss (**Figure 2-66**) for each subwatershed.

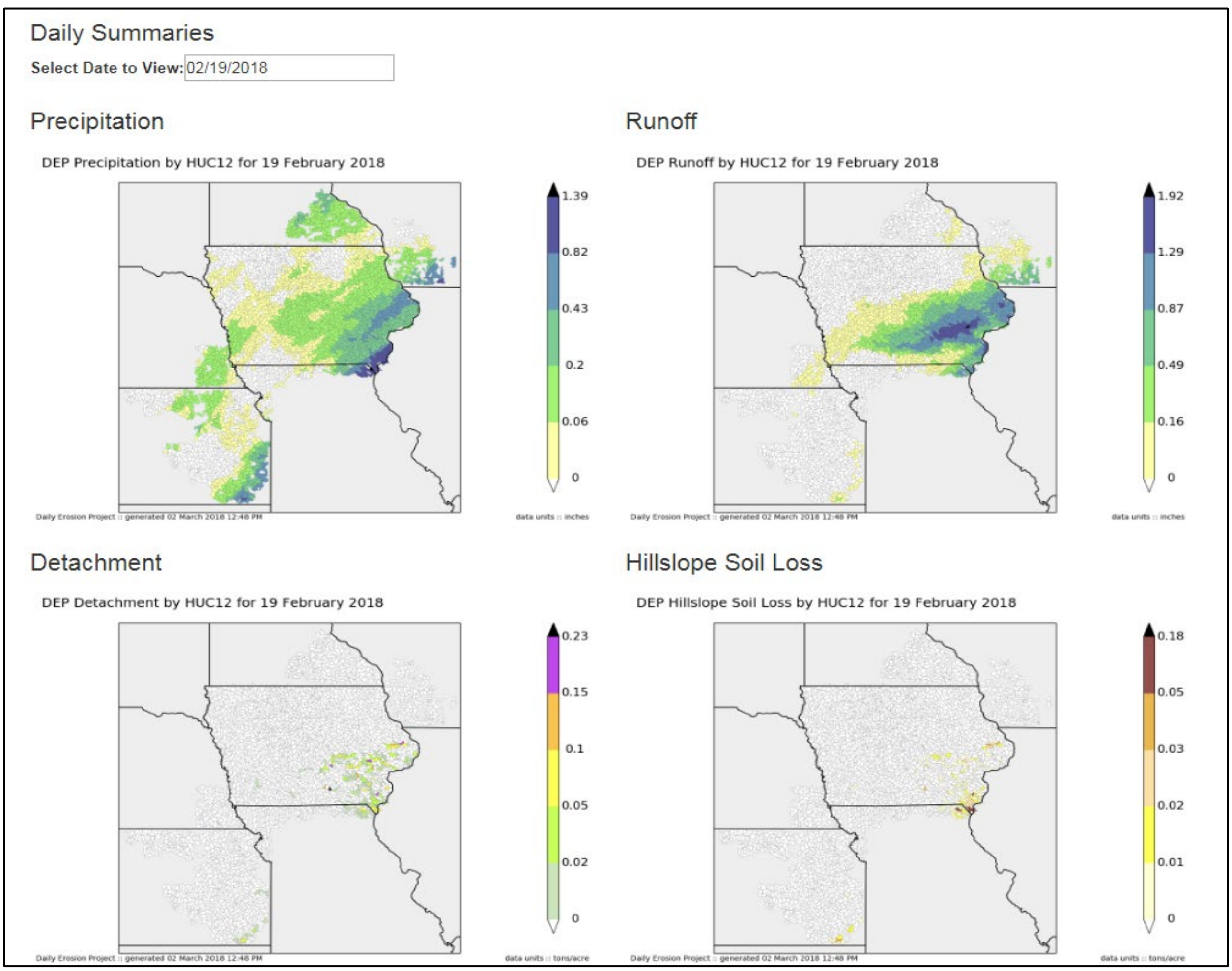

Figure 2-64. Example Output from the DEP Website.

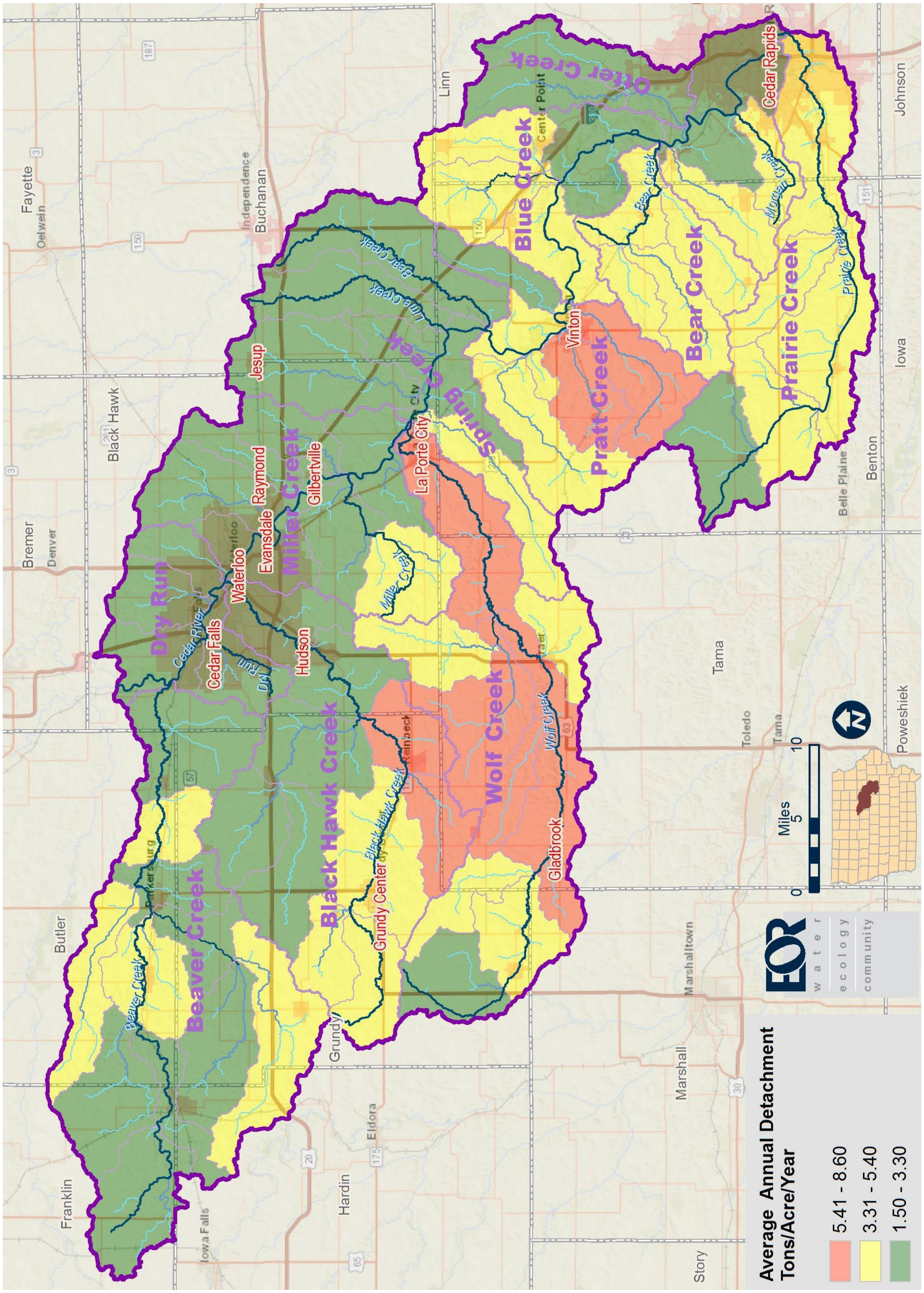

Figure 2-65: Middle Cedar Watershed—Average Annual Soil Detachment (Daily Erosion Project) 2008-2017.

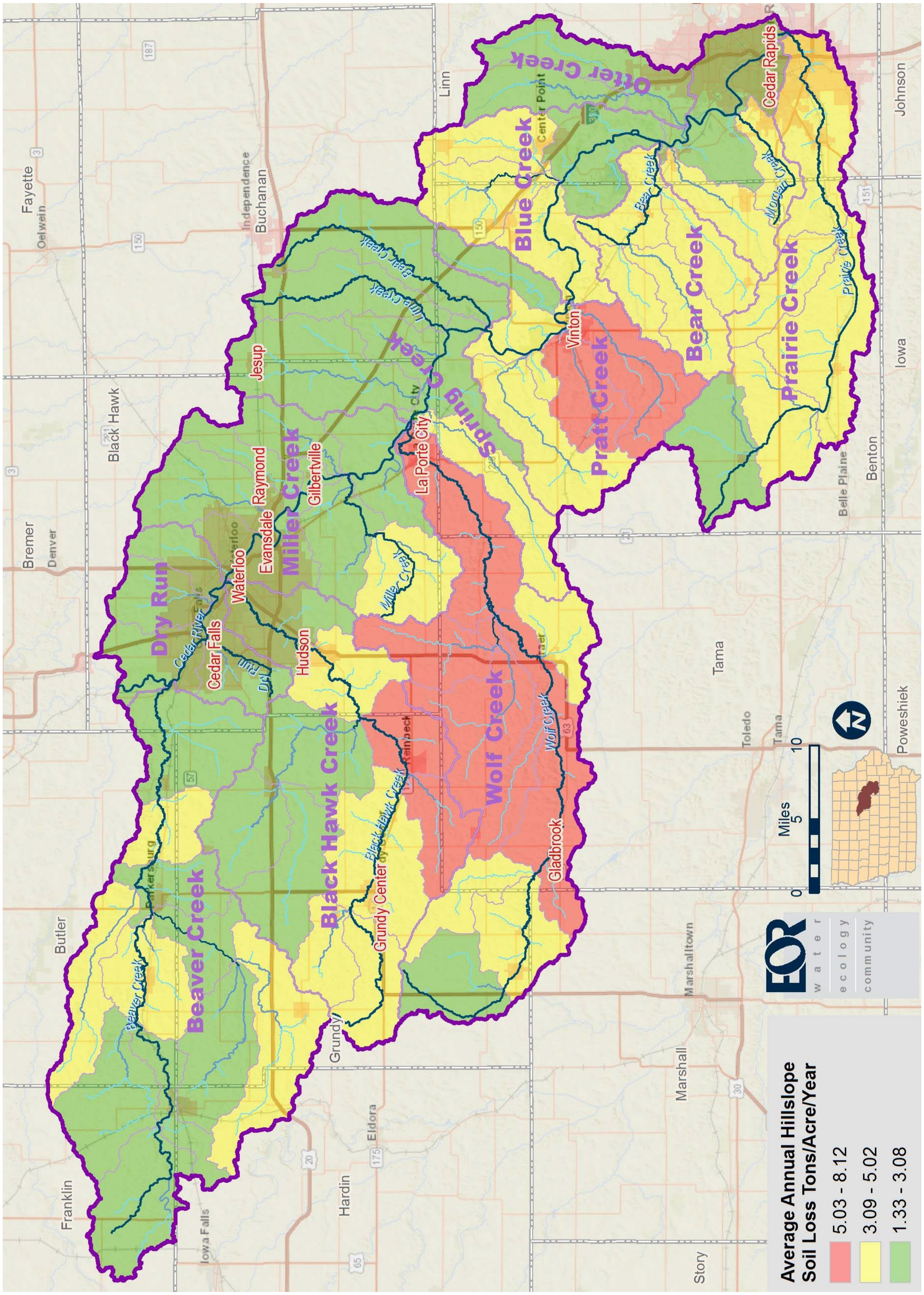

Figure 2-66. Middle Cedar Watershed—Average Annual Hillslope Soil Loss (Daily Erosion Project) 2008-2017.

2.2.11. Existing Conservation Practices

The Iowa DNR in cooperation with ISU conducted an inventory of agricultural conservation practices throughout Iowa. According to the DNR project website, "The goal of the Iowa BMP Mapping Project is to provide a complete baseline set of BMPs dating from the 2007-2010 timeframe for use in watershed modeling, historic occurrence, and future practice tracking. The BMPs mapped are: terraces, water and sediment control basins (WASCOB), grassed waterways, pond dams, contour strip cropping and contour buffer strips. However, it is unclear whether mapped practices meet NRCS standards, or if they are actually the indicated practice, since onsite field verification has not been performed. Data being utilized to digitize the BMPs include LiDAR-derived products such as DEM, Hillshade and Slope grids; CIR aerial photography from the 2007-2010 timeframe, NAIP aerial photography and historic aerial photography. BMPs are being collected by 12-digit HUC and finished products can be downloaded from https://athene.gis.iastate.edu/consprac/consprac.html." This information was used to determine the existing adoption rates for each of the practices, which informed the conservation practice implementation plan for each subwatershed. A summary of existing practices is included in **Table 2-20**.

Table 2-20. Existing Conservation Practices in the Middle Cedar Watershed: BMP Mapping Project.

HUC -12 Name	# of WASCOBs	# of Pond Dams	Strip-cropping Acres	Terrace Feet	Contour Buffer Strip (Acres)	Grassed Waterways (Acres)
Middle Fork South Beaver Creek	110	6	0	20,322	0	366
Headwaters South Beaver Creek	90	9	0	97,627	0	351
South Beaver Creek	9	2	83	30,237	21	116
Headwaters Beaver Creek	43	4	30	183,154	201	240
North Beaver Creek	35	6	0	92,194	99	236
Drainage Ditch 148-Beaver Creek	126	3	0	32,169	28	135
Gran Creek-Beaver Creek	195	4	0	13,584	235	164
Johnson Creek	170	15	0	85,852	86	248
Phelps Creek-Beaver Creek	44	3	0	35,801	0	135
Max Creek- Beaver Creek	74	26	0	38,443	207	115
Hammers Creek- Beaver Creek	84	24	0	125,122	26	274
South Fork Black Hawk Creek	3	2	0	27,870	0	203
Headwaters N. Fork Black Hawk Crk	2	5	0	16,248	0	112
North Fork Black Hawk Creek	47	5	0	189,880	0	837
Holland Creek	12	1	0	1,422	0	175
Headwaters Black Hawk Creek	57	4	0	115,311	140	239
Mosquito Creek	14	3	0	38,363	11	352
Minnehaha Creek-Black Hawk Crk.	65	5	0	87,500	11	591
Village of Reinbeck-Black Hawk Crk.	63	0	0	56,070	0	278
Wilson Creek-Black Hawk Creek	88	4	228	127,494	150	281
Prescotts Creek-Black Hawk Creek	25	7	0	100,481	161	235
Dry Run	10	8	0	15,446	10	106
Waterloo Municipal Airport	34	15	0	25,719	0	138
Black Hawk Park-Cedar River	27	13	0	55,615	18	196
Headwaters Wolf Creek	8	0	0	45,555	0	188
Little Wolf Creek	19	1	117	39,369	85	207

HUC -12 Name	# of WASCOBs	# of Pond Dams	Strip-cropping Acres	Terrace Feet	Contour Buffer Strip (Acres)	Grassed Waterways (Acres)
Village of Conrad-Wolf Creek	27	1	0	12,285	0	419
Fourmile Creek	102	10	25	75,133	381	275
Coon Creek	34	1	0	8,196	129	302
Rock Creek	37	1	53	59,553	75	424
Twelvemile Creek	78	11	106	44,566	245	730
Devils Run-Wolf Creek	169	10	137	115,853	871	709
Wolf Creek	27	32	262	236,747	798	697
Elk Run	36	14	0	68,912	178	727
Poyner Creek	16	3	0	7,824	0	165
Indian Creek	19	5	0	17,911	28	206
Headwaters Miller Creek	19	3	0	82,702	79	485
Miller Creek	33	9	0	182,983	95	309
Sink Creek-Cedar River	40	3	0	4,856	0	138
Mud Creek-Cedar River	39	5	0	52,240	66	240
Rock Creek-Cedar River	81	7	0	119,467	239	460
Spring Creek	172	7	0	44,960	41	575
Lime Creek	22	17	0	72,361	120	438
Bear Creek-Cedar River	69	14	9	77,616	77	501
McFarlane State Park-Cedar River	48	18	0	106,357	122	406
Pratt Creek	13	11	0	320,255	564	610
Hinkle Creek	8	14	142	303,467	559	479
Prairie Creek-Cedar River	6	4	82	18,542	43	171
Mud Creek	26	6	0	167,854	461	575
Dudgeon Lake State Wildlife Management Area-Cedar River	0	6	0	65,045	317	86
Opossum Creek	2	2	0	15,967	0	169
Wildcat Creek	12	3	0	50,588	0	407
Little Bear Creek	31	7	53	27,815	165	330
Bear Creek	1	41	37	77,988	313	127
West Otter Creek	4	8	29	0	40	154
East Otter Creek-Otter Creek	13	27	0	13,927	32	148
Headwaters Prairie Creek	1	3	0	11,501	54	251
Village of Van Horne-Prairie Creek	1	4	32	27,348	314	409
Mud Creek-Prairie Creek	10	2	155	32,905	77	328
Weasel Creek-Prairie Creek	2	6	101	37,523	409	621
Prairie Creek	33	11	0	58,927	209	452
East Branch Blue Creek	28	11	0	55,140	232	232
Blue Creek	58	20	0	63,245	158	292
Wildcat Bluff-Cedar River	33	62	29	75,538	17	171
Nelson Creek-Cedar River	21	54	63	23,306	66	100
Dry Creek	14	1	20	34,065	95	253
Morgan Creek	3	8	28	15,835	70	213
Silver Creek-Cedar River	110	6	0	20,322	0	366
TOTAL	**2952**	**663**	**1821**	**4604473**	**9228**	**21668**

3. ISSUES, GOALS, AND OBJECTIVES

The process used to identify issues facing the Middle Cedar Watershed (MCW) consisted of an active public engagement effort, a series of meetings with local conservationists, and direct communication with representatives of the Middle Cedar Watershed Management Authority (MCWMA) membership. Prior to beginning the engagement phase of the issues identification process, watershed planners compiled and reviewed past studies and plans related to the watershed. This included local subwatershed management plans, watershed assessment data compiled by the Iowa Department of Natural Resources (Iowa DNR), the Iowa Flood Center and local watershed partners, to name a few. The watershed assessment data was compiled and summarized for use in the issues identification process.

A public open house was held in the City of Vinton on November 28th, 2017 to solicit input on issues facing the watershed from the agricultural community. Significant effort was spent ahead of the meeting getting the word out about the watershed management planning process and recruiting attendees. This consisted of reaching out to various groups in the watershed including; direct contact with each of the MCWMA members requesting distribution of meeting announcement, announcements via social media, project partners, press releases to local media, and distribution to ISA membership in watershed.

The open house included several stations where watershed planners and project partners provided detailed summaries of watershed assessment information that had been developed. Informational station topics included the watershed planning process, flooding, agricultural conservation practices, flooding and several stations to convey water quality information. The water quality stations included information on impaired waters in the watershed and water quality monitoring summaries for nitrate, phosphorus, sediment and *Escherichia coli (E. coli)*. In addition to the informational stations, meeting participants were given a brief presentation on the watershed management planning process along with an overview of critical watershed management topics.

Public input received at the City of Vinton open house included: historic use of Cedar River as a fishing and recreational destination, concerns about current water quality conditions, the impact of past flooding on the agricultural economy, goals for future water trail, and questions about various conservation practices among others. Meeting attendees most noted their reason for attending was to learn more about the MCWMA.

A second open house was held in the City of Cedar Falls on January 9th, 2018 to solicit input on issues facing the watershed from the urban and developing areas within the watershed. A similar outreach effort to that used for the City of Vinton meeting was conducted but an emphasis was placed on working with the MCWMA large city members: Cedar Rapids, Cedar Falls, and Waterloo, to solicit meeting attendees. The City of Cedar Falls meeting included similar informational stations for participants with the exception of focusing on urban stormwater management issues. A similar presentation was given to meeting attendees that summarized the watershed management planning process and described critical watershed management topics with a focus on urban issues.

In addition to the public open houses, the planning team held numerous meetings with key stakeholders to solicit their input on issues facing the watershed. Meetings were held with many of the MCWMA members including the Soil and Water Conservation Districts (SWCDs) in the watershed, Benton, Linn and Grundy Counties, the City of Cedar Falls, the City of Waterloo, the City of Cedar Rapids, the City of Grundy Center and the City of Vinton. Partner organizations including the Iowa Agriculture Water Alliance (IAWA) and the Black Hawk Creek Water & Soil Coalition were conferred with to provide their input.

As a concurrent effort, subwatershed management plans were developed for five HUC-12 Subwatersheds within the MCW which included meeting with local farmers. These meetings were used, in part, to identify specific issues to this group of watershed residents with an emphasis on the challenges and potential for various agricultural conservation practices.

Input received throughout this initial phase of the project was compiled and grouped by issue area:

- Flooding/Water Quantity
- Water Quality
- Recreation
- Funding & Organization
- Watershed Policy
- Education & Outreach
- Monitoring & Evaluation

A draft summary narrative describing each of the issues facing the watershed was initially distributed to a working group of MCWMA representatives for their review. A revised version of the summary was then provided to the entire MCWMA board, project partners and other key stakeholders. One key recommendation offered during the review process was to include Partnerships as an additional issue area.

Once the issues facing the watershed were well defined, the planning team facilitated a goal setting workshop with MCWMA representatives, project partners and key stakeholders. Goal statements from existing subwatershed management plans within the watershed, the Upper Cedar Watershed Management Plan, the Canon River One Watershed One Plan, and the Squaw Creek Watershed Management Plan were compiled and used as examples during the workshop. Example goal statements were presented to illustrate the variety of goals used in watershed management planning. Meeting participants set goals and developed objectives for the following issue areas; Water Quantity/Flooding, Water Quality, Recreation, Funding & Organization, Policy, and Education & Outreach. Subsequent to the workshop, goals for Monitoring & Evaluation were set via input from local and state organizations with monitoring experience in the watershed and goals were set for Partnerships. Additional goals and objectives for Education & Outreach were provided by Iowa State Extension and Outreach (see Appendix J).

A draft of the goals and objectives section of the Middle Cedar Watershed Management Plan (MCWMP) was distributed to the MCWMA Board, project partners and key stakeholders for review. Numerous comments and recommended revisions were provided and were incorporated.

A public open house was held on September 10th, 2018 to solicit input on the watershed goals and objectives. A series of informational boards were used to summarize each of the issues facing the watershed along with the goals and objectives that the MCWMA proposes for addressing those issues. Participants provided feedback on the goals and objectives including input on which goals they felt were most important for the MCWMA to address. The outcome of this prioritization can be found in Section 4.2.

3.1. Flooding/Water Quantity

The Middle Cedar Watershed experiences flooding primarily along the Cedar River but also on many of the smaller tributaries. Flood levels, rates of streamflow and flood frequency have become more severe in recent years.

Floods are naturally occurring phenomena that can and do happen almost anywhere. In its most basic form, a flood is an accumulation of water over normally dry areas. Floods become hazardous to people and property when they inundate an area where development has occurred, causing losses. Mild flood losses may have little impact on people or property, such as damage to landscaping or the generation of unwanted debris. Severe flooding can destroy buildings, ruin crops, and cause critical injuries or death.

According to the Iowa Flood Center, Iowa has seen 18 billion dollars in flood damage over the last 30 years (Shea 2019). Flooding in Iowa during 2008 resulted in the 6th largest FEMA disaster declaration based on estimated financial public assistance. The MCW was the focal point of the 2008 floods as dramatic images of a flooded downtown Cedar Rapids were shown in media coverage across the nation. More than 10 square miles of the city was impacted by floodwaters as the Cedar River crested to a record level on June 13th. The City of Cedar Falls experienced the worst flood disaster in its recorded history during this flood, with damages to an estimated 500 homes and businesses. The Cedar Falls Fire Department rescued over 175 flood victims over the course of the 2008 flood event. Although Department personnel trains for flood rescues, those efforts still present the dangers of swift currents, floating debris, and downed power lines and are further complicated when such rescues take place during nighttime hours. Many smaller, riverside towns were impacted during the floods of 2008, including the City of Palo where the entire population was evacuated for up to a week and the City of Vinton where the municipal electrical generating plant was taken out of service.

The second highest Cedar River crest elevation in Cedar Rapids occurred in September 2016. During this flood, more than 50 roads were closed or damaged, restricting access to critical emergency facilities and forcing a large public transportation operation out of service. In addition, some schools were closed for up to five days, and even after school was back in session, many bus routes remained inaccessible. More than 60 small businesses closed for as long as two weeks, and a local hotel had to permanently close in result of the storm's economic impact. The area experienced multiple evacuations that included a jail, an assisted living center, a health center, and at least 5,000 homes. Countless homes, apartments, and other residential properties experienced major damage that left them uninhabitable or completely destroyed. The flooding impacts could have been much worse if it had not been for the aggressive response by the city, including deployment of flood barriers and evacuations in the flood zone. The city and its residents were very well prepared to meet the challenge of the 2016 flood primarily because of the difficult lessons learned in 2008.

While the floods of 2008 and 2016 were historic events, with several factors contributing to their severity, the MCW remains vulnerable to flooding. The financial impact of flooding in the MCW is significant. Potential property losses associated with the one percent flood event (100-year flood) in the watershed are estimated at a staggering $436 million. In many cases the financial strain caused by a flood is borne at a disproportionate rate among certain residents of the watershed.

Flooding in the MCW is not limited to the Cedar River. Several of the large tributaries to the Cedar River experience flooding, notable examples include: Beaver Creek which impacts portions of Ackley and New

Hartford; Black Hawk Creek which impacts portions of Grundy Center, Reinbeck, Hudson and Waterloo; and Prairie Creek which impacts portions of Keystone, Blairstown, Norway Fairfax and Cedar Rapids.

Many of the smaller streams and drainage ways throughout the watershed produce localized flooding in response to smaller rains. While this flooding does not typically involve inundating buildings, it results in more frequent impacts to low lying farm fields along these waterbodies. This type of flooding can be caused by undersized road crossings and accumulation of woody debris but can also occur when the volume of runoff simply overwhelms the capacity of the drainage system. This type of flooding, referred to as flash-flooding is more common in the developed portions of the watershed where storm sewer pipes are used to convey runoff. Storm sewer systems are typically designed to only convey runoff from moderate storm events. Large storms can overwhelm the network of pipes, leading to overland flow and street flooding. A dramatic example of flash flooding occurred in June 2014 when portions of Cedar Rapids received over five inches of rain in less than six hours resulting in substantial damages to private property.

Watershed residents have commented that flooding seems to occur more frequently than it has in the past. A review of historic water level records provides some insight into streamflow trends that support this suspicion. The USGS has measured water levels and flows on the Cedar River at Cedar Rapids since 1903 and the data indicates a steady rise over time. The average annual flow of water recorded at this station has increased at a rate of 34 cubic feet per second per year over this time period with the most dramatic rise occurring since the 1950s. A 2013 study done by the USGS reported that the average annual flow at this station for the entire period of record (1903 to 2013) was 3,980 cubic feet per second but when looking at the most recent 30 years the average annual discharge has been 5,520 cubic feet per second, an increase of nearly 40%. Additional USGS stations throughout the watershed show similar trends (Beaver Creek increased 25%, Black Hawk Creek increased 27%, Cedar River at Waterloo increased 22%).

The increase in stream flows seen in the MCW can be attributed to two basic factors: an increase in precipitation and a decrease in the land's ability to store rainfall in soils, wetlands, and ponds. The Iowa Climatology Bureau precipitation data for Cedar Rapids since 1896 indicates a 32% increase in precipitation from the period 1896-2008. There has also been a change in the seasonal timing of precipitation with an increase in the first half of the year and a decrease in the second half, leading to wetter springs and drier autumns. The precipitation data also shows a higher tendency for more intense rain events which produce greater runoff. Cedar Rapids has seen a five-fold increase in the number of years having eight or more days with daily total precipitation exceeding 1.25 inches.

Increased precipitation alone does not fully account for the increases that have been seen in watershed stream flow. Greater volumes of runoff generated from precipitation are delivered to streams due to changes in land cover type and management practices. The watershed has lost its ability to store water in its soils and the efficiency of drainage systems has been improved. This means when rain falls on the land, it is more likely to run off directly into a stream. Studies have shown that loss of continuous living cover over the year (months of bare soil on cropland before planting and after harvest) and increased soil disturbances associated with tillage practice can result in an increase in runoff. Perennial vegetation plays a large role in storing water on the land by helping soils absorb more rain before it runs off to streams. In developed areas within the watershed, runoff rates are dramatically increased when precipitation lands on paved surfaces and rooftops that do not absorb any water. In the urban setting, this runoff is then collected and delivered to the streams via storm sewer pipes that are designed to quickly and efficiently convey water while minimizing potential flooding locally.

Since there likely will always be some degree of flooding in the MCW, it is critical to create a more resilient watershed. A resilient community is able to mitigate, prepare for, respond to, and recover from floods. Beyond flooding, there are other concerns associated with the amount of runoff in the watershed. Increased rates, streamflow velocities, and volumes of runoff can have a direct impact on the streams within the watershed. Additional impacts can include water quality and streambank stability. High rates of flow cause erosive conditions within the stream leading to streambank failure, scouring of the stream channel, and widening of the stream.

3.1.1. Flooding/Water Quantity Goals and Objectives

Flooding/WQ Goals	Flooding/WQ Objectives
Reduce flood risk and damage to local communities/ neighborhoods	Establish action plans to protect vulnerable and low-income communities from flood risk and damages.
	Target low-income and vulnerable communities with flood prevention and reduction projects and services. Target the causes of the high flood risk in these areas with risk reduction/resiliency projects and initiatives, expanded funding, and outreach and engagement programs.
Reduce causes of flooding potential	Prioritize structural and non-structural BMPs to implement upstream (both urban and rural) to reduce peak flows and volume.
	Advocate flooding solutions that do not lead to problems in another location.
	Explore utilizing existing floodway to provide additional temporary flood storage.
	Leverage recreational areas to provide protective flood buffers between land uses and water resources.
Protect life and property from flood damage	Encourage regulatory entities to ensure the local floodplain management policies and ordinances currently in effect in the watershed are fully implemented.
	Encourage the use of flood insurance by watershed residents by encouraging participation in the National Flood Insurance Program (NFIP).
	Assist watershed communities in achieving the goals identified in their Hazard Mitigation Plans.
Improve stormwater management at local levels	Encourage coordination among jurisdictions within the watershed in developing consistent approaches to stormwater management.
	Encourage jurisdictions throughout the watershed to update local regulations, design practices, and infrastructure to more effectively manage changing precipitation patterns.
	Encourage the use of Low Impact Development and Green Infrastructure in all new and re-development.
	Encourage adoption of local stormwater ordinances that effectively protect surface and groundwater resources with modern, evidence-based performance standards (rate, volume, timing, quality)
Increase watershed awareness related to water quantity	Help watershed landowners better understand the connections between land use management practices and both local and downstream flooding
	Encourage communication and cooperation among jurisdictions within the watershed on land use changes and water-related projects.

Implementation activities that are intended to collectively address these objectives can be found in the Flooding Mitigation and Water Quality Strategies Section. Also, refer to the Objectives Implementation Activities Matrix in Appendix I for more specific implementation actions associated with each objective.

3.2. Water Quality

Water quality within the Cedar River and many of its tributaries is degraded by high levels of nitrate, phosphorus, sedimentation, and fecal bacteria that pose a threat to aquatic biota and to public health.

The MCW faces water quality issues that are seen across the State of Iowa and in watersheds throughout the Midwest. Elevated levels of pollutants are impacting streams, lakes and groundwater and diminishing the public's use of these resources. When rainfall, snowmelt or irrigation water runs over land or through the ground it picks up these pollutants and deposits them into waterbodies in a process referred to as nonpoint source pollution (NPS). This term distinguishes this source of pollution from the type of pollution from an identifiable source (referred to as a point source) like the discharge from a waste water treatment plant, an industrial discharge or even the discharge of urban runoff through a city storm sewer network. Nonpoint source pollution is the major water quality problem in the MCW. It has landed a number of watershed streams and lakes onto Iowa's impaired waters list and has resulted in community water supplies susceptible to levels of contamination above drinking water standards.

Nonpoint source pollutants traditionally addressed in watershed management plans include sediment, fecal bacteria, and the nutrients nitrogen and phosphorus. These pollutants are derived in varying degrees from natural areas, agricultural land, urban areas, construction sites, roads, parking lots and other areas. Other common pollutants include pesticides, salts, oil and grease. Even heat can be viewed as a pollutant when runoff water temperatures increase as it flows over warm impervious surfaces and impact fisheries as is the case for trout streams like the McLoud Run in Cedar Rapids.

In Iowa, sediment is the leading nonpoint source pollutant. Sediment in Iowa comes from erosion on agricultural land, erosion of construction sites, streambanks and lake shorelines. Sediment can be harmful by filling in lakes and depositing on streambeds which covers fish habitat, and reduces visibility in the water.

The Iowa State University Daily Erosion Project estimates that average annual hillslope soil loss in the subwatersheds in the MCW ranges from 1.4 to 8.1 tons from each acre of land. The highest rates of average annual hillslope soil loss are found in the upper subwatersheds of the Wolf Creek, Black Hawk Creek and Pratt Creek subwatersheds.

Disease producing (pathogenic) organisms are a prevalent nonpoint pollutant that can cause health problems for people coming into contact with contaminated waters. Testing for disease producing organisms is difficult and expensive so two closely related bacteria groups, fecal coliforms and *E. coli* are commonly used to indicate the presence of pathogens. For simplicity this pollutant group is then referred to as fecal bacteria. Sources of fecal bacteria to waters in the MCW are diverse and include wildlife populations, livestock, pets and even human sewage.

Levels of fecal bacteria above State standards have been found in nearly one third of the State-designated stream segments within the MCW including 10 segments of the Cedar River, 17 of its major tributaries and Pleasant Creek Lake. It is important to note that elevated fecal bacteria levels are found in the majority of stream sites that have been tested. The lack of a documented finding on a given stream should not be construed as implying that fecal bacteria contamination is not a concern. Fecal bacteria contamination in the watershed is very common and precautions should be taken when coming into contact with water in watershed streams and lakes.

Nutrients, especially nitrogen and phosphorus, are other major nonpoint pollutants in Iowa. Nutrients are naturally occurring within soils and plant matter, but excess nutrients can be added to waters in the MCW from fertilizers (primarily from agricultural land and to a much lesser degree, lawns and urban areas) and from organic sources such as manure and human sewage. While nitrogen and phosphorus pose similar concerns for the water resources within the watershed, there are fundamental differences that impact the ability to manage them. Nitrogen, in its various forms, is soluble in water whereas the major form of phosphorus is often attached to soil particles.

Excessive nutrients in water from either chemical fertilizer or organic matter (including manure) can cause algae blooms in lakes, sometimes making lakes smelly and boating difficult. Algae blooms can reach harmful levels when they pose significant health concerns. Harmful algae blooms are common in lakes during calm, hot summer weather. People and animals can become sick from contact with toxic blue-green algae, by swallowing or having skin contact with water or by breathing in tiny droplets of water in the air. Dogs are particularly vulnerable to toxic algae because they're more likely to wade into lakes with algal scum; several have died from blue-green algae exposure. In 2016, 37 beach advisories were issued in Iowa, due to high levels of microcystin, which is the toxin produced by some forms of blue-green algae blooms that make the water unsafe for swimming. In the MCW, the beach at Pleasant Creek Lake Recreational Area near Shellsburg was impacted in 2016 and 2015. Casey Lake (Hickory Hills Park in Tama County) and Meyer's Lake in Evansdale are subject to very poor water transparency due to significant algae blooms which landed them on Iowa's impaired waters list.

High levels of nutrients can also cause water to be unfit for drinking. Some communities in the MCW are finding excess nitrate in their drinking water from polluted runoff which requires additional and costly treatment. Such water is unhealthy to drink, particularly for babies, and studies are emerging that indicate a potential link between nitrate consumption and cancer. The State of Iowa has designated Cedar Falls, Waterloo, and Conrad as Priority Community Water Supply Systems due to the susceptibility of their source water aquifers to surface water contamination and high levels of nitrate in their finished water. In addition to these aquifers, the one river segment in the watershed designated as a drinking water source has been listed as impaired for nitrate. (Refer to Watershed Assessment at the beginning of this plan for further information) A Total Maximum Daily Load Study (TMDL) was developed for this segment of the Cedar River which estimated the contribution of nitrate coming from various tributaries and set reduction targets needed to reduce nitrate levels and reach the water quality standard. The TMDL established a 37% reduction target for non-point sources of nitrate,

The MCWMA, under the Iowa Nutrient Reduction Strategy (INRS), has committed to reduce nitrogen and phosphorus export to Iowa waters and the Gulf of Mexico. The INRS was developed cooperatively by the Iowa Department of Agriculture and Land Stewardship, the Iowa Department of Natural Resources, and the Iowa State University College of Agriculture and Life Sciences in response to the 2008 Action Plan of the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (also referred to as the Hypoxia Task Force). The 2008 Action Plan set a goal for reducing the Gulf of Mexico hypoxic zone ("dead-zone") and called for implementation of "specific, practical, and cost-effective voluntary actions" by all Federal agencies, States, and Tribes. The Task Force called upon each of the 12 states along the Mississippi River to develop its own nutrient reduction strategy. The INRS set a goal of 45% reduction in nitrogen and phosphorus loading for both point and non-point sources combined. Accounting for potential load reduction from point sources, nonpoint sources need to achieve 41% load reduction in nitrogen and 29% load reduction in phosphorus to meet the overall 45% reduction goal.

The INRS has seen little progress in reducing the state's nitrogen and phosphorus contribution to the Gulf of Mexico. In 2019, the Iowa Environmental Council found that since the implementation of the INRS in 2013, implementation rates of reduction strategies have remained low and stagnant, and in the case of some practices, implementation rates have actually declined since 2013. This is in large part due to the voluntary participation from non-point sources (i.e. agriculture) which contribute the bulk of nutrients from Iowa. It is important for the MCWMA to stay committed to the goals of the INRS and expand implementation of its strategies.

Beaver Creek near Ackley Iowa, (Photo Credit: EOR)

3.2.1. Water Quality Goals and Objectives

Water Quality Goals	Water Quality Objectives
All waters within the Middle Cedar Watershed meet their designated uses.	Improve water quality of currently impaired waters (as well as those determined to be impaired in the future) to a level where they meet State water quality standards based on designated uses. See Section 6.
	Work towards meeting or exceeding the reductions targets identified in the existing TMDLs within the watershed.
	Develop TMDLs for all impaired waters within the watershed.
	Maintain water quality within waters that currently meet State water quality standards based on their designated uses.
	Encourage the Iowa DNR to conduct Use Assessment and Use Attainability Analysis (UA/UAA) for priority streams within the watershed.
	Track changes in water quality through a watershed-wide monitoring program.
Promote management activities to protect high quality drinking water sources.	Prioritize water quality BMPs in areas identified as being highly susceptible to groundwater pollution.
Meet the Iowa Nutrient Reduction Strategy goals for non-point source nitrogen (41%) and phosphorus (29%) reduction at the HUC-8 scale.	Work with watershed land owners and operators to utilize soil health, in-field, edge of field and riparian area management practice to reduce nutrient and sediment loading from agricultural areas.
	Work with watershed residents and developers to utilize green infrastructure practices to reduce nutrient loading from urban stormwater.
	Prioritize water quality improvement practices that • Preserve topsoil and reduce sediment runoff • Promote volume control • Provide habitat value, particularly for pollinator species • Provide greater return on investment
	In urban settings, promote Low Impact Development, Green Infrastructure and other natural mechanisms as the preferred stormwater management method.
	Promote the integration of conservation practice language into agricultural rental agreements between leasing land operators and landowners regarding motivation/incentives to; protect and preserve agricultural soils and runoff and to incorporate long-term practices
	In urban and rural communities, promote aspirational goals/vision of improved water quality and runoff reductions.

Implementation activities that are intended to collectively address these objectives can be found in the Flooding Mitigation and Water Quality Strategies Section. Also, refer to the Objectives Implementation Activities Matrix in Appendix I for more specific implementation actions associated with each objective.

3.3. Recreation

The Cedar River and many of its tributaries provide opportunities for water-based recreational activities including fishing, canoeing/kayaking and wildlife observation. More frequent flooding and increasing pollutant loads are impacting the recreational value of these resources.

Iowa has an extensive network of rivers and streams running across all areas of the state, traversing its agricultural landscapes and flowing through its cities. With limited lakes and reservoirs, these streams and rivers provide the primary opportunity for water-based recreation in the state. The majority of Iowans (85%) reported visiting a lake, river or creek in Iowa in the last two years, according to a recent survey conducted by the University of Northern Iowa for the Iowa DNR. A survey conducted by Iowa State University (Iowa Rivers and River Corridors Survey—2009) found that the most popular river/stream activities were relaxation, fishing, trail-related activities and wildlife viewing (Ji, Herriges, and Kling 2010). This suggests that Iowans value not only rivers and streams, but also the riparian corridors adjacent to them. Iowans also reported safe water and abundant game-fish as important characteristics influencing their choice of rivers/streams to visit. In addition to providing a recreational value to the state, river recreation provides an economic benefit. A study conducted by Iowa State University found that the overall economic impact from river recreation along 73 Iowa river and stream segments supports more than 6,350 jobs, generating an estimated $824 million in sales revenue and $130 million of personal income (Otto 2012).

The Cedar River is one of the most heavily used rivers in the state. The only rivers more heavily used are the Mississippi and Des Moines Rivers, according to the ISU survey. The Iowa DNR estimates that $17.5 million is spent on river recreation annually on the Cedar River between Cedar Rapids and Waterloo. The Cedar River has a long history as a recreational destination. Watershed residents recall a time when resorts were prevalent in the Vinton area, including Minne Estema Park which offered paddleboat rides on the river. Water–based recreational opportunities in the watershed beyond the Cedar River are limited. Some of the tributaries to the Cedar River that are valued as recreational resources include: Lime Creek and Bear Creek which were identified by the Iowa DNR as Outstanding Waters; the high value fisheries of Buffalo Creek and McLoud Run (Iowa's only urban trout stream); Black Hawk Creek, which is an Iowa DNR designated Canoe Route; and Wolf Creek which is regularly used for canoeing and kayaking from La Porte City to the confluence with the Cedar River. Current water quality conditions in the Watershed are the largest factor limiting recreation. Several reaches of the Cedar River and many of its tributaries have levels of bacterial contamination that pose a risk to human health.

There is a large demand for additional water-based recreational opportunities in the MCW, and a wide range of ideas are being considered to meet this demand. The Cities of Cedar Falls and Waterloo are in the early phases of scoping white-water parks within the Cedar River, and water-trails are envisioned for the Cedar River, Beaver Creek, and Black Hawk Creek. A Master Plan was recently completed for Cedar Lake in Cedar Rapids which included a vision for increasing wildlife habitat and generating more opportunities for lake users. Enhancing and expanding the recreational value of the Cedar River and its tributaries not only provides a quality of life benefit, it can also lead to an increased conservation ethic as people become more connected to the natural world around them.

3.3.1. Recreation Goals and Objectives

Recreation Goals	Recreation Objectives
Enhance the watershed's existing water-based recreational areas	Improve standard of living of watershed residents by providing high quality recreational opportunities on the watershed streams, lakes and riparian corridors.
Develop new recreational opportunities on lakes and streams across the watershed	Promote partnerships between public and private organizations to increase recreational opportunities in the watershed including connections between communities.
	Partner with state and local tourist organizations and chambers of commerce to promote the watershed as a recreational destination.
	Support recreational development projects being considered by communities within the watershed including: • Water Trails • White-Water Parks • Riparian Recreational Trails • Access Areas
Improve the health of the watershed ecosystem.	Support efforts in the watershed that emphasize the use of recreational areas to improve ecosystem health, provide habitat and movement corridors for wildlife, increase soil health, and control invasive species

Implementation activities have been developed to address each of these objectives and can be found in the Implementation Schedule. Also, refer to the Objectives Implementation Activities Matrix in Appendix I.

Vegetable stand (Photo Credit: EOR)

3.4. Funding & Organization

Effective watershed management is contingent on the organizational structure and internal capacity of the Middle Cedar Watershed Management Authority as well as the security of adequate funding sources into the future.

Public engagement (Photo Credit: IVRCD)

Many governmental and non-governmental units exist today to address issues for the public good. For instance, some ensure there are roads that are safe to travel and are maintained so people can travel reliably to jobs or schools. As new issues arise, either existing entities take these on, or in some cases, other entities form to address the issues. As severe flooding has been experienced all too often in the watershed, damaging crops, roads, waterways, and impacting cities, the need to address some root causes of flooding is becoming an ever growing issue. In addition, poor water quality in the MCW limit local opportunities for human and wildlife use including the consumption, recreation, and general enjoyment of water. Poor water quality becomes even more severe as it contributes to downstream resources, which has prompted the development of the INRS.

Many states and regions, in the case of water management, have had to face that the boundaries of the issues are along watershed divides. Watersheds cross over multiple jurisdictions, making it challenging for existing local entities, like cities and counties, to address the problem. The MCW spans about 1.5 million acres and crosses or includes the jurisdictional boundaries of 10 counties and 48 cities. Thus the scale of the MCWMA is challenging. There are a very large number of governmental entities, whom have little or no history of collaborating on water issues, which makes the management challenges greater. The sheer number of cities, counties, SWCDs, and diverse partners and that some eligible cities are not members of the MCWMA, must be considered as the organization builds itself up.

Many areas in the country have turned to creating some form of watershed management organization to effectively manage these water issues, matching the scale and boundaries to fit the need. With these new authorities, there needs to be a lasting organizational structure, accountable to the public, along with some form of stable funding. Iowa Code Chapter 466B Subchapter II provides for the creation of WMAs on an as-needed basis following the completion of a 28E agreement. There is no taxation authority granted to WMAs in 466B, so this presents a challenge. The daily operation of those WMAs requires a clear definition of local staffing needs, internal reporting requirements, planning objectives, and decision-making guidelines to achieve the necessary implementation goals. WMAs that do not have a stable funding source to keep a base level of operation may ultimately not be as effective at getting projects done as they otherwise could be.

When additional funding through grants or bonds can be leveraged (which often need a local monetary match), those funds can be used to accelerate priority projects, allowing protection from flooding and water quality impacts to be a reality on the ground sooner.

3.4.1. Funding and Organization Goals and Objectives

Funding and Organization Goals	Funding and Organization Objectives
Identify and obtain funding sources that are reliable and sufficient to meet the goals identified in the watershed management plan.	Establish a stable funding model and method for the watershed and continue a sustainable funding mechanism for a Middle Cedar Watershed Coordinator.
	Create early implementation successes to demonstrate value of the MCWMA and build confidence in stakeholders that the MCWMA can deliver positive outcomes with its resources.
Effectively manage the MCWMA through implementation of this watershed management plan and appropriate governance structure.	Include staffing resources in the mid and long term organization plan for the MCWMA for continuity, ability to find and acquire funding, implement projects, and coordination hub for stakeholders.

Implementation activities that are intended to collectively address these objectives can be found in the Funding and Organization Strategies Section. Also, refer to the Objectives Implementation Activities Matrix in Appendix I for more specific implementation actions associated with each objective.

Cedar River, Vinton Iowa (Photo Credit: EOR)

3.5. Watershed Policy

While there are stormwater regulations in place for municipal separate storm sewer systems (MS4s), construction activities and industrial activities, much of the land use activities in the Middle Cedar Watershed are unregulated. This creates significant burden on those entities charged with providing financial and technical assistance to the agricultural community in order to address the quantity and quality of agricultural stormwater runoff.

The MCW faces significant barriers in managing water resources which is perpetuated by the vast majority of land uses currently being unregulated. Notwithstanding those barriers, several tools and processes, some already in place, can be used to conserve and improve water and other natural resources in the MCW.

Over 73% of the MCW land area is in some form of row-crop cultivation. As of 2018, there were 357 animal feeding operations within the MCW. Both row-crop cultivation and livestock have been identified as large contributors to the pollutant loads in the MCW. Under state and federal water quality law, these uses remain largely unregulated, and although local entities and the MCWMA can play a role in that regulatory process by providing resources to landowners to more easily comply with those laws, they have no enforcement authority. However, within its capacity, the MCWMA does have three primary tools for improving agricultural practices to achieve watershed management goals. These include financial assistance, education; and technical assistance, which all require active and frequent farmer outreach activities.

Education is arguably the most important tool the MCWMA can use to address watershed management issues. Raising awareness and facilitating behavioral changes will achieve significant, valuable improvements across the entire watershed. A tangible example of the power increased awareness plays in changing behavior is that of the surface application of manure, a practice that was fairly common in the recent past. Over time people began to realize the practice was undesirable from a social, economic and environmental standpoint and it was largely eliminated.

A perennial barrier to any environmental improvement activity is adequate financial resources. Farmers operate in a high-risk environment, with very narrow margins for error. As a result, adopting new technologies is often deemed either too expensive, or too risky. Ultimately, voluntary action is likely to be the most effective method for achieving watershed management goals; and in some instances, voluntary action is the only solution. Voluntary action can be encouraged, even subsidized, in a variety of ways by local entities. Some examples of this include property tax reductions or locally-managed revolving loan funds. Local authorities strive to connect agricultural land users with existing federal and state funding. Technical assistance, although more demanding and complicated than financial assistance and education, is a key tool for watershed management. Ideally, financial assistance and technical assistance can be used in conjunction with one another to enhance and expand the potential of conservation efforts within the watershed.

The MCW has 10 Municipal Separate Storm Sewers (MS4) Communities. Seven of these communities are part of the Cedar Falls-Waterloo metro area, and three are in the Cedar Rapids metro area. The vast majority of the MCW population resides within these communities. They also contain the majority of the impervious surfaces in the watershed. Numerous businesses, industries, and other land uses contribute both stormwater pollutants and wastewater pollutants to the rivers and streams of the watershed. Residential uses are widespread, and although not always apparent, contribute pollutants to watershed resources. Unlike agricultural uses, local authorities have regulatory authority over several issues in the urban setting.

The agency with the most regulatory power related to water resources is the Iowa DNR. It regulates stormwater and erosion and sediment control under the National Pollutant Discharge Elimination System (NPDES) permit program. This program requires a stormwater permit be granted by the Iowa DNR for three primary activities:

- Construction activities disturbing one or more acres or that are part of a larger project disturbing one or more acres.
- Certain industrial or commercial activities classified as having “stormwater discharge associate with industrial activity;”.
- Municipal Separate Storm Sewer System (MS4) communities.

All 10 MS4 communities in the MCW have already adopted local stormwater regulations under the NPDES permit program.

The Iowa DNR also has a voluntary Source Water Protection (SWP) program for communities to join. It includes three phases. The first is to receive an assessment from the Iowa DNR outlining any active wells, delineating source water protection areas, listing the susceptibility to contamination classification, and providing the known potential sources of contamination. Second, the community develops a SWP Plan based on the information provided by the Iowa DNR. Lastly, the SWP Plan is implemented.

The Iowa DNR also regulates:

- Illicit discharges: The Iowa DNR requires MS4 designated communities to reduce pollutants in stormwater from illicit discharges and construction sites.
- Construction activities: In all floodplains and floodways in the state, the Iowa DNR enforces a minimum standard for development and requires notification for the intended construction of a dam, obstruction, deposit or excavation in order to determine if a flood plain development permit is required. Before the US Army Corps of Engineers can issue Clean Water Act Section 404 permits, the Iowa DNR must issue Section 401 Water Quality Certificates to ensure construction projects will not violate state water quality standards.
- Sewer systems: Local boards of health have the primary responsibility for sewer system regulations that serve four homes or fewer or less than 15 people, but the state is responsible for larger systems. Counties are required to comply with the minimum state standards, but if they fail to adopt or enforce those standards, the Iowa DNR will enforce these standards.
- Animal Feeding Operations: The Iowa DNR regulates the planning, permitting, siting, and operation of all AFOs, regardless of the type or size.

The INRS is a science and technology-based approach to assess and reduce nutrients delivered to Iowa waterways and the Gulf of Mexico. The strategy outlines voluntary efforts to reduce nutrients in surface water from both point sources, such as wastewater treatment plants and industrial facilities, and nonpoint sources, including farm fields and urban areas, in a scientific, reasonable and cost-effective manner.

3.5.1. Watershed Policy Goals and Objectives

Watershed Policy Goals	Watershed Policy Objectives
Encourage communities with regulations in place that protect water resources to improve oversight and enforcement of those regulations.	Improve the quality of discharges from small municipal wastewater facilities up to the level of modern wastewater standards.
	Explore Nutrient Reduction Exchange between various partners to allow new methods for rural and urban dischargers to meet higher goals/standards.
	Where urban development is expanding into rural areas, promote stewardship of farm lands.
	In urban settings, encourage local jurisdictions to adjust regulations to promote Low Impact Development, Green Infrastructure and other natural mechanisms as the preferred stormwater management method.

Implementation activities that are intended to collectively address these objectives can be found in the Policy Strategies Section. Also, refer to the Objectives Implementation Activities Matrix in Appendix I for more specific implementation actions associated with each objective.


Pratt Creek, Mt. Auburn Iowa (Photo Credit: EOR)

3.6. Education & Outreach

Many of the people who live, recreate or conduct business in the watershed are unfamiliar with watershed management concepts and the impact their activities have on the quality of downstream water resources.

Increasing awareness of watershed issues is a fundamental need in the MCW as it is in most areas. While the Cedar River and its major tributaries are well-known, many watershed residents and local officials are less familiar with the smaller creeks throughout the watershed. Increasing the base knowledge of the resources within the watershed and their value is critical. Creating an informed community and empowering residents to become stewards of the watershed is the foundation of a successful watershed management organization. The ability to affect change within a watershed is most powerful when it originates from local residents. The manner in which watershed education is delivered must be tailored to the intended audience. Working with watershed partners can be an effective strategy for communicating watershed messaging.

The Cedar River Watershed Coalition conducted a survey in 2011 while developing an interpretation and outreach plan for the Cedar River Watershed County Conservation Boards that determined the best messages to communicate to a broad audience within the watershed include; “we’re all in this watershed together”; “the Cedar River: It’s OUR watershed and OUR responsibility”; and “it costs more to repair flood damage to property and lives than it does to work to reduce flooding now”.

Typical education and outreach efforts in rural watersheds are primarily focused on the benefits afforded by various types of conservation practices. While this type of education/outreach is critical for getting conservation practices installed in the watershed, there are larger messages that need to be delivered. Watershed residents and local officials need to be informed about core watershed issues of flooding and water quality and how land uses and practices shape them. Understanding the connection of what is done on the land and the impact it has on downstream resources is an important step in increasing watershed awareness (Eells & Pease, 2011). Another key message that must be delivered is that there are actions that can be taken in the watershed to reduce flooding and improve water quality.

Within the Municipal Separate Storm Sewers (MS4) communities there has been some effort to educate residents about watershed issues but it is limited to a few of the larger communities. Cedar Falls, Waterloo, Hiawatha and Cedar Rapids are members of the Iowa Storm Water Education Partnership (ISWEP). The organization focuses on providing resources to assist members with their education and outreach needs; specifically on actions residents can take on their properties to mitigate stormwater management issues. ISWEP also provides resources to help guide local officials on steps they can take to manage stormwater at the community level. These educational messages are needed in the remaining MS4 communities as well as the smaller communities throughout the watershed.

3.6.1. Education and Outreach Goals and Objectives

Education & Outreach Goals	Education and Outreach Objectives
Increase awareness of the watershed and its resources	Utilize diverse approaches to build awareness of watershed issues.
Inspire watershed stewardship and ownership	Assist stakeholders in understanding what it means to be a resident of the watershed and the downstream impacts of common land uses and new development.
	Attempt to provide increased resources to partner and member organizations such as SWCDs, County Conservations, and ISU Extension for education services.
Disseminate water-resource information and materials	Implement the goals, objectives, and action steps for the early project outreach period as identified in the Middle Cedar Watershed Education and Outreach Action Plan prepared by Iowa State University Extension (refer to Appendix J) .
	Help locals understand that mitigation funds (FEMA's PDM and FMA and HMGP) are available
	Involve youth groups, including FFA and 4H, in outreach to parents and other family members. Incorporate family-focused programming to foster multi-generational discussions at home.
Ensure all stakeholders in the watershed are included in activities and programs.	Identify and support a water conservation/soil health champion in every subwatershed.
	Increase voluntary action by promoting the message that while conservation practices are voluntary, they should not be thought of as optional. Ask leaders in conservation and sustainable farming to be leaders in delivering this message.
	Develop and implement a rewards program to encourage stakeholder action
	Collaborate with leaders to expand watershed education resource access and availability
Identify and empower local watershed stewards to build watershed management ethic at grassroots level	Create a public recognition/reward campaign to incentivize farmers/producers desire to preserve their soils and lands.
	Recognize cities and urban sites that voluntarily go above and beyond the minimum standards.

Implementation activities that are intended to collectively address these objectives can be found in the Education Outreach Strategies Section. Also, refer to the Objectives Implementation Activities Matrix in Appendix I for more specific implementation actions associated with each objective.

3.7. Evaluation & Monitoring

In order to assess performance and communicate achievements at the local, state and federal level, the Middle Cedar Watershed Management Authority needs to establish a monitoring program. Not only should this monitoring program establish baseline conditions on resource health it should also continue collecting the information needed to establish trends and evaluate projects and programs to better inform future management decisions.

The collection of data on MCW streams and rivers is a critical and often overlooked component of watershed management. Having adequate data on rivers and streams is essential to characterizing their condition and communicating water quality issues with the public. Ongoing monitoring of water quality conditions can be used to detect changes and evaluate progress being made towards improving water quality from improvements in the watershed and to support future management decisions. It can also be used as an educational tool to illustrate water quality issues for watershed residents and decision makers. Having a clear objective in mind is important as there are numerous ways in which monitoring data can be collected including compliance monitoring, trend detection, BMP effectiveness, and education. Lack of monitoring data, or monitoring data collected for a clear purpose are common issues that hinder watershed management.

Compliance monitoring focuses on sampling select water quality parameters for comparison to water quality standards and criteria. This type of monitoring is typically done at the State level as a way of determining if resources comply with requirements of the Federal Clean Water Act. Iowa DNR is required to conduct monitoring across the state every two years to determine water quality conditions and determine whether or not resources are meeting their designated uses (such as supporting aquatic life or recreation). Ultimately this information is used to set pollutant reduction goals for those water bodies that are not meeting their designated uses, which are referred to as an 'impaired water'. In the Middle Cedar, the most recent round of compliance monitoring found 45 impaired streams and three impaired lakes. The Iowa DNR monitoring is conducted on a subset of the streams within the watershed to represent conditions in the entire watershed. Smaller streams and headwater portions of larger streams are not typically monitored due to lack of time and resources at the state level.

Monitoring for trend detection is typically conducted at a small number of strategically located sites within a watershed, commonly referred to as sentinel or legacy sites. The type of monitoring that is done for trend detection is fairly rigorous and involves taking continuous flow measurements and water quality measurements throughout the year since concentrations of pollutants in lakes and streams are highly variable throughout the year, and from year to year. The goal is to collect enough data throughout the year to adequately represent the changes in quality of the stream with time. The data is typically reported in terms of the total amount of pollutant delivered by the stream each year or an average annual pollutant concentration. Several years of data is needed before trends can be detected.

Sentinel sites within the MCW are currently limited to Cedar River at Waterloo, Cedar River at Cedar Rapids, Black Hawk Creek at Hudson, and Wolf Creek near Dysart. These are monitoring stations that have a long-term continuous flow monitoring conducted by the USGS and some level of water quality monitoring done by Iowa DNR. A comparison of the Cedar River sites can be used for a general overview of what changes are happening within the watershed as one site is at the top of the watershed and one is near the outlet. The large size of the watershed will likely limit the ability to detect meaningful trends at either of these locations in the short to midterm time period. The monitoring stations within the smaller watersheds (Beaver, Black Hawk, and Wolf) will provide an opportunity to detect trends within those areas. Collection of water quality data at these sites will need to be significantly expanded as they have historically consisted of monthly measurements. The ISA, in conjunction with Coe College and the City of Cedar Rapids are currently conducting water quality monitoring of tributaries throughout the watershed. The Iowa Flood Center currently conducts continuous stream level monitoring at 22 additional sites within the MCW that could be upgraded to sentinel sites with the addition of calculating flow from water levels and the addition of frequent water quality monitoring. An additional benefit of an expanded network of sentinel sites would be the ability to compare subwatersheds for the purpose of prioritizing management activities. Also, University of Iowa IIHR—Hydroscience & Engineering have an additional five real-time water quality sensors in the MCW.

Monitoring can also be used to validate the effectiveness of various conservation practices as they are implemented in the watershed. Many of these practices have been monitored in other areas of the State and their effectiveness has been well documented, but locally collected data is always preferable. Watershed residents have indicated that they would be more likely to implement practices if they have been shown to work in their area.

Monitoring can also be used as an educational tool. Citizen led water monitoring efforts are an excellent way to increase awareness of the health of local waterbodies. Agricultural producers can measure nutrient levels in ditches/drain tile outflow as a way of seeing first-hand how much nitrogen is leaving their fields. This information can be valuable to producers looking to reduce capital investments in fertilizers.

3.7.1. Evaluation and Monitoring Goals and Objectives

Evaluation and Monitoring Goals	Evaluation and Monitoring Objectives
Evaluate temporal trends in water quality and quantity in the watershed.	Continue to work with watershed partners to conduct sentinel site monitoring on the Cedar River and major tributaries.
	Use hydrologic and water quality models to estimate stream discharge and loading.
Determine the water quality and quantity conditions of streams, lakes and drinking water sources within the watershed.	Continue to work with the Iowa Soybean Association, Coe College and the City of Cedar Rapids to conduct snapshot monitoring on streams throughout the watershed.
Evaluate the effectiveness of MCWMA management efforts.	Use the Iowa Nutrient Reductions Strategy Logic Model Approach to measure progression towards meeting watershed nutrient reduction goals. Use measured results from monitoring equipment.

Implementation activities that are intended to collectively address these objectives can be found in the Monitoring and Evaluation Strategies Section. Also, refer to the Objectives Implementation Activities Matrix in Appendix I for more specific implementation actions associated with each objective.

3.8. Partnerships

Watershed Management Authorities (WMAs) are, by definition, partnerships between local cities, counties, and Soil & Water Conservation Districts. The MCWMA was formed to jointly address the challenges facing the watershed. While the MCWMA intends to assume a leadership role it does not bear the sole responsibility nor does it possess all the resources - financial, regulatory authority, or knowledge - needed to meet the challenge of managing the watershed.

A key to effective watershed management is working with all watershed stakeholders: residents and producers, MCWMA member communities, non-profit organizations, state agencies, and private entities in a collaborative manner. There are many overlapping missions, goals and responsibilities among these groups so coordination of efforts can result in greater efficiency and a reduction in expenditure. Working with partners can provide access to opportunities to incorporate conservation practices throughout the watershed and facilitates sharing of knowledge and information about new technologies and innovative approaches.

As one of the watersheds included in the IWA, the MCWMA has support services provided by numerous university, agency, local, and individual partners including the Iowa DNR, HSEMD, University of Iowa IIHR-Hydroscience and Engineering, IFC, ISU, USGS and the UNI Tallgrass Prairie Center.

Each type of stakeholder can play a critical role in improving watershed resources. Every day actions taken by watershed residents and producers are most directly tied the quality of watershed resources, therefore this group has the greatest potential to make positive changes. Conservation-minded producers provide a real-world example of the way in which water quality improvements can be achieved. These farmer-champions typically serve as a catalyst for conservation efforts by their watershed neighbors.

Locally led collaborations focusing on conservation and water quality improvement have proven to be one of the most effective tools in watershed management. There are several examples of initiatives in the MCW that have been effective at improving waterways and supporting the community.

The Miller Creek Water Quality Improvement Project is an example of a successful collaboration between numerous partners including: Black Hawk and Tama Soil and Water Conservation Districts, Black Hawk County, the Natural Resources Conservation Service (NRCS), IAWA, ISA and BMC Aggregates. The Miller Creek project aims to provide producers within the watershed with technical and financial assistance for conservation practices to help reduce nutrient runoff into Miller Creek.

An example of a grass-roots collaboration within the urbanized portion of the watershed is the McLoud Run Coalition in Cedar Rapids. The coalition of local fly-fishers, Sierra Club and Izaak Walton League members, Iowa DNR and the City of Cedar Rapids worked to provide an urban trout fishing experience, along with educating the public about watersheds and water quality. They received grant funds to install stream stabilization and habitat improvement structures and conducted fish stocking resulting in a valuable resource for the community.

The watershed is also home to an innovative urban-rural partnership led by the City of Cedar Rapids. The Middle Cedar Partnership Project is a collaboration between downstream water users, specifically the City of Cedar Rapids, upstream conservation entities (SWCDs, NRCS, Iowa DNR, etc.) and local farmers working together to reduce nitrate loads to the Cedar River and to improve water quantity and soil health.

The MCW is fortunate to have been selected as a priority watershed for the Midwest Row Crop Collaborative (MRCC), a diverse coalition working to expand agricultural solutions that protect air and water quality and enhance soil health. MRCC members include Cargill, Environmental Defense Fund, General Mills, Kellogg Company, Land O'Lakes, McDonald's, Monsanto, PepsiCo, The Nature Conservancy, Unilever, Walmart, and World Wildlife Fund. In the MCW the MRCC current efforts focus on a nutrient management outreach campaign as well as scalability of watershed management tools and approaches.

The County Conservation Boards within the MCW have similar goals in protecting and restoring water resources and habitat. They are charged with managing and protecting natural areas and engaging/educating the public about conservation. County Conservation Boards also have established resources for conservation projects like the Linn County Water and Land Legacy Bond which provided over $12,000,000 for conservation projects in 2018. One of the major priorities of the bond is improving water quality of the Cedar River and its tributaries.

3.8.1. Partnership Goals and Objectives

Partnership Goal	Partnership Objectives
Work cooperatively to achieve mutual watershed management objectives.	Identify stakeholders and resources and facilitate partnerships to implement the watershed plan.
	Identify opportunities for the MCWMA to assist the cities, counties, SWCDs and other stakeholders on their watershed management and conservation efforts.
	Utilize existing State and non-profit watershed management and conservation related initiatives.
	Cultivate and expand upon existing private/public partnerships that have been developed in the watershed.
	Bring in additional partners that may have vested interests in the watershed not already at the table. Specifically, conservation and recreation partnerships
	Cultivate additional partnerships with industries within the watershed with an emphasis on agribusiness.
	Explore unique approaches for crops and farming methods that are less impactful to the system hydrology and water bodies.

Collaborating with Partners has been identified as an over-arching approach for implementing all MCWMA activities. See the Partners in Watershed Management section for more information. Also, refer to the Objectives Implementation Activities Matrix in Appendix I.

4. PRIORITIZATION

4.1. Prioritization of Issues and Goals

Middle Cedar Watershed Management Authority (MCWMA) board members, project partners, stakeholders, and residents of the watershed were given several opportunities to prioritize watershed issues, goals, and implementation mechanisms. The first prioritization exercise was conducted at the Goals Workshop held in July 2018. Workshop participants were asked to rank issues facing the Middle Cedar watershed (MCW) that had been previously identified. Specifically, participants were asked to identify what they considered to be the most important issue and indicate additional issues of importance. The following issues were rated:

- Flooding risk
- Nutrients: drinking water, algae blooms, fisheries impacts
- Sedimentation: recreation, fisheries impacts
- Bacteria: health concerns
- Drinking water quality
- Recreational opportunities
- Partnerships/existing initiatives

At their July meeting, the MCWMA Board, along with project partners and other stakeholders in attendance, were presented with a series of maps depicting various watershed issues. The objective of the presentation was to illustrate the variability of these issues across the geography of the watershed. Maps of the following issues were presented:

- Flood Risk
- Draft Socio-Economic Status Mapping
- Impaired Waters: Aquatic Life
- Watersheds with Completed TMDLs
- Recreational Opportunities
- Population Density
- Flood Losses Total
- Flood Losses/Capita
- Past Conservation Planning Initiatives
- Grassed Waterway Adoption Rates
- Tile NO3 Loading/Acre
- Sediment Loading/Acre
- Animal Feeding Operations & Animal Units/Acre
- 100-year Floodplain
- Impaired Waters: Recreational Use
- Impaired Waters: Drinking Water
- Well Water Quality
- Water Quality Monitoring
  - Bacteria
  - Nitrogen
  - Phosphorus
  - Sediment
- MS4 Communities
- Flood Losses/Acre
- Total Nitrogen Loading/Acre
- Hillslope Soil Loss
- Total Phosphorus Loading/Acre
- Groundwater Vulnerability

Participants were asked to provide feedback on the issues presented, specifically on how each of the factors could be used to guide future watershed management activities. An example of how the various factors could potentially be combined to highlight priority areas was presented for discussion. A map was also presented that was based on the previous prioritization exercise; the factors and associated weights used to develop the multifactor subwatershed rating map were as follows:

- Flooding: Total Flood Loss (Percentile 1-10)
- Water Quality: Nitrogen Loading (N: Percentile 1-10)
- Recreational Value: Mainstem, Canoe Routes & Lakes, Primary Streams, Others (1,5,10)
- Existing Initiatives: Past Project Areas, Implementation Funding & Middle Cedar Subwatershed Plan, Others (1,5,10)

Meeting participants provided feedback on the weighting factors, which was then used to further refine the methodology in preparation for the Subwatershed Targeting exercise at the Board's November meeting.

At the September 10, 2018 Open House, attendees, which included several MCWMA Board Members, project partners and several watershed residents, were asked to prioritize the goals that were set for each of the watershed issues.

4.2. Targeting Implementation Subwatersheds

At the November Board meeting, a subwatershed targeting exercise was conducted. The goal of the exercise was to identify the specific HUC-12 subwatersheds where the MCWMA should focus future management efforts. Previous discussions/ranking exercises examined the issues that were most important for the MCWMA to address. The MCWMA board, stakeholders, and watershed residents identified the following issues, in order of priority: Water quality, flooding, past initiatives, and recreational value.

Specific rating factors were developed for each of the issues based on priority. Water quality was consistently the highest ranked issue so five rating factors were used. Flooding and Past Initiatives were of secondary importance, so each issue was given two factors. The remaining issue identified as a priority, recreational value, was given a single rating factor. The targeting exercise asked participants to rank the rating factors from one to 10 with one being the most important factor in selecting specific subwatershed in which to work.

Results of the targeting exercise were segregated into two groups: Board Members and Advisor/Project Partners (**Table 4-1**).

Table 4-1. Subwatershed Targeting Factors and Ranks.

	Factor	Board Rank	Advisor Rank	Board Mean	Advisor Mean
WQ1	Subwatersheds that have the highest loading rates of Nitrate	1	3	2.3	4.9
WQ2	Subwatersheds that have highest loading rates of Sediment & Total Phosphorus	4	6	3.9	5.9
WQ3	Subwatershed that likely contribute large amounts of Bacteria to streams	5	7	5.5	6.1
WQ4	Subwatersheds that contribute to sensitive public drinking water supplies	3	1	3.5	2.3
WQ5	Subwatersheds where degraded water quality poses a health threat - recreational contact	6	5	6.1	5.5
F1	Subwatersheds that most contribute to financial loss due to flooding	2	4	3.4	5.4
F2	Subwatersheds that most contribute to flooding of high socio-economic vulnerability communities	8	2	7.2	4.1

	Factor	Board Rank	Advisor Rank	Board Mean	Advisor Mean
P1	Subwatersheds with past conservation initiatives	7	8	6.7	6.6
P2	Subwatersheds with comprehensive plans adopted	9	10	7.8	7.6
R1	Subwatershed with high water-based recreational value (outstanding waters, canoe routes, high value fisheries)	10	9	8.7	6.6

The results of the targeting exercise were then used to rank each of the 68 HUC-12 subwatersheds of the MCW as follows:

- **Factor Values:** For variable factors (nitrate, TSS & TP, and bacteria load, and contribution to flooding), the raw data was converted to a zero to one scale. The subwatershed with the highest value for each factor was set to one and the remaining subwatersheds were set to the appropriate fraction of that value.
- For set factors, values were set to zero or one. If a subwatershed met the conditions of the factor they were set to a value of one, if not they were set at a value of zero.
- **Factor Weight:** Board Member mean ranking was inversed (10-rank) and multiplied by 10, so higher ranked factors would have higher weights. (e.g. nitrate: Board mean value = 2.3, factor weight = 77)
- **Factor Score:** The factor values were multiplied by the factor weight to calculate factor scores, which were then summed to determine the overall targeting score for each subwatershed.

Based on this evaluation, the priority subwatersheds in the MCW were identified and are shown in **Table 4-2** and illustrated in **Figure 4-1** and. The subwatersheds included as priority (total of 23 subwatersheds) represent a third of the subwatersheds, with the high priority subwatersheds representing 10%.

Table 4-2. Priority Subwatersheds Based on Targeting Exercise.

Priority	HUC-12	HUC-12 Code
High Priority	Lime Creek	070802051003
High Priority	Wolf Creek	070802050809
High Priority	Prescotts Creek-Black Hawk Creek	070802050602
High Priority	Dry Run	070802050701
High Priority	Morgan Creek	070802051506
High Priority	Village of Reinbeck-Black Hawk Creek	070802050505
High Priority	Black Hawk Park-Cedar River	070802050703
Priority	Hammers Creek-Beaver Creek	070802050304
Priority	Silver Creek-Cedar River	070802051507
Priority	Sink Creek-Cedar River	070802050906
Priority	Holland Creek	070802050501
Priority	Miller Creek	070802050905
Priority	Headwaters Beaver Creek	070802050201
Priority	Devils Run-Wolf Creek	070802050808
Priority	Wilson Creek-Black Hawk Creek	070802050601

Priority	HUC-12	HUC-12 Code
Priority	Mosquito Creek	070802050503
Priority	Minnehaha Creek-Black Hawk Creek	070802050504
Priority	East Otter Creek-Otter Creek	070802051302
Priority	Waterloo Municipal Airport	070802050702
Priority	Headwaters Black Hawk Creek	070802050502
Priority	Headwaters North Fork Black Hawk Creek	070802050402
Priority	Max Creek-Beaver Creek	070802050303
Priority	North Fork Black Hawk Creek	070802050403

Targeting rankings for all 68 HUC-12 subwatersheds of the MCW can be found in Appendix F.

4.3. Practice Specific Targeting

At the HUC-12 scale, targeting specific locations for implementing conservation practices can be completed using the resources available to the MCWMA, most importantly, the output from the Agricultural Conservation Practices Framework (ACPF) analysis. The ACPF analysis identifies suitable locations for practices within the subwatershed but an additional step is needed to target priority locations. The following are methods that can be used to target specific conservation practices in a HUC-12 subwatershed management plan (this level of targeting was completed for the five case-study subwatershed management plans):

- **Runoff risk -** These practices include all the soil health practices (cover crops, extended rotations, nitrogen management, and phosphorus management), no-till, perennial cover, and WASCOBs. All of these practices are recommended across the watershed and are very valuable in reducing the pollutant loads in runoff. Therefore, land with a relatively higher runoff risk should be prioritized for these practices. Riparian buffers downstream of areas with relatively high runoff risk should also be prioritized over those in areas with a lower runoff risk.
- **Relative slope steepness -** These include contour buffer strips and terraces. Their implementation is prioritized based on slope steepness rather than runoff risk because such practices are found all across the landscape and not just adjacent to streams. Both contour buffer strips and terraces reduce sheet and rill erosion, which is why they are most valuable on steeper slopes. Therefore, these practices should be prioritized in locations where slopes are steepest in relation to the subwatershed's landscape.
- **Practice Specific Criteria -** Grassed waterways, and nutrient removal wetlands each have specific methods for targeting specific sites.
    - **Grassed waterways** are beneficial in locations where gullies are most likely to form in streams. Moore's Stream Power Index (SPI) is applied to these practices to determine ideal locations for implementation. The SPI determines which locations for these practices have the highest stream power, therefore determining areas where gullies are more likely to form. Therefore, the grassed waterways in locations with the highest relative SPI should be prioritized and targeted for implementation.

- **Nutrient Removal Wetlands** are sited using general ratios for contributing area to wetland size. Larger wetlands generally will provide greater nutrient removal benefits. Therefore, the Corn Suitability Rating 2 (CSR2) is used as a surrogate for land value. The CSR2 is used for targeting specific sites because of the large cost and amount of land associated with wetlands. In many cases, the ACPF analysis will identify wetland sites in series of two or more. When this is the case, only one wetland within the series should be implemented in the initial process. The area of each wetland pool and drainage area can be used a secondary measure for prioritization.

- **Crop productivity** - Some conservation practices do not have a specific criterion that would provide a helpful guide for implementation. These include drainage water management practices, denitrifying bioreactors, and saturated buffers. However, the CSR2 as an indicator of crop productivity, can be used to prioritize specific practice locations.


Cedar River near Gilbertville Iowa (Photo Credit:

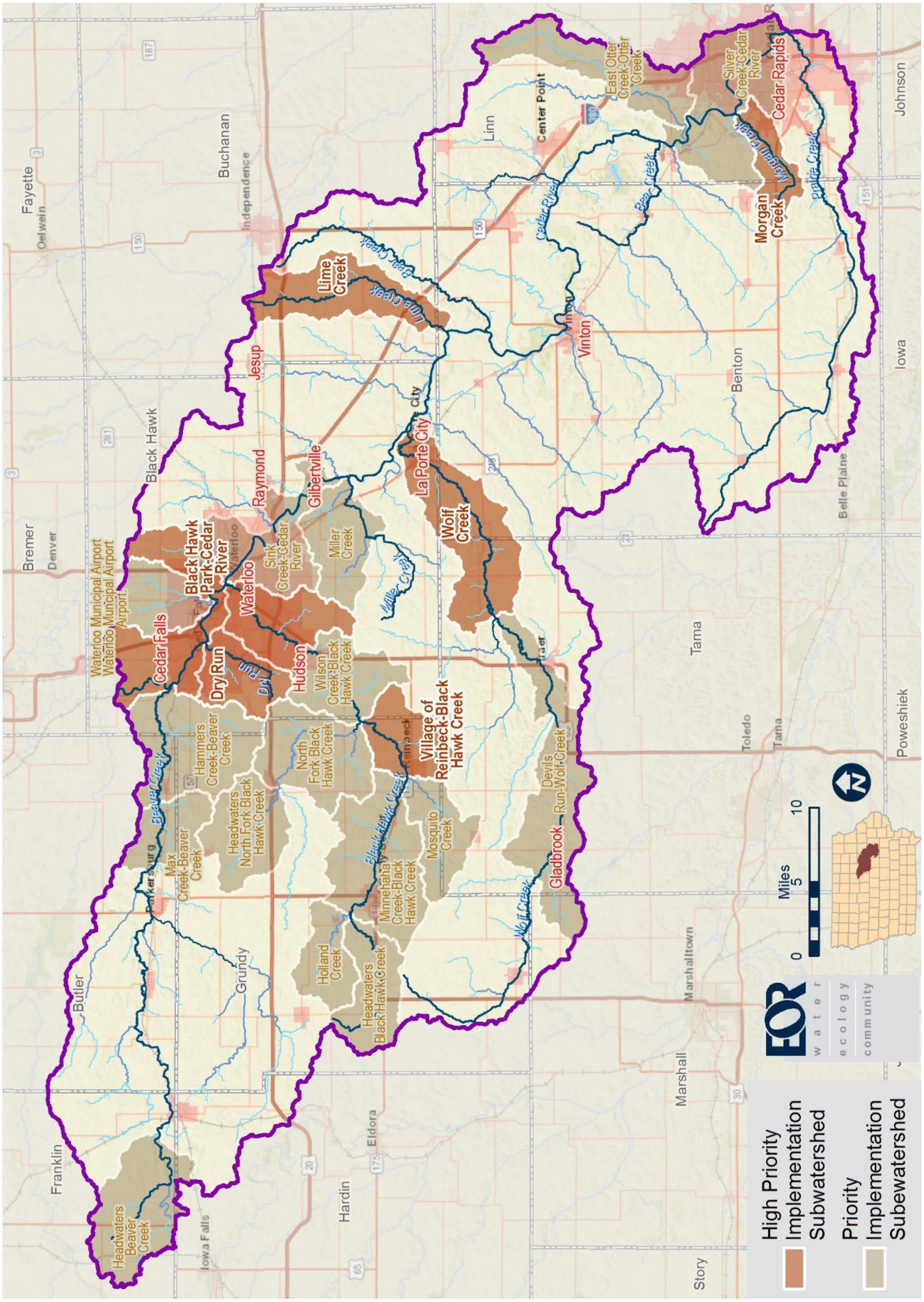

Figure 4-1. Middle Cedar Watershed—Prioritized Implementation Subwatersheds.

4.4. Prioritizing Implementation Mechanisms

During the goals and prioritization session held at La Porte City Hall on July 19, 2018, MCWMA Board members, project partners and key stakeholders were asked to prioritize the methods and mechanisms to be used to achieve the goals defined within the Middle Cedar Watershed Management Plan (MCWMP). Ranking of implementation mechanisms was conducted through an exercise called ‘if I had a million dollars’. Each participant was given one million dollars in play money and was instructed to ‘spend’ their money by placing it into one of eight implementation mechanism buckets. Seven of the implementation mechanisms were chosen ahead of the meeting and were reviewed prior to the exercise. Board members elected to add ‘Developing New Markets’ as an additional mechanism. The following implementation mechanisms, with average expenditure as voted upon by MCWMA board members:

- **Cost-Share** ***$304K*** Providing financial incentives to landowners to incorporate conservation practices on their property or to change land use practices. The cost-share is typically associated with the cost for constructing a practice or the cost in terms of loss of income as a result of the change in land use practice.
- **Capital Improvements-** ***$129K*** Projects that are primarily funded and constructed by the MCWMA or other government entities, typically large structural projects.
- **Feasibility Studies-** ***$108K*** Generally used to further refine or evaluate a given capital improvement or provide greater prioritization for siting conservation practices.
- **Coordination-** ***$167K*** The activities related to collaborating with various entities that have a vested interest in managing the watershed including MCWMA member organizations and representatives, State agencies, project partners and watershed stakeholders.
- **Education/Outreach-*****$154K*** Increasing knowledge about watershed issues and available solutions among people living, working or recreating in the watershed.
- **Developing New Markets-** ***$38K*** The general desire to develop markets for commodities other than annual row crops that could have a less impact on water quality and watershed hydrology.
- **Policy-** ***$38K*** Ensuring ordinances currently in place are effective and are being uniformly and appropriately enforced.
- **Monitoring and Evaluation-*****$63K*** The actual measurement of water quality and flow within the waters of the watershed as well as evaluating the operations and programs of the watershed management authority in an effort to determine whether or not the organizations efforts are making a positive change.

Results of the exercise indicated the three mechanisms contributing to water quality and flood control conservation practices (Cost share, Capital Improvements, Studies/Analysis) appear to be a high priority for stakeholders as does coordination with partners. Ensuring effectiveness of policies, developing markets, and monitoring and evaluating MCWMA activities and water conditions were not as highly prioritized. This prioritization can guide the MCWMA to decide how to distribute funds and schedule projects so that their actions align with the priorities of stakeholders.

The MCWMA board discussed base-line funding levels and came to the conclusion that an annual budget of $150,000 would be appropriate to fund a watershed coordinator, a portion of an education outreach specialist and to cover miscellaneous organizational costs.

5. RELATED STUDIES

Information from other plans and studies is related to the Middle Cedar Watershed Management Plan (MCWMP), and the plans and studies often provide finer detail in the areas to which they apply. Each study listed below is hereby incorporated into this plan, and recommendations therein should be considered supplemental to those set forth in this plan. Any recommendations in conflict with those in the MCWMP are assumed to incorporate local knowledge and should be given some precedent over the recommendations of the MCWMP. In some cases, these studies have outdated content, which would warrant a more extensive review of which recommendations should be pursued.

5.1. Middle Cedar Watershed Management Plan Case Study HUC-12 Subwatershed Plans

Five subwatershed management plans were developed as case studies during the MCWMP process. The subwatersheds were selected through consultation with local conservation practitioners based on the needs of the specific geographies across the watershed. All five case-study HUC-12 subwatershed plans can be found on the MCWMA website: http://www.middlecedarwma.com/the-watershed-plan.html

5.1.1. Village of Reinbeck – Black Hawk Creek HUC-12 Subwatershed Plan

Village of Reinbeck – Black Hawk Creek Subwatershed 70802050505

The Village of Reinbeck- Black Hawk Creek Subwatershed spans Grundy, Tama, and Black Hawk Counties. The 16,956-acre area is a subdivision of the Headwaters Black Hawk Creek HUC-10 Watershed and the Middle Cedar HUC-8 Subbasin. According to the 2010 United States Census, the subwatershed has an estimated population of 1,956, the majority of which (1,664) reside within the City of Reinbeck. The subwatershed is 81% row crop agriculture. This subwatershed management plan was developed through use of a stakeholder engagement process consisting of two meetings with local farmers. The stakeholders shared concerns about area water resources, helped set a vision for future, and provided valuable input on the types of conservation practices best suited to the subwatershed. The subwatershed management plan includes a specific scenario of conservation practices needed to meet the INRS, based on the input provided by local farmers and subwatershed residents. The subwatershed plan also identifies bacteria reductions needed to reach State standards for the segment of impaired stream within the subwatershed.

5.1.2. Headwaters Prairie Creek HUC-12 Subwatershed Plan

Headwaters Prairie Creek Subwatershed 070802051401

The Headwaters Prairie Creek Subwatershed is located in the southwest corner of Benton County. The 25,321-acre area is a subdivision of the Prairie Creek HUC-10 Watershed and the Middle Cedar HUC-8 Subbasin. According to the 2010 United States Census, the subwatershed has an estimated population of 1,415, the majority of which reside within the City of Van Horne and the City of Keystone. The subwatershed is 88% row crop agriculture. This subwatershed management plan was developed through use of a stakeholder engagement process consisting of two meetings with local farmers. The stakeholders shared concerns about area water resources, helped set a vision for future, and provided valuable input on the types of conservation practices best suited to the subwatershed. The subwatershed management plan includes a specific scenario of conservation practices needed to meet the INRS based on the input provided by local farmers and subwatershed residents.

5.1.3. Village of Van Horne – Prairie Creek HUC-12 Subwatershed Plan

Village of Van Horne – Prairie Creek Subwatershed 070802051402

The Village of Van Horne Prairie Creek Subwatershed is located on the southwest side of Benton County. The 22,333-acre area is a subdivision of the Prairie Creek HUC-10 Watershed and the Middle Cedar HUC-8 Subbasin. According to the 2010 United States Census, the subwatershed has an estimated population of 484. The subwatershed is 85% row crop agriculture. This subwatershed management plan was developed through use of a stakeholder engagement process consisting of two meetings with local farmers. The stakeholders shared concerns about area water resources, helped set a vision for future, and provided valuable input on the types of conservation practices best suited to the subwatershed. The subwatershed management plan includes a specific scenario of conservation practices needed to meet the INRS based on the input provided by local farmers and subwatershed residents.

5.1.4. North Beaver Creek HUC-12 Subwatershed Plan

North Beaver Creek Subwatershed 070802050202

The North Beaver Creek Subwatershed spans across Franklin and Butler Counties. This watershed lies in an entirely rural area; there are no urban towns or rural villages. The 28,028-acre area is a subdivision of the Headwaters Beaver Creek HUC-10 Watershed and the Middle Cedar HUC-8 Subbasin. According to the 2010 United States Census, the subwatershed has an estimated population of 305. The subwatershed is 84% row crop agriculture. This subwatershed management plan was developed through use of a stakeholder engagement process consisting of two meetings with local farmers. The stakeholders shared concerns about area water resources, helped set a vision for future, and provided valuable input on the types of conservation practices best suited to the subwatershed. The subwatershed management plan includes a specific scenario of conservation practices needed to meet the INRS based on the input provided by local farmers and subwatershed residents.

5.1.5. Morgan Creek HUC-12 Subwatershed Plan

Morgan Creek Subwatershed 070802051506

The Morgan Creek Subwatershed spans across Franklin and Butler Counties subwatershed spans Linn and Benton County and includes a portion of Cedar Rapids. The 12,175-acre area is a subdivision of the Blue Creek HUC-10 Watershed and the Middle Cedar HUC-8 Subbasin. According to the 2010 United States Census, the subwatershed has an estimated population of 4,707. The subwatershed is 67% row crop agriculture. This subwatershed management plan was developed through use of a stakeholder engagement process consisting of two meetings with local farmers. The stakeholders shared concerns about area water resources, helped set a vision for future, and provided valuable input on the types of conservation practices best suited to the subwatershed. The subwatershed plan includes a specific scenario of conservation practices needed to meet the INRS based on the input provided by local farmers and subwatershed residents. The subwatershed plan also identifies bacteria reductions needed to reach State standards for the segment of impaired stream within the subwatershed.

5.2. Other Subwatershed Management Plans

5.2.1. Watershed Management Plan for Dry Run Creek (2009)

Dry Run Subwatershed 070802050701

Dry Run Creek is a 15,177-acre watershed, which flows from the agricultural lands of Black Hawk County through residential, industrial, and commercial areas including the City of Cedar Falls and the University of Northern Iowa before outletting into the Cedar River. In 2002, a segment of the southwest branch was listed on Iowa's 303(d) list of impaired waters due to a lack of diversity and abundance of aquatic life. In 2008, the creek received a second impairment designation when it was placed on the 303(d) list for bacterial impairment. This subwatershed plan was developed by the Black Hawk Soil and Water Conservation District in 2009, and includes goals for infiltrating rainfall in urban areas, reducing sediment delivery, improving streambank habitat, and conducting an extensive information and education program.

http://blackhawkswcd.org/wp-content/uploads/2014/02/dryruncreekwmps.pdf

5.2.2. Benton/Tama Watershed Improvement Plan

Wolf Creek Subwatershed 070802050809

Rock Creek Subwatershed 070802051001

Pratt Creek Subwatershed 070802051101

A roadmap for improved water quality, sustained agricultural productivity, and reduced flood risk was prepared by the Iowa Soybean Association Environmental Programs and Services through funding by the Sand County Foundation. This subwatershed management plan is intended to provide a roadmap for water and soil improvements in the Benton/Tama watershed, while at the same time maintaining or improving agronomic performance and quality of life. This plan lays out a phased approach to implementation to ensure continuous improvements are being made towards achieving long-term goals for the subwatershed.

https://www.iasoybeans.com/upl/downloads/publications/benton-tama.pdf

5.2.3. Holland Creek Watershed Plan (2018)

Holland Creek Subwatershed 070802050501

A guide for healthy soil and clean water in the Holland Creek Watershed was developed by the Iowa Soybean Association Environmental Programs and Services in 2018. Funding to support watershed planning in the Holland Creek Watershed and development of the document was provided by the Natural Resources Conservation Service. This subwatershed plan is intended to provide guidance for land and water improvements in the Holland Creek Watershed while simultaneously enhancing agricultural vitality. This plan lays out a phased approach to conservation implementation to facilitate continuous progress towards achieving long-term watershed goals.

https://www.iasoybeans.com/upl/downloads/publications/holland-creek-watershed-plan.pdf

5.2.4. Lime Creek Watershed Improvement Plan

Lime Creek Subwatershed 070802051003

A roadmap for improved water quality, sustained agricultural productivity, and reduced flood risk was prepared by the Iowa Soybean Association Environmental Programs and Services. Funding to support the development of this document and associated watershed planning activities in the Lime Creek Watershed was provided by the Walton Family Foundation. This document is intended to provide a roadmap for water and soil improvements in the Lime Creek Watershed while at the same time maintaining or improving agronomic performance and quality of life. Environmental improvements are a big task, and trying to tackle everything at once can be daunting. This plan lays out a phased approach to implementation to ensure continuous improvements are made towards achieving long-term goals for the watershed.

https://www.iasoybeans.com/upl/downloads/publications/lime-creek.pdf

5.2.5. Miller Creek Watershed Improvement Plan

Headwaters Miller Creek Subwatershed 070802050904

Miller Creek Subwatershed 070802050905

A roadmap for improved water quality, sustained agricultural productivity, and reduced flood risk was prepared by the Iowa Soybean Association Environmental Programs and Services through funding by the Sand County Foundation. This document is intended to provide a roadmap for water and soil improvements in the Miller Creek watershed while at the same time maintaining or improving agronomic performance and quality of life. This plan lays out a phased approach to implementation to ensure continuous improvements are being made towards achieving long-term goals for the watershed.

https://www.iasoybeans.com/upl/downloads/publications/miller-creek.pdf

5.3. Watershed Assessments

5.3.1. Birdsall Watershed Assessment (2017)

Black Hawk Park-Cedar River Subwatershed 070802050703

Prepared by Robinson Engineering Company, 2017. The Birdsall Watershed is a small watershed on the west side of the City of Cedar Falls. As a requirement of the City of Cedar Falls' National Pollutant Discharge Elimination System (NPDES) General Permit No. 2, the city requested that the watershed be assessed. This assessment looked at a number of components to determine the current health of the watershed and Birdsall Creek.

http://www.cedarfalls.com/DocumentCenter/View/4920

5.3.2. Brandilynn Watershed Assessment (2014)

Prescotts Creek-Black Hawk Creek Subwatershed 070802050602
Prepared by Robinson Engineering Company. The Brandilynn Watershed is a small watershed in the City of Cedar Falls. As a requirement of the City of Cedar Falls' National Pollutant Discharge Elimination System (NPDES) General Permit No. 2, the city requested that the watershed be assessed. This assessment looked at a number of components to determine the current health of the watershed and Brandilynn Creek.

http://www.cedarfalls.com/DocumentCenter/View/3256

5.3.3. Green Creek Watershed Assessment (2015)

Prescotts Creek-Black Hawk Creek Subwatershed 070802050602
Prepared by Robinson Engineering Company. The Green Creek Watershed is a small watershed on the eastern side of the City of Cedar Falls. As a requirement of the City of Cedar Falls' National Pollutant Discharge Elimination System (NPDES) General Permit No. 2, the city requested that the watershed be assessed. This assessment looked at a number of components to determine the current health of the watershed and Green Creek.

http://www.cedarfalls.com/DocumentCenter/View/4038

5.4. City Stormwater Management Plans

5.4.1. City of Vinton Stormwater Management Plan

Hinkle Creek Subwatershed 070802051102
Mud Creek Subwatershed 070802051104
Dudgeon Lake State WMA – Cedar River Subwatershed 070802051105
A stormwater management plan for the City of Vinton was developed during the Middle Cedar Watershed Management Planning process as a case study. The City of Vinton is located on the Cedar River near the confluences with two of its tributaries, Hinkle Creek and Mud Creek, which join the Cedar River to the north and south of downtown Vinton, respectively. The city has experienced significant flooding in recent years due to high waters resulting from flooding on the Cedar River and these tributaries. The stormwater management plan investigates the various causes of flooding within the city including Cedar River crests and stormwater infrastructure capacity. Alternatives to address flooding in the city are proposed along with recommendations for phasing.

http://www.middlecedarwma.com/the-watershed-plan.html

5.4.2. La Porte City Watershed Assessment and Plan

Wolf Creek Subwatershed 070802050809
Currently La Porte City experiences flooding throughout town, at times related to regional flooding from either Wolf Creek or the Cedar River or, much more frequently and noticeably, from localized intense rain events. The watershed assessment, prepared by MSA Professional Services, Inc., in 2018 investigates the causes of flooding in the city and proposes several solutions. The plan includes goals to increase the number of water quality practices in the community and to implement innovative infrastructure that promotes sustainable living.

5.4.3. City of Cedar Falls Stormwater Management

Black Hawk Park – Cedar River Subwatershed 70802050703

Dry Run Subwatershed 70802050701

Prescotts Creek – Black Hawk Creek Subwatershed 70802050602

The City of Cedar Falls has taken an active role in stormwater management in recent years and intends to continue with the following efforts:

- Continuing the permeable alley program with 2-4 alleys each year
- Roadway corridor Bioretention cells
  - University Avenue
  - Greenhill Road
  - W. 1st Street
  - Hudson Road
  - Other roadway corridors
- Parkland Bioretention cells (all Cedar Falls parks)
- Northern Cedar Falls wetland/ponding flood mitigation (area in city limits north of the Cedar River)
- Various flood mitigation efforts (all Special Flood Hazard Areas (SFHA))
- Stormwater detention/water quality efforts for new developments and subdivisions
- Continued stream corridor restoration projects (all SFHA areas)
- Permeable pavements, biocells or other oil/water separation devices on municipal parking lot improvements
- Growing a more robust tree planting and open green space program for stormwater management
- Water quality and monitoring initiatives, impaired streams, nitrate issues, etc. (northern Cedar Falls, Dry Run Creek – University, South and Southwest branch)
- Stormwater education initiatives

https://www.cedarfalls.com/122/Storm-Water-Program

5.4.4. West Growth Area Service Plan: Cedar Rapids Stormwater Master Plan

Silver Creek – Cedar River Subwatershed 070802051507

Morgan Creek Subwatershed 70802051506

Prairie Creek Subwatershed 070802051405

This report summarizes stormwater service needs and associated capital costs for the West Growth Area (WGA) of Cedar Rapids, Iowa east and west of the future State Highway 100 route identified in the city's long term planning document, EnvisionCR . The objective of this report is to present a conceptual storm sewer service plan for the WGA, estimate the city's future stormwater-related financial obligations, and evaluate the adequacy of the city's current stormwater impact fee for funding the obligations. The conceptual storm sewer service plan includes estimates for the amount of storm sewer pipe and detention storage volume required to meet the city's criteria for post developed peak flow rates. Future storm sewer pipe (conveyance) needs were estimated using data about the city's current storm sewer system and future land use. Storage requirements were determined by reviewing the topography and future land use in the WGA. Topographic information, future land use, and future arterial roadway alignment data were then used to identify potential regional detention pond locations and sizes. The regional detention concept is a collection of regional ponds selected to serve as much of the WGA as is feasible.

http://www.cedar-rapids.org/local_government/departments_g_-_v/public_works/stormwater_master_plan.php#revize_document_center_rz3586

Billboard, Conrad Iowa, (Photo Credit: EOR)

6. FLOOD MITIGATION & WATER QUALITY IMPROVEMENT STRATEGIES

A suite of conservation practices has been evaluated in this plan in an attempt to determine the overall effectiveness of aggregate implementation in terms of both flood mitigation and water quality improvement. The emphasis in this section is placed on Best Management Practice (BMP) retrofits in both the agricultural and urban landscapes. For a more detailed description of the processes and methods used in this analysis, please see Appendix E: Flood Mitigation & Water Quality Implementation Analysis.

6.1. Flood Mitigation Strategies

The Hydrologic Assessment that was performed for the Middle Cedar Watershed (MCW) by the Iowa Flood Center (IFC) and the University of Iowa IIHR—Hydroscience & Engineering (Iowa Flood Center and IIHR 2019) was used to evaluate the potential for flood damage reduction resulting from the implementation of a subset of the conservation practices described in Section 6.2. These included practices that improve soil health (cover crops, extended crop rotations, and no-till), conversion of cropland to native prairie (i.e. perennial cover), and distributed storage (WASCOBs and nutrient removal wetlands). A detailed description of how this evaluation was performed is found in Appendix E.

In contrast to water quality, no specific, numerical goals for flood reduction or flood damage reduction have been set – partly because goal setting for flood damage reduction is better performed at the local scale and doing so at this scale would require a more detailed analysis of flooding in the MCW than was possible to perform, and partly because flood damage reduction can involve a variety of strategies that do not necessarily focus on modifying flooding itself, but focus instead on reducing a community's susceptibility and vulnerability to flooding by removing people and property from the floodplain.

A list of community-level flood mitigation plans can be found on the website for the East Central Iowa Council of Governments (https://www.ecicog.org/). Additionally, a list of Hazard Mitigation Plans in the MCW can be found in Appendix B, and a list of Notices of Interest for Hazard Mitigation Assistance (HMA) is found in **Table 6-1** below. These HMA projects are currently unfunded, and the MCWMA could provide assistance in acquiring funding to complete them.

Table 6-1: Notices of Interest for Hazard Mitigation Assistance.

Entity Name	Project Type/Title	Estimated Amount
City of Cedar Falls	Property Acquisition	$3,015,180.00
City of Cedar Rapids	Detention Basin- 25th St SW & 1st Ave SW	$770,000.00
City of Cedar Rapids	Detention Basin 29th St & F Ave NW	$6,670,000.00
City of Cedar Rapids	Detention Basin Expansion-Hagan's 2nd	$2,490,000.00
City of Cedar Rapids	Acquisition of repetitive loss area #11	$150,000.00

The Iowa Flood Center's document titled *Flood Mitigation Planning for the Middle Cedar River Watershed* is included as Appendix C to this plan. Among other things, the document contains a list of all communities in the MCW that participate in the National Flood Insurance Program (NFIP) and its Community Rating System (CRS). The vast majority of communities listed are rated Level 10, which is the lowest rating and does provide any insurance discounts to property owners. Communities can earn points and increase their CRS rating by completing a variety of activities in four different categories:

- Public Information
- Mapping & Regulations
- Flood Damage Reduction
- Flood Preparedness

The document also contains a checklist that communities can use in assessing existing flood mitigation plans or as a guide to building a plan in the absence of one.

At the watershed scale, there is a degree to which flooding can be modified over the long term, as demonstrated in the [Hydrologic Assessment]. In the report, the Iowa Flood Center and University of Iowa IIHR—Hydroscience & Engineering (IIHR) outlined that identifying areas of the watershed with the highest runoff potential should be the first step in selecting flood mitigation project sites, followed by site-scale assessment of factors such as landowner interest, local knowledge of issues, and geology. Some of the key discussion from the Hydrologic Assessment can be found in Appendix E.

6.2. Agricultural Strategies to Address Nutrient and Sediment Pollution

The suite of conservation strategies appropriate for addressing the nutrients and sediments contained in agricultural runoff are presented in the context of the agricultural conservation practices pyramid in **Figure 6-1**. At the base of the conservation pyramid are practices that build soil health in addition to reducing nutrient and sediment runoff. These practices are a priority for conservation in the watershed because their primary mechanism for reducing nutrient runoff is through reduced application, resulting in a reduction in expenditures. Soil health building conservation practices do not take land out of production. They can increase crop productivity and decrease costs associated with fertilizer application and tillage, thus improving farm profitability. They also provide flood benefit through increased storage and infiltration. The next level in the conservation pyramid consists of in-field practices. These conservation practices are the next priority because their mechanism for nutrient and sediment removal is through trapping directly on the farm field. In-field practices are commonly used to address rill and gully erosion in farm fields. These practices typically involve taking small areas out of production within a given farm field which, in some cases, can complicate routine farming operations by subdividing fields. The next level in the conservation pyramid consist of edge-of-field practices. These practices typically

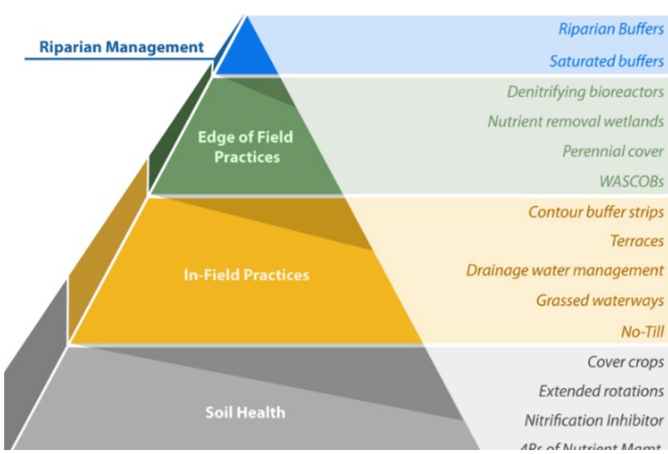

Figure 6-1. Agricultural Conservation Pyramid (adapted from Tomer et al. 2013).

involve agricultural land retirement and conversion to conservation. They are typically larger, more costly practices but can involve nutrient and sediment removal for large drainage areas. At the top of the conservation pyramid are riparian area practices that can be considered a last defense in keeping nutrients and sediment out of the stream. In addition to agricultural conservation practices, various strategies are available for treating stormwater in developed areas. These practices traditionally rely on impounding water to allow suspended materials within the stormwater to settle out, through biological processes that use nutrients or through infiltrating stormwater into the ground.

6.2.1. Soil Health Practices

Starting at the base of the conservation pyramid, the following practices reduce nutrient and sediment runoff from fields while also building soil health. These conservation practices lead to an increase in soil organic matter, improved soil texture and greater microbial activity. As a result, healthy soils can provide higher water and nutrient holding capacity and increased infiltration rates. They can also contribute to higher crop productivity and provide increased carbon sequestration. Soil health improvement also has important benefits for flood risk reduction, since according to the Natural Resources Conservation Service (USDA-NRCS 2013), one percent of organic matter in the top six inches of soil holds approximately 27,000 gallons of water per acre. Soil health practices can be implemented on areas of row crop production throughout the subwatershed regardless of topographic setting. The following are examples of practices that improve soil health. More detailed information on each of these practices can be found in Appendix D. **Bolded practices provide flood reduction benefits.**

- **Cover Crops**
- **Extended Crop Rotations**
- **No-till/Reduced Tillage**
- Nitrification Inhibitors
- 4Rs of Nutrient Management

6.2.2. In-field Conservation Practices

The following conservation practices are categorized as in-field management practice because they are implemented directly within the actively farmed area of a field. These practices have benefits for both water quality improvement as well as flood mitigation, since the practices help to slow down runoff rates while also filtering out pollutants. The following are examples of in-field conservation practices. More detailed information on each of these practices can be found in the Appendix D.

- Contour Buffer Strips
- Terraces
- Drainage Water Management
- Grassed Waterways
- Prairie Strips
- Denitrifying Bioreactors

6.2.3. Edge of Field Conservation Practices

The following conservation practices are categorized as edge of field practices due to their implementation immediately adjacent to the actively farmed field. Note that conversion to perennial cover is included in this group; the rationale being that since the converted area would no longer be an actively farmed area, it would essentially have been converted to a field edge. The following are examples of edge of field practices. More detailed information on each of these practices can be found in Appendix D. **Bolded practices provide flood reduction benefits.**

- **Nutrient Removal Wetlands**
- **Perennial Cover**
- **Water & Sediment Control Basins (WASCOBS)**

6.2.4. Riparian Area Management

The final tier of the conservation pyramid consists of management practices and projects within the areas adjacent to existing waterways. These practices are commonly referred to as riparian area conservation practices. More detailed information on each of these practices can be found in Appendix D.

- Riparian Buffers
- Saturated Buffers

6.3. Urban Stormwater Management Strategies

Several strategies are available for addressing pollutant loading from urban areas. These strategies, collectively referred to as stormwater management, address pollution generated in developed settings that include large proportions of impervious surfaces. These surfaces (buildings, roadways, parking lots, etc.) accumulate pollutants over time which are then washed off to surface waters during rainfalls and spring snowmelt. Typical pollutants of concern in developed areas are phosphorus and sediment. Urban stormwater management practices can be grouped as; traditional stormwater storage practices, low impact development (LID) practices and programmatic approaches.

Stormwater pipe, (Photo Credit: EOR)

6.3.1. Low Impact Development Practices

The urban conservation practices described in this section adopt the low impact development (LID) approach to stormwater management. Use of LID practices should be encouraged in new development projects, retrofit projects and public works improvements such as road reconstruction projects. LID practices are an effective means to achieve surface water protection, stormwater volume control, and infiltration or groundwater recharge. Various LID practices are described below, including the typical land use settings in which they are applicable and the mechanisms used to treat runoff. LID approaches are preferred over traditional stormwater management techniques because they provide a wider range of benefits for the community and environment. They increase resiliency in the landscape and typically emphasize infiltrating stormwater runoff which reduces volumes. **Bolded practices provide flood reduction benefits.**

- **Bioretention Basins**
- **Bioswale**
- **Box Planter**
- **Green Roof**
- **Permeable Pavement**
- Naturalized Drainage Ways
- **Rainwater/Stormwater Harvesting for Reuse**
- **Rain Barrels**
- **Rain Gardens**
- **Tree Trenches**
- **Conversion of Turf Grass to Native Prairie**
- **Conversion of Impervious Surface to Native Prairie**
- Enhanced Treatment using Sand Filters

6.3.2. Stormwater Storage Practices

Traditionally, the approach for treating urban stormwater focused on practices that slowed the rate of stormwater discharge as a way to reduce destructive velocities and to manage flood level. The need for storage and moderating flow rates is necessitated because of the degree of impervious surfaces in urban areas that do not allow for rainfall to soak into the ground and, therefore, lead to an increase in flow rates and volumes. The design of large storage areas that provide runoff control evolved to include water quality functionality. Water quality improvement in these practices comes when stormwater is allowed to pond for an adequate time to allow for suspended materials to settle out and become entrapped within the ponds. **Bolded practices provide flood reduction benefits.**

- Detention Basins
- **Retention Basins**
- **Underground Storage**

6.4. Strategies to Address Bacteria

Developing an implementation plan for reducing bacteria concentrations and meeting water quality standards should begin with the most cost effective and efficient methods. This section describes the steps to identify sources and reduce loading by source control and the implementation of best management practices (BMPs). "Bacteria" is a general term used to describe fecal coliform or *Escherichia coli (E. coli)* bacteria, both of which are an indicator for the potential presence of pathogens that may be harmful to human health. When addressing bacteria sources, priority should be placed on first reducing human source contributions since these sources are more likely to contain pathogens that are harmful to human health. General strategies to address bacteria include:

- Bacteria Source Identification and Mapping
- Ensuring state laws and local ordinances are up-to-date and enforced
- Collection of pet waste
- Bans on wildlife feeding
- Monitoring and Detection

6.4.1. Bacteria Source Control Strategies

The most effective method to reduce loads and meet long-term water quality goals is to address the sources that directly contribute bacteria to waterbodies. Source controls are best management practices that focus on limiting the introduction of bacteria into the landscape where it could be transported to waterbodies. Incorporating source controls into local ordinances is a very effective method to reduce release of bacteria into the watershed. Source control activities that reduce bacteria releases from direct sources include:

- WWTP upgrades
- Improvements to septic systems
- Livestock Exclusion from Surface Waterbodies
- Manure Management
- Pasture Management
- Confined Feeding Operations Controls
- Routine Maintenance of Onsite Wastewater Treatment System
- Pet Waste Collection
- Wildlife Feeding Bans
- Urban Green Infrastructure Practices
- Reduce Dry-weather Flows in Urban Stormwater Pipes

More detailed information on each of these practices can be found in Appendix D.

6.4.2. Bacteria Treatment Strategies

Source control and the methods mentioned above should be the first step of reducing bacterial loading as these methods are the most cost efficient and effective. Source control, however, is not always feasible and there are a number of Best Management Practices BMPs that can reduce bacteria-laden runoff to waterbodies. Based on available data, some conventional stormwater BMPs reduce bacterial loads to receiving waters by (a) treating stormwater and removing bacteria from discharged water, or (b) reducing total water discharge along with the associated bacterial load. In some cases, multiple BMPs, including pretreatment, may be necessary to achieve significant reductions in bacteria concentrations. Additionally, many BMPs are designed to reduce the loading of several pollutants at the same time.

Prior to evaluating BMP performance or selecting BMP strategies to target bacteria, it is important to understand basic fate and transport mechanisms as well as treatment processes anticipated to be effective for removing or inactivating bacteria. Inactivating bacteria refers to a natural process in which bacteria die-off or fail to reproduce due to existing environmental factors such as pH. Bacteria can thus be controlled without being removed. However, bacteria population can also increase without further bacteria loading if environmental conditions are conducive to population growth within the conveyance or receiving waters.

Properly designed BMPs that reduce the total volume of agricultural or urban runoff (e.g., infiltration BMPs) to receiving waters can effectively reduce the bacteria load by an amount equivalent to that contained in the reduced volume. They may also reduce the frequency of bacterial discharges to receiving waters if volume reductions are sufficient to retain runoff from most events.

BMPs that filter and/or reduce the rate or frequency of runoff (e.g., filtration or other BMPs that do not reduce volumes but do provide treatment) may reduce bacteria concentrations in this runoff and thereby reduce loading to receiving waters. Filtration and similar BMPs should, however, be carefully planned and investigated before implementation as they are sometimes ineffective and may even result in increased bacteria concentrations in discharges.

Overall, data on BMP effectiveness is limited and, with the exception of properly designed infiltration BMPs, broadly applicable conclusions cannot be drawn. Additional studies are needed for all BMP types to increase the confidence of performance estimates with regard to bacteria.

The measures and BMPs described below are not the only available methods for reducing bacteria, but are the actions most recommended and applicable to the watershed. As mentioned above, efforts to reduce and eliminate bacteria sources should be conducted first, when possible.

- Infiltration/Bio-infiltration
- Filtration/Bio-filtration
- Filter strips/buffers
- Stormwater ponds and constructed wetlands
- Feedlot runoff control

6.5. Use of Native Vegetation

Native vegetation should be used in all conservation practices where re-vegetation is required Visit the Tallgrass Prairie Center website (www.tallgrassprairiecenter.org) for complete information about the benefits of native vegetation. The following are examples of conservation practices where native vegetation would be most beneficial.

- Perennial cover: A diverse prairie planting is the most beneficial and resilient permanent cover for erodible or non-productive land and buffers strips.
- In-field prairie strips: Science-based Trails of Rowcrops Integrated with Prairie Strips (STRIPS) are relatively small (30’ minimum width) contour buffer strips strategically placed in crop fields. These strips can yield disproportionate benefits for soil and water: According to data from the Iowa Nutrient Reduction Strategy (INRS), water quality has been shown to improve 66-90%, while streamflow is reduced as much as 37%. Visit ISU’s STRIPS website for detailed information (www.nrem.iastate.edu/research/STRIPS/).

- Permanent cover for conservation practices: Ponds, basins and other conservation structures require effective, practical vegetation. In most cases, prairie vegetation may be appropriate. Native vegetation should always be a component of constructed wetlands and considered for oxbow/floodplain restoration.

Diverse, deep-rooted prairie grasses and wildflowers provide durable, perennial cover that protects soil, enhances water quality, and mitigates flooding by slowing runoff, increasing infiltration, reducing soil erosion, and capturing nutrients. This is also a practice that provides an opportunity for pollinator plants, which may be an avenue for expanding potential partners and funding opportunities.

Prairie vegetation reduces and slows runoff and increases infiltration:

- Dense foliage and robust stems reduce runoff rates during heavy rain events and can result in 1.6 times less runoff overall. (Schulte et al. 2017).
- Standing foliage and residue intercepts up to 70% of rainfall (Brye et al. 2000).
- Decaying foliage and extensive roots add organic matter to the soil, increasing infiltration and water-holding capacity. Stored water is gradually released.
- Deep perennial roots lower the water table, reducing underground drainage to streams.
- Diverse vegetation spreads water demand across three seasons. Some prairie plants actively take up water in the spring; others in the summer and fall.
- Prairie vegetation reduces soil erosion and captures nutrients:
- Prairie vegetation reduces soil erosion and surface water sedimentation by slowing runoff and increasing infiltration.
- Large prairie roots trap and take up excess nitrogen making its way to streams and lakes in water leaching through the soil. Nitrogen loss is reduced by 84%. (Zhou et al. 2014).
- By decreasing erosion, native vegetation retains excess phosphorus, which enters water bodies attached to soil particles, on site. Phosphorus loss is reduced by up to 90%. (Zhou et al. 2014).


Native prairie vegetation, (Photo Credit: EOR)

6.6. Flood Mitigation and Water Quality Improvement Implementation Recommendations

Implementation of conservation practices in High Priority subwatersheds is phased in over the first seven years of the plan. Implementation of conservation practices in Priority subwatersheds begins in year eight and is phased in over the remaining thirteen years of the 20 year plan period. **Figure 6-2** shows how the conservation practices are phased in for the two levels of priority subwatersheds. It is important to note that this distribution of costs is for planning purposes, to show the magnitude of effort needed to reach the nutrient reduction strategy goals. In practice, it is likely that expenses would be concentrated within a given subwatershed. It should also be noted that one of the High Priority subwatersheds, Devils Run – Wolf Creek, is eligible for funding through the Iowa Watershed Approach HUD Grant.

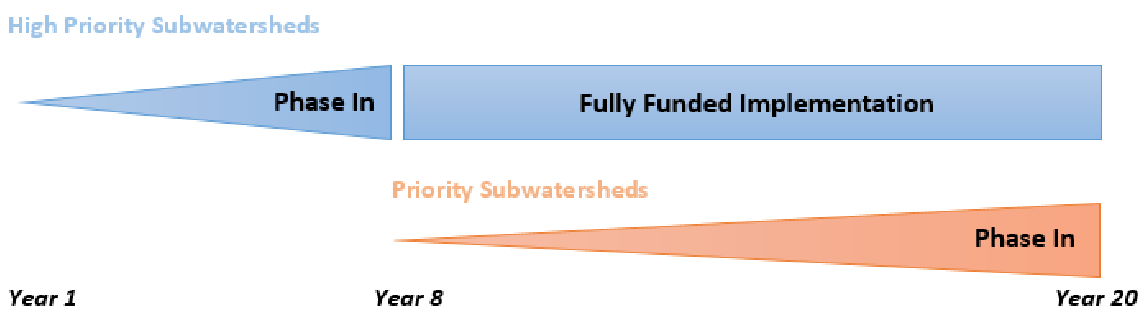

Figure 6-2. Phase In of Funding for High Priority and Priority Subwatersheds

Completion of implementation in the High Priority and Priority subwatersheds will accomplish the nutrient reduction goals established in this plan for approximately a third of the HUC-12 subwatersheds in the MCW. By 2039, the annual spending necessary to complete implementation in those watersheds will be reached (approximately $20 million). This annual spending will need to continue until all conservation practices are implemented. Additionally, further treatment will be needed in the remainder of the subwatersheds (not listed as High Priority or Priority) in order to meet the ultimate goals of MCWMP. After 20 years, most early practices will have exhausted their useful life and will need to be rebuilt, which adds to ongoing costs. This just means that once a practice is implemented, continued maintenance and reconstruction is necessary to maintain the benefits they provide to the watershed. The estimated annual costs associated with BMP implementation staging within the High Priority and Priority watersheds is summarized in **Table 6-2.** The total cost over the 20-year period, following this timeline and phase-in described in **Figure 6-2**, sums up to approximately $213 million. Detailed annual costs for the subwatershed conservation plan are shown in Appendix E.

Table 6-2. Subwatershed Conservation Practices Plan.

Priority	HUC 12 Name	Annual Investments			Annual Savings	Net Annual Implementation Cost
		Total	Agricultural Practices	Urban Practices	Agricultural Practices	
		($/yr)	($/yr)	($/yr)	($/yr)	($/yr)
High	Black Hawk Park-Cedar River	$2,851,000	$1,250,000	$1,601,000	-$478,000	$2,373,000
High	Dry Run	$1,490,000	$783,000	$707,000	-$349,000	$1,141,000
High	Lime Creek	$1,169,000	$1,169,000	$0	-$837,000	$332,000
High	Morgan Creek	$836,000	$623,000	$213,000	-$290,000	$546,000
High	Prescotts Creek-Black Hawk Creek	$1,966,000	$990,000	$976,000	-$378,000	$1,588,000
High	Village of Reinbeck-Black Hawk Creek	$792,000	$792,000	$0	-$494,000	$298,000
High	Wolf Creek	$1,336,000	$1,167,000	$169,000	-$351,000	$985,000
Priority	Devils Run-Wolf Creek	$2,441,000	$2,441,000	$0	-$1,103,000	$1,338,000
Priority	East Otter Creek-Otter Creek	$1,177,000	$1,108,000	$69,000	-$564,000	$613,000
Priority	Hammers Creek-Beaver Creek	$1,412,000	$1,412,000	$0	-$821,000	$591,000
Priority	Headwaters Beaver Creek	$656,000	$656,000	$0	-$492,000	$164,000
Priority	Headwaters Black Hawk Creek	$843,000	$843,000	$0	-$587,000	$256,000
Priority	Headwaters North Fork Black Hawk Creek	$1,045,000	$1,045,000	$0	-$672,000	$373,000
Priority	Holland Creek	$713,000	$713,000	$0	-$439,000	$274,000
Priority	Max Creek-Beaver Creek	$705,000	$705,000	$0	-$369,000	$336,000
Priority	Miller Creek	$1,188,000	$1,171,000	$17,000	-$75,000	$1,113,000
Priority	Minnehaha Creek-Black Hawk Creek	$1,681,000	$1,681,000	$0	-$1,099,000	$582,000
Priority	Mosquito Creek	$766,000	$766,000	$0	-$502,000	$264,000
Priority	North Fork Black Hawk Creek	$1,240,000	$1,240,000	$0	-$812,000	$428,000
Priority	Silver Creek-Cedar River	$3,555,000	$1,630,000	$1,925,000	-$307,000	$3,248,000
Priority	Sink Creek-Cedar River	$2,461,000	$996,000	$1,465,000	-$305,000	$2,156,000
Priority	Waterloo Municipal Airport	$821,000	$637,000	$184,000	-$374,000	$447,000
Priority	Wilson Creek-Black Hawk Creek	$1,232,000	$997,000	$235,000	-$558,000	$674,000
	Total	**$32,376,000**	**$24,815,000**	**$7,561,000**	**-$12,256,000**	**$20,120,000**

In addition to providing pollutant reductions, many of the proposed conservation practices provide flood reduction benefits. Flood reduction benefits were estimated using the analysis performed by IIHR, which evaluated the flood reduction benefits of converting cropland to native prairie, improved soil health, and distributed storage (**Table 6-3**). The analysis assumes all areas upstream of the reporting location adopt the same level of BMP implementation. For reporting locations on the Cedar River, this includes implementation in the Upper Cedar watershed.

Table 6-3 Annual Flood Reduction Savings from Conservation Practices in all areas upstream of reporting location.

Priority	HUC 12 Name	Annual Flood Reduction Savings ($/yr)
High	Black Hawk Park-Cedar River	$550,000.00
High	Dry Run	$110,000.00
High	Lime Creek	$12,000.00
High	Morgan Creek	$0.00
High	Prescotts Creek-Black Hawk Creek	$4,112,000.00
High	Village of Reinbeck-Black Hawk Creek	$130,000.00
High	Wolf Creek	$447,000.00
Priority	Devils Run-Wolf Creek	$121,000.00
Priority	East Otter Creek-Otter Creek	$90,000.00
Priority	Hammers Creek-Beaver Creek	$845,000.00
Priority	Headwaters Beaver Creek	$3,000.00
Priority	Headwaters Black Hawk Creek	$2,000.00
Priority	Headwaters North Fork Black Hawk Creek	$38,000.00
Priority	Holland Creek	$4,000.00
Priority	Max Creek-Beaver Creek	$62,000.00
Priority	Miller Creek	$29,000.00
Priority	Minnehaha Creek-Black Hawk Creek	$28,000.00
Priority	Mosquito Creek	$4,000.00
Priority	North Fork Black Hawk Creek	$48,000.00
Priority	Silver Creek-Cedar River	$1,103,000.00
Priority	Sink Creek-Cedar River	$746,000.00
Priority	Waterloo Municipal Airport	$48,000.00
Priority	Wilson Creek-Black Hawk Creek	$54,000.00

Bacteria Reduction Implementation Activity

The Cedar River Watershed, Iowa TMDL for Indicator Bacteria, *Escherichia Coli (E. Coli*) ("Cedar River Bacteria TMDL") identified four highly effective management practices for improving water quality as part of an Informational Implementation Plan. Paraphrased and amended here, they are:

1. All WWTP effluent and rivers entering Iowa will have bacteria concentrations less than or equal to the Iowa WQS.
2. Unpermitted feedlots will control/capture the first one-half inch of rain.
3. Cropland bacteria loading will be reduced by 40 percent through proper timing and application of animal waste.
4. (a) Cattle in streams will be reduced by 40 percent and (b) leaking septic systems will be eliminated.

Runoff from open feedlots (#2) was identified as the predominant (>80%) stressor in the watershed. Implementation of #3 and #4 was predicted to provide additional benefits; however, the reductions in bacteria concentrations were not significant as #1 and #2.

Those recommendations targeting nonpoint sources (#2, #3, and #4) are broadly being addressed elsewhere. Recommendations #2 and #4(b) are addressed by the recommended Policy Strategies identified in the MCWMP, and recommendation #3 is addressed by the Subwatershed Conservation Practices Plan.

In order to address #4(a), a supplementary exercise was performed as part of the MCWMP. The exercise identified open feedlots adjacent to streams to estimate the total mileage of potentially vulnerable stream, and the linear cost for fencing these lengths, shown in **Table 6-4**. Refer to **Appendix E** for a detailed explanation of analysis.

Table 6-4. Stream fencing cost assumptions.

HUC-12 Name	Miles of Stream	Miles of Fencing	Estimated Project Cost using Multistrand Barbed-Wire Fencing (40% Adoption)
Bear Creek	1.62	3.23	$11,273
Bear Creek-Cedar River	1.83	3.65	$12,731
Devils Run-Wolf Creek	1.35	2.69	$9,376
Drainage Ditch 148-Beaver Creek	5.30	10.61	$36,957
Fourmile Creek	0.02	0.03	$118
Gran Creek-Beaver Creek	4.69	9.38	$32,699
Headwaters Black Hawk Creek	2.46	4.92	$17,144
Lime Creek	1.96	3.91	$13,636
Little Bear Creek	1.97	3.95	$13,765
Minnehaha Creek-Black Hawk Creek	2.43	4.87	$16,964
Mud Creek-Cedar River	2.61	5.22	$18,204
North Fork Black Hawk Creek	3.57	7.14	$24,880
Rock Creek-Cedar River	1.61	3.23	$11,245
Village of Conrad-Wolf Creek	2.83	5.66	$19,714
Weasel Creek-Prairie Creek	1.31	2.62	$9,145
		Total Cost	**$247,849**

Additional cost for alternative watering supplies estimated at $4,000 per system with sixteen systems in the watershed that likely have access to a stream (per the analysis performed) were included in the implementation schedule.

7. FUNDING & ORGANIZATIONAL STRATEGIES

A key element of any organization is consideration of its funding options and organizational structure. The summary provided reflects the on-going discussions on the topic from goal setting workshops, where some specific examples of funding levels and allocation formulas were discussed.

7.1. Background

The Middle Cedar Watershed Management Authority (MCWMA) was formed in 2016 under the 2010 legislation to address the myriad water-related issues such as water quality impacts and flooding. The first Watershed Management Authorities (WMAs) were formed in 2012, and there are several additions to the list each year. The MCWMA was formed to coordinate new initiatives to address water management issues, including both water quality and water quantity.

The enabling legislation provides that WMAs coordinate in a cooperative fashion to oversee watershed planning and implementation. The legislation does not provide a fixed or mandated funding method for the organizations to implement their work. As with many of the new WMAs in the state, the MCWMA has relied largely on grant funding for the initial startup, the development of the Middle Cedar Watershed Management Plan (MCWMP) and structure, and the initial implementation work. Therefore, addressing the future funding question is an important part of the watershed planning process.

In addition to the formal structure of the MCWMA and its board, there should also be other elements and guiding principles that will strengthen the effectiveness and legitimacy of the MCWMA, like any public organization. These elements include:

- Open, frequent communications and strong partnership with local stakeholders
- Well-developed watershed plan grounded in local setting & priorities
- Outreach
- Local issues identification
- Measurable goals
- Meaningful implementation plan
- Evaluation of progress to goals
- Stable funding to support implementation
- Updating process to revise/adapt plans and priorities for changing conditions

Using an open process and these basic elements, the public can trust the process and see the need and value for sound water management, which translates into long-term support for the mission.

7.2. Need for Organizational Capacity

Increasing flood severity and frequency have drawn increased attention to water management. Water quality problems are affecting both rural and urban residents of Iowa as well as downstream communities in other States. Current government and organizational structures struggle to address the larger root causes of these problems since watershed boundaries do not follow political (city or county) boundaries.

Coordination of water management activities of various formats discussed above typically relies on some staff resources, whether through contracting, consulting, or employment, that will focus attention on implementing the organization’s plan. The staff resources, in whatever form it takes, are responsible for interpreting management plans, implementing priorities, and pursuing opportunities, outside funding, and projects. Additional opportunities can come in the form of grants, new programs, partnerships, education, etc.

In order to carry out the mission of the organization as outlined in the MCWMP, many problems will need to be addressed and opportunities capitalized on, all of which requires someone's time and attention. Key tasks that will need attention by the MCWMA include:

- Outreach to agricultural producers
- Communication hub with local partners – coordinating center for requests and tracking accomplishments
- Educational materials – assembly and distribution
- Identifying needed studies to better focus implementation
- Finding grants and preparing grant applications
- Grant administration and reporting
- Managing projects led by the MCWMA
- Tracking pollutant reductions and success of project built in the watershed
- Monitoring and evaluation

To implement these various tasks, there needs to be someone that is responsible for them. And in order to find and retain qualified staff to make implementation happen, there needs to be stable funding to support staff.

7.3. Organizational Strategies

The MCWMA is a relatively new organization. In fact, the WMA structure is relatively new in Iowa, and there is not as much institutional track record as other organizations may have. The MCWMA organization will naturally evolve over time, and with time it will have stronger institutional processes and structures. There are currently many important and urgent management challenges for which it was formed. In the initial years of this organization, there needs to be a focus on not only implementing projects on the ground, for which funding is already in place, but also for building up the organization's processes and structure. The MCWMA needs to develop its internal resources and processes and should work toward something akin to an operations plan for the staff and organization. Some elements that need attention in the first one to two years are:

- Staff requirements
- Base funding level and method
- Strong board leadership
- Organizational plan
- Training for board officials and staff
    - Public board orientation – best practices for division of work between board policy and staff implementation.
    - Encourage WMAs of Iowa to develop this training/orientation workshop to provide guidance regarding manager and board member duties and good practices of a board and organization.

Addressing funding and staffing levels are imperative first steps that should be accomplished in the first year to provide a segue for acting on the latter items identified above. Without a dedicated focus and allocation of resources assigned to the mission of the MCWMA, it will be difficult to accomplish much, if anything, of the goals identified in this plan.

A key measure of an organization's success is being able to implement practices on the ground. A challenge in this watershed is the scale and need to implement changes on private agricultural lands. Despite the availability of cost-share to help pay for practices, there still appears to be a large hurdle of getting landowners to agree to implement the practices on their land. Therefore, having strong team that is able to achieve success with implementation requires that the staff know how to deliver a message to agricultural producers in a manner that inspires them to pursue the cost share and/or projects being promoted. Some creative and innovative engagement approaches are needed for this. Engagement strategies are outlined in the ISU Extension Education and Outreach Plan in Appendix J.

7.4. Funding Strategies

There are a variety of funding options available to the MCWMA. Several of these options are listed in **Table 7-1**. Each funding option shown includes an overview of upfront costs, risks, advantages, disadvantages, duration of funding, and the ongoing commitments that will be required. If pursuing alternative funding that does not require levies (by others, at this point), it is important to understand how each method will impact the MCWMA's operating needs and the capacity for implementation.

In addition to considering these funding options, whether via local entities or changes to the watershed legislation, it is recommended that the MCWMA continue working with local watershed management partners within the watershed to collaborate on implementation efforts. These local organizations have existing funding sources that can be used to implement some of the practices that have been identified in this plan. Within the watershed there are four known subwatersheds with watershed management plans that have been identified as priority or high priority watersheds in. These include:

- Dry Run Creek watershed (High Priority)
- Lime Creek watershed (High Priority)
- Holland Creek watershed (Priority)
- Wolf Creek watershed (High Priority) as part of the Benton/Tama watershed plan

As an example of potential opportunities, the Benton/Tama Nutrient Reduction Demonstration Project is providing cost-share incentives for landowners implementing nitrification inhibitors, changing tillage practices, adding prairie strips and structural practices, or implementing cover crops. More information can be found at https://www.bentontamanutrientreduction.org/practices--cost-share-info.html. Additionally, the Grundy SWCD secured funding from the Iowa Department of Agriculture and Land Stewardship (IDALS) as part of their Water Quality Initiative Program. The goal of the project is to expand collaboration with landowners to reduce nutrient pollution from nonpoint sources in the Black Hawk Creek Watershed. More information can be found at: https://img1.wsimg.com/blobby/go/276457ca-a1f8-4e31-a456-fe802bf2b691/downloads/Newsletter_Spring2019%20update.pdf?ver=1560867930947.

Additional funding resources are included in Appendix G.

Next Steps to Establish Base Funding

The MCWMA Board discussed base-line funding levels and came to the conclusion that an annual budget of $150,000 would be appropriate to fund a watershed coordinator, an administrative position, to help with grant writing, and miscellaneous organizational costs.

This MCWMP identifies numerous goals for watershed-scale management activities. Achieving these goals will require staff and a strong organizational structure. A base level of funding is necessary for salary, implementation activities, and match for future grants and public-private partnership opportunities.

The following next steps are a suggested path forward to form a stable and sustainable MCWMA organization.

1. Discuss & select a draft/potential funding allocation methodology
    a. Develop example funding scenarios for MCWMA using different methods
    b. Leadership group reviews options and suggests top two to three methods
    c. Entire MCMWA board reviews and selects preferred draft method
2. Develop list of the key benefits and accomplishments the MCWMA will provide over next 5-10 years to build the case for member financial support of the MCWMA
3. Attend at least one meeting of the elected officials (City Council, Board of Supervisors, Soil & Water Conservation District Commissioners) of each member entity to provide background on the MCWMA, explain the proposed funding mechanism, and answer questions.
4. Select final funding allocation and levels, based on feedback from member the organizations
    a. MCWMA Leadership group recommends preferred option
    b. Full MCWMA Board approves recommended option
5. MCWMA board members go back to their respective member boards with action request for ratification (if needed).

Stakeholder engagement, (Photo Credit: IVRCD)

Table 7-1. Funding Options for the MCWMA.

Current Opportunities for Funding						
Funding Option	**Upfront Cost**	**Risks**	**Advantages**	**Disadvantages**	**Duration of funding**	**Ongoing commitment**
Grant	Cost of application development and grant reporting	1. May not be awarded 2. Not long-term…must choose investments in projects/programs year-by-year	1. Outside money 2. Recirculation of taxes (if from gov't) 3. Can be used for specific, capital projects	1. Restricted spending uses 2. May require local match 3. Not stable long-term	1-2 years per grant (sometimes longer)	To be sustainable, 50-200 hours per year for developing applications
Private Public Partnerships	Time to meet with potential sponsors, develop system/framework	1. At the discretion/priorities of private businesses 2. Funding could go down during economic downturns 3. Less precedent so uncertainty of setting up new system	Leverage outside money, with some connection to the area	1. Restricted spending uses 2. may be investment instead of philanthropic	uncertain	Providing updates and accountability to sponsor(s)
Possible Opportunities for Funding, with MCWMA Board Approval						
Funding Option	**Upfront Cost**	**Risks**	**Advantages**	**Disadvantages**	**Duration of funding**	**Ongoing commitment**
MCWMA self-funding/partner member funding	Contribution of annual amount determined by land cover, population, or other demographics	Some communities may be hesitant about local funding and fairness of method chosen	1. Can structure for fair contribution of funds from each community 2. Local control 3. Stable, sustainable funding model	1. Potential to create disputes about contribution amounts 2. May need to create binding contract	perpetual	Annual contribution from each community; time could depend on mechanism (30-50 hours per year)
Water trust fund	High - may need investments from large organizations like The Nature Conservancy, funds partner MCWMA member funding method could go straight to this fund	1. Relies on stock market 2. may not have enough funding sources available	1. Long-term sustainability of organization 2. could be funded by tax income (if implemented) from individual communities	1. High upfront cost 2. stocks can be unreliable	perpetual	Financial manager to invest in stocks - review investments (100 hours per year)
Wetland/Stream Mitigation Banking	None- tap into already existing banks	Funding comes from NRCS - may not be able to use as cost share match	1. Easement on land & other costs (i.e. engineering and construction) are covered by bank 2. can be used in conjunction with 90% cost share & later as sole source of funding for wetland/stream mitigation practice implementation	1. Must be prior-converted farmland 2. Must be NRCS regulated (no navigable waters) 3. limited to stream and wetland mitigation projects	For as long as market exists for purchasing credits	Farmer engagement (60-150 hours per year)
Future Opportunities for Funding, with State-Level Policy Change						
Funding Option	**Upfront Cost**	**Risks**	**Advantages**	**Disadvantages**	**Duration of funding**	**Ongoing commitment**
Sales Tax on agr. products, e.g., fertilizers	Time and efforts for research and the setup of the ordinance itself	1. May face opposition (wasted time?) 2. Could initiate backlash from farmers - reducing engagement 3. Legislative authority unknown	1. Reliable, steady source of income 2. Directly ties to pollution source, and depending on tax amount may be indirect incentive to reduce use of fertilizers	1. Political resistance 2. Logistical unknowns (may need legislation for direct use of MCWMA)	perpetual	Managing income (40-80 hours per year)
Tourism/recreation taxes and fees	Time and efforts for research and the setup of the ordinance itself	1. May not be implemented (wasted time?) 2. Local govts could question if it impacts tourism	1. Reliable, steady source of income 2. As tourism increases - more funding can go into water quality - potentially increasing tourism attraction (positive feedback loop)	1. Political resistance 2. Local funding source (not directly for use of MCWMA) 3. Only tax/fee for those using recreational areas - not necessarily those harming	perpetual	Managing income, setting fees (40-100 hours per year)

State Sales Tax (3/8 cent)	Time and efforts for meeting with representatives to encourage implementing this approved tax - must ensure they include a funding allocation to WMA's in Iowa	Past efforts have not been successful - may be wasted time	1. Reliable, steady source of income 2. Voter-approved/popular to protect water	1. state-level political resistance 2. state source - must share allocations with all WMAs	Dependent upon State's annual decisions about funding allocation	Managing income (20-40 hours per year)
Water District Levy	Setting up watershed districts, developing policy changes	May need enabling legislation	1. Attaching funding to area/watershed of improvement 2. reliable, steady source of income	1. Large amount of time/effort needed to setup 2. Political resistance 3. may require significant policy changes to allow for water(shed) districts & tax levee	perpetual	Organizational governing (20-80 hours per year)
Possible Mechanisms for Individual Member Entities to Provide Funding to the MCWMA						
Funding Option	**Upfront Cost**	**Risks**	**Advantages**	**Disadvantages**	**Duration of funding**	**Ongoing commitment**
Loan/Bond such as Clean Water SRF and associated Sponsored Projects	Cost of application development/setup	1. May not be awarded/cost effective 2. may not have money to pay back 3. may incur interest	1. No need for upfront money 2. gives time for finding more sustainable funding resources	1. Restricted spending uses 2. Have to pay back what has been spent and/or have local government guarantor 3. May need to identify a bonding agent	3-20 years for loan 10-40 years for bond	To be sustainable, 50-100 hours per year for developing application
Enterprise fund revenues	Set up separate accounting/fund system w/in organization using standard accounting practices.	Becomes insolvent if needed steady revenue source (e.g., fees system like in utilities) does not meet the obligations; an issue of being self-sustaining.	Typical municipal/county way to structure utility and funds.	Assumes a utility rate payer base is established, which is not the case here.	perpetual	Administrative support to track funds separately for accounting purposes.
Stormwater utility fee	Time and efforts to setup of the utility itself (GIS, Policy)	If perceived as tax (which it is not) could face opposition (wasted time?)	1. Reliable, steady source of income 2. Good precedent for utilities (water, sewer, electric, etc.) 3. Can build in incentives (lower discharge = lower fee)	1. Political resistance 2. Utilities less common in rural areas	perpetual	Managing collection and appeals (40-150 hours per year)
Property tax exemptions and abatements and/or Conservation tax credits	Time and efforts for research and the setup of the ordinance itself	Need to get local jurisdictions (e.g., cities, counties) on board first	Incentive for landowners to implement conservation practices	1. Tax exemption may not be enough to incentivize practice implementation 2. Setting up program may be time consuming 3. would need to justify reduction in tax income to gov't	Reduced taxes rather than direct funding - dependent on decision about term of program	Setting requirements, reviewing who meets requirements, enrolling landowners (100-200 hours per year)
Water Quality Trading /Nutrient Reduction Exchange	Fairly high – program setup, landowner commitments	Landowners may not pursue since local/state/federal regulations may not have created need for credit purchases	1. Provides incentive for landowners to implement conservation practices 2. Offsets cost of implementation 3. Can be turned into non-profit for MCWMA	1. Funding is not available until credits are sold 2. facilities may choose not to buy credits - loss to farmers enrolled in program	dependent upon enrollment	10-20 hours per month (may be higher or lower depending on level of enrollment) for outreach to landowners, costs of engineering and construction

8. POLICY STRATEGIES

The following recommendations are geared towards collaborating with those entities within the watershed that have existing water-related policies in place. Encouraging the regulation of additional activities that have a role in flooding and water quality degradation **are not** addressed in this plan but may need to be considered in the future.

After a thorough review of the existing policies present in the watershed, seven categories of needs associated with specific areas of concern within the watershed have been identified. These include:

- Stormwater Management – practice of redirecting runoff from streets, parking lots, and other impervious surfaces into natural buffers or detention areas in an effort to control the rate, volume and quality of runoff.
- Erosion and Sediment Control – effort to prevent erosion or sedimentation during construction activities or from activities resulting in depleted vegetation.
- Illicit Discharge – detection and elimination of unlawful discharges into storm sewers resulting in contaminated public waterways.
- Floodplain Management – reduction of flood losses and the protection of natural resources within the floodplain.
- Sanitary Sewer System – reduction of sanitary sewer overflows through improved management, operations, and maintenance of private and public sanitary sewer operations.
- Feedlot Management – reducing the presence of animal waste products in public waterways.
- Source Water Protection – protection of drinking water from contamination, including both wellhead and surface water protection.

An assessment of these categories of policies adopted by Middle Cedar Watershed Management Authority (MCWMA) members and Municipal Separate Storm Sewer System (MS4) communities within the watershed identified many inconsistencies. Such inconsistencies will potentially result in significant delays in addressing watershed-level issues. Therefore, putting time, personnel, and funding into achieving the uniform adoption of policies among watershed communities is an essential watershed management effort. It should be noted that the following recommendations are made for all communities within the watershed, regardless of whether or not they are MS4 Communities or members of the MCWMA. MS4 communities in the MCW include:

- Cedar Falls
- Cedar Rapids
- Elk Run Heights
- Evansdale
- Hiawatha
- Hudson
- Raymond
- Robins
- University of Northern Iowa
- Waterloo

8.1. Stormwater and Erosion and Sediment Control

All 10 MS4 communities in the Middle Cedar Watershed (MCW) have adopted local stormwater regulations under the NPDES permit program (see section 4.5). However, These NPDES permits are not sufficient to address the arising challenges in stormwater management and erosion and sediment control, so it is important for cities and counties to adopt or amend ordinances within their communities that enforce higher standards (see the Model Stormwater Ordinance in Appendix H).

8.2. Illicit Discharge

MS4 designated communities are required by the Iowa Department of Natural Resources (Iowa DNR) to reduce pollutants in stormwater from illicit discharges and construction sites. However, very few communities within the watershed have adopted ordinances to detect, prohibit, or regulate illicit discharges.

8.3. Floodplain Management

Iowa enforces a minimum standard for development in the floodplain and floodways, but cities and counties may extend those standards to be more stringent. Properties within the floodplain are vulnerable to devastating flood events and water exposed to floodplain development can also be vulnerable to harsh pollutants.

8.4. Sanitary Sewer

Sanitary sewers are an important component of water quality. The quality of the water can be influenced by the method of water treatment before being discharged into public waters and the amount of wastewater in relation to the capacity of sewer lines and the treatment plant. Local ordinances should be adopted to extend requirements of the Iowa DNR to ensure communities are able to properly treat and handle the wastewater within their jurisdiction. Most communities within the watershed have sanitary sewer ordinances in place.

8.5. Source Water Protection

Source water protection (SWP) includes the protection of groundwater (wellhead) and surface water. Communities can join the Iowa DNR's SWP program (see section 4.5), but because the program is not regulatory, it is recommended that communities include the development of ordinances within their SWP Plans. If a community is not developing a SWP Plan, that is a great starting point and should be a priority above ordinances.

8.6. Feedlots

Regardless of the type or size, the Iowa Department of Natural Resources regulates the planning, permitting, siting, and operation of AFOs. All AFOs must apply for a permit to establish a new operation, or to expand or modify an existing operation. Permits include conditions on various aspects of animal feeding operations, including setbacks from adjacent residential uses and wells, and properly retaining, storing, and disposing of manure. The regulations for Confinements and Open Feedlots are slightly different. Large confinements are required to develop and submit for approval a Manure Management Plan (MMP); small confinements can voluntarily adopt such plans. Manure Management Plans contain information on how manure will be stored between applications, and a plan for timing and method of manure application. Open Feedlots are subject to similar regulations on siting and construction but must develop and comply with a Nutrient Management Plan.

Legislation in the state of Iowa also prohibits local authorities from either adopting or enforcing any regulations that are not consistent with state law and regulations. Therefore, cities and counties may not develop new policies enforcing AFOs beyond what is already enforced by the state of Iowa. That being said, feedlots can be prohibited within floodplains and vigorous educational platforms can be developed to raise awareness on water quality issues correlated with AFOs.

8.7. Policy Resources

It is encouraging that a number of communities are already working to adopt and enforce policies to assist their efforts in mitigating flood damages and improving water quality. It is important, however, that all communities are taking similar steps to amend zoning, subdivision, and storm water polices/regulations to match planning objectives. It is recommended that watershed communities conduct a thorough policy and regulatory audit to distinguish between local and state roles and responsibilities. With this information, the MCWMA should then work with landowners on pre-disaster mitigation measures, such as purchasing easements on farmland or providing incentives to landowners (see the *Flood Resilience Checklist* from EPA in Appendix C).

The following is a list of specific recommendations to advise and assist the watershed communities in adopting policies and practices that will ultimately assist in achieving the goals of this plan.

Stormwater and Erosion and Sediment Control:

- Adopt a Stormwater Utility fee. This strategy charges landowners based on the area of impervious surfaces on their property. This fee can be used as a source of funding for stormwater systems and BMPs.
- Create pollution prevention requirements for construction permits.
- Make improvements on points of emphasis for sediment and erosion control.
- Review and coordinate the implementation of management techniques to slow, spread, and infiltrate floodwater.
- Conduct routine long-term monitoring and maintenance of BMPs.

Illicit Discharge:

- Discourage the practice of dumping illicit discharges into public water ways and storm sewers

Floodplain Management:

- Floodplain ordinances (better than state requirements).
    - Reserve open spaces for floodplains and stream buffers.
    - Designate safer areas for development, areas less vulnerable to future flooding.
- Limitations on construction activities within the 100-year and 500-year floodplain to prevent property damage and losses to flooding.
- BMPs in ditch maintenance projects and riparian areas – as a supplement to conservation efforts.

- Education on risks and best practices associated with floodplain development.
- Guidelines for Animal Feeding Operations (AFOs).

Sanitary Sewer:

- Quantity limits and quality standards for businesses and industries discharging wastewater loads.
- Incentives for reduced pollutant loads from businesses and industries.
- Improve the quality of discharges from small municipal wastewater facilities up to the level of modern wastewater standards.
- Enact and enforce sewage land application ordinances.
- The Cedar River Watershed TMDL for indicator bacteria recommends that all leaking septic systems in the watershed be eliminated.

Source Water Protection:

- Well-head protection.
  - Buffer zones for specific land uses/activities (i.e. BMP implementation for construction activities).
  - Routine monitoring of water quality.
- Surface water protection - include everything under well-head protection.

Feedlots:

- Discourage CAFOs in the floodplain.
- Evaluate and improve county feedlot inspections and review to ensure compliance with state law especially with new or expanding feedlot operations.
- Clearly defined resources and required buffers.
  - Designated areas – 200 feet.
  - High quality resources – 800 feet.
  - Residence (not owned by farmer), church, school, public areas – 750 feet.
- Incentives for adopting environmentally sound practices.
- Public outreach and education informing public of rules and regulations on AFOs.
- Work with landowners to exclude animals from or limit access to streams and rivers using fences or other exclusion methods.

The Cedar River Watershed TMDL for indicator bacteria includes the following recommended strategy for reducing bacteria loading to the Cedar River.

- Unpermitted feedlots will control/capture the first one-half inch of rain. The average storm event in this part of the country is typically between 0.5 and 0.6 inch. Controlling runoff from the average storm can easily equate to capturing 70-90 percent of the *Escherichia coli (E. coli)* loading.
  - Strict requirements for stormwater BMPs in and around drainage points.
  - Monitoring and maintenance of BMPs.

8.8. Policy Implementation Actions

The primary objective of the actions described below is to educate communities on opportunities and the benefits of ordinance adoption and to provide technical assistance to communities/counties who wish to adopt/amend new ordinances.

1. Determine what ordinances currently exist in the MCW.
    a. A sub-committee of MCWMA Board members will work with MCWMA member entities to compile information about which watershed-related ordinances currently exist.
    b. Invite each member entity to provide an overview of their ordinances at each MCWMA meeting, as a learning opportunity.
2. Identify and assess the need for better oversight of policies and ordinances among existing communities/counties on a 5-year cycle.
    a. A sub-committee of MCWMA Board members will identify communities/counties where ordinances are lacking or additional oversight is needed. These ordinances could include illicit discharge, erosion & sediment control, and floodplain management.
    b. Provide technical assistance to communities and counties (elected officials and staff) regarding stormwater/floodplain ordinances and management.
    c. Offer presentations about stormwater management to three to five communities per year, particularly non-MS4 communities where resources are most limited.
    d. Provide resources for watershed communities related to ordinance development, such as those available through Iowa Storm Water Education Partnership.
    e. Keep detailed records of ordinance adoption and continue educational efforts.

Cattle, Van Horne, Iowa (Photo Credit: EOR)

9. EDUCATION & OUTREACH STRATEGIES

Residents across the Middle Cedar Watershed (MCW) expressed a desire for increasing the basic understanding and awareness of the watershed and its resources. In order to create an informed community, this section outlines strategies from previous plans, incorporates feedback from residents that attended HUC-12 stakeholder input sessions and three public open houses held during the Middle Cedar Watershed Management Plan (MCWMP) process. It is intended that the Middle Cedar Watershed Management Authority (MCWMA) and members utilize this information to continue the important work of educating the public on vital waterbodies and how to protect and enhance them for future generations. In addition to the following recommendations, Iowa State University (ISU) Extension and Outreach developed a detailed education & outreach plan specifically intended to guide the watershed project coordinator in engaging stakeholders and promoting flood reduction and water quality improvement projects in the watershed. This document was developed for the Iowa Watershed Approach project and is included in Appendix J.

9.1. Local Strategies

In 2011, Cedar River County Conservation Board Directors worked with consultants to develop the Cedar River Watershed Interpretation and Outreach Plan (Eells and Pease 2011). This primary objective of the plan was to understand what activities would engage people in the watershed. The plan included several strategies that were echoed in the comments shared by residents that participated in the MCWMP issues identification public engagement events. The strategies include:

- Support the work of the Middle Cedar Watershed Coordinator: Every project needs someone driving it forward, whether that is setting up events, promoting best management practices, or writing grants. The watershed coordinator can reach urban and rural residents and connect them with municipal resources or technical farm agencies. The watershed coordinator needs to be supported by the Middle Cedar Watershed Management Authority (MCWMA) board and other watershed partners. This support includes attending and promoting watershed events and connecting them with individuals or organizations that are influential in the community.
- Regular news article columns, radio spots, interactive websites, podcasts, and social media sites dedicated to flood recovery and watershed work need to be included in daily news outlets: Everyone, from farmers wanting current information on in-field practices to nearby county park residents wanting cleanup days in their creeks, agreed that they want to hear more about what is going on and how to be involved. A consistent media outlet is an invaluable resource for maintaining civic engagement for both urban and rural residents. Create a website that provides project information and asks residents to submit their stories, which can be re-posted to the website to generate attention. Record a podcast that is uploaded to a regular YouTube channel.
- Watershed work is not terribly compelling, but make it as engaging as possible: Municipal ordinances, zoning regulations, and property tax evaluations quickly induce yawns among even the most engaged watershed citizen. It is important to link practices on the ground with the policies that made it happen. One example is inviting residents to a lunch event at a local farm that highlights the use of monitored prairie strips and cover crops linking it to the water quality goals of the WMP, or a neighborhood subdivision that requires raingardens/bio-retention practices tied to municipal stormwater regulations.

- Go to where the people are gathering: Asking residents to attend an evening or weekend meeting can feel more like a punishment than an opportunity. One way to avoid overtaxing communities is to leverage events that are already occurring and provide interactive materials. Community festivals, county fairs, and expos can provide a table or booth for the MCWMA to provide information to those that do not normally attend watershed meetings.
- Relationships. Relationships. Relationships: Much like the real estate mantra of "location, location, location", building relationships and turning those into partnerships is a vital component of any successful watershed work. It is advantageous to engage with a variety of different groups who actively assist farmers, create recreational activities, or support environmental policies. In fact, local tourist organizations and chambers of commerce can be an important relationship to cultivate in order to promote the watershed as a recreational destination. Reaching out to hunting groups, conservation advocates, and natural resource-focused non-profits, can provide further avenues of partnerships on projects that are unique to the area.

9.2. Clear and Persuasive Messaging

Whether the message is on a billboard or conveyed in a meeting with local homeowners, how the MCWMA talks about and conveys watershed work matters. Some of the broader messages can reach audiences both rural/urban and upstream/downstream. Education materials should be created in such a way that invite stakeholders to buy-in and provide a way for everyone to talk about the watershed. The following are a few suggestions for outreach messages:

- We're All in This Watershed Together: While it's true that urban and rural areas treat stormwater differently, and communities upstream and downstream are affected by flooding in different ways, what also remains true is that everyone can do something to have an impact. It is imperative to help watershed landowners have a better understanding of the connections between land use management practices and both local and downstream flooding.
- The Cedar River: It's OUR watershed and OUR responsibility: This message speaks to the land stewardship sentiment heard at several rural and urban events. Additionally, it is t-shirt ready and could be eye-catching if designed accordingly.
- It costs more in the long run to repair flood damage to property and lives, than it does to work to minimize it now: Point to preventative measures; this message speaks to the financial, emotional, and infrastructure related costs that flood disasters inflict on communities.

9.3. Rural Messages

While the above messages can be used broadly across the watershed, the following are more targeted to rural audiences:

- Did you know that your land would make a great site for a practice (Target producers based on modeling data)?
- Cost share is available, and certain practices can have stacked cost-share.
- We can all be a part of improving water quality in the MCW.
- We have a great opportunity with substantial resources to reduce flooding and water quality downstream.

- The work that we do will have measurable benefits, and you can be a part of it.
- Do it for the next generation!
- Do it for our community and economic development opportunities.

9.4. Urban Messages

The messaging for urban audiences includes a few overlapping messages from above, but emphasizes stormwater practices:

- Do it for the next generation!
- Do it for our community and economic development opportunities
- It costs more in the long run to repair flood damage to property and lives, than it does to work to minimize it now
- We are all downstream from somewhere
- Clear Choices. Clean Runoff!
- Be the solution to runoff pollution

9.5. Countering Negative Messaging

There is always the possibility of receiving negative responses with regards to watershed practices at a meeting or event. This could be in the form of someone strongly stating that they do not want government interference on their property, or a group of people pointing to the expense new infrastructure would cost them. It is always best to de-escalate these instances and find ways to engage that are responsive and meaningful. Try responding with current research results for specific practices, point to examples in nearby farms or cities, emphasize flood mitigation as an investment, or find ways to discuss the shared risk and shared benefits that the project or plan presents. While this will not ensure successful de-escalation every time, the intent is to redirect the conversation into a more productive interaction. It is also helpful to ask community members who have been directly affected by flooding disasters to speak to their experience and the hardships they and their communities have faced. It can be very powerful to prepare individual community members to share their personal stories of resilience and dedication to preventing future flooding. When preparing for community meetings, try to include individual community members who will share their personal stories. This preparation can help to preemptively counteract potential negativity.

9.6. Education and Outreach Implementation Activities

The following are objectives that were developed by MCWMP participants to meet education and outreach goals.

- Utilize diverse approaches to build awareness of watershed issues.
- Assist stakeholders in understanding what it means to be a resident of the watershed and the downstream impacts of common land uses and new development.
- Attempt to provide increased resources to partner and member organizations for education services.
- Implement the action steps for the early project outreach period as identified in the Middle Cedar Watershed Education and Outreach Action Plan prepared by ISU Extension and Outreach (Appendix J).

- Involve youth groups, including Future Farmers of America (FFA) and 4H, in outreach to parents and other family members.
- Incorporate family-focused programming to foster multi-generational discussions at home.
- Identify and support a water conservation/soil health champion in every subwatershed.
- Increase voluntary action by promoting the message that while conservation practices are voluntary, they should not be thought of as optional. Ask leaders in conservation and sustainable farming to be leaders in delivering this message.
- Develop and implement a rewards program to encourage stakeholder action.
- Collaborate with leaders to expand watershed education resource access and availability.
- Create a public recognition/reward campaign to incentivize farmers/producers desire to preserve their soils and lands.
- Recognize cities and urban sites that voluntarily go above and beyond the minimum standards.
- Develop & implement an outreach program to educate watershed communities on ordinance adoption addressing water related issues.

In order to reach the goal of increasing basic understanding and awareness of the watershed across rural/urban and upstream/downstream sectors, a three-phased action plan has been developed. Each phase builds on the previous one and works to progress the project further along. The initial phase will focus on establishing relationships and building trust; the second phase deepens those relationships into active partnerships; and the third phase consists of evaluative measures that reveal successes and challenges to be addressed. The implementation of these phases will involve different responsibilities depending on the scale of the organization. Therefore, the following guidelines should be followed to distinguish between work at the HUC-8 watershed scale and the HUC-12 subwatershed scale.

- Watershed scale education and outreach should focus on relationship building between WMA member entities and with state and federal partners, advocacy of this 20-year plan, and resource allocation for organizations working to achieve the educational goals of this plan.
- Education and outreach efforts at the HUC-12 subwatershed scale should focus on organizing outreach events and workshops, developing materials that speak to their local residents, and meeting face to face with local landowners, agricultural organizations, private businesses, and other interested parties.

Phase One: Start Up Because the MCWMA is a new organization that covers over one million acres and includes cities and counties of very different sizes and characteristics, the key objective in the first phase is to build relationships with the cities, counties, and SWCDs that are currently members of the MCWMA, as well as those that have not yet opted to join. High level education is important in this first phase to promote the organization as an authority on water-related issues. Relationship building will require frequent meetings with community leaders to convey the importance of the MCWMA, and to make the case for why each member / potential member would benefit through financial support of the MCWMA. The goal of this first phase is to interact with each city, county, and SWCD within the MCW to become familiar with the people/political landscape and to gain trust of community members.

Phase One: Education Outreach efforts at the HUC-8 watershed scale include:

- A targeted outreach effort centered on familiarizing cities, counties, and SWCDs with the MCWMA, specifically focused on the content of the plan and the benefits of providing financial support for the organization.
- Participation in community events, such as county fairs, with a booth geared toward introducing the MCWMA and the newly completed plan.
- Development of a basic presentation about the MCWMA that can be given by the Watershed Project Coordinator at member entity meetings such as City Councils, Boards of Supervisors, SWCD commissioners, and key stakeholder groups such as County Conservation Board or County Engineer meetings.
- Implement the goals, objectives, and action steps for the early project outreach period as identified in the Middle Cedar Watershed Education and Outreach Action Plan prepared by ISU Extension and Outreach (refer to Appendix J).
- Educate watershed residents about flood hazards, strategies for reducing damages and becoming more resilient.
- Help watershed landowners better understand the connections between land use management practices and both local and downstream flooding.
- Partner with state and local tourist organizations and chambers of commerce to promote the watershed as a recreational destination.

HUC-12 subwatershed scale education and outreach efforts are also important and should be continued as part of subwatershed projects. HUC-12 scale education and outreach strategies for rural areas:

- Set up three face-to-face meetings with local co-op agronomists/ agricultural retailers.
- Set up three face-to-face meetings with the Natural Resources Conservation Service and/or Soil and Water Conservation District staff.
- Attend one local or regional meeting a month to network with farmers and landowners.
- Contact emergency response organizations and set up two meetings with their staff to begin to understand who is most vulnerable in flood disasters.
- Collaborate with local elected officials.

HUC-12 scale education and outreach strategies for urban areas:

- Set up three one-on-one meetings with municipal staff, including the city manager/administrator, stormwater coordinator, and public works staff to discuss flooding and water quality improvement opportunities.
- Find three to four groups involved in watershed-related activities and attend one gathering/event a month. This could be natural resource/environmental clubs interested in canoeing/kayaking, hunting groups, and local water protection group.
- Give one or two radio interviews discussing the plan.

Phase Two: Implementation The approach for HUC-8 scale education and outreach during the implementation phase of the plan period includes continuation of phase one efforts related to educating local communities on the mission of the MCWMA but will expand to include additional messages. The phase two education outreach at the HUC-8 scale include activities such as:

- Participation in community events, such as county fairs, with a booth geared toward water quality and flood mitigation strategies.
- Utilize diverse approaches to build awareness of watershed issues.
- Create aspirational vision of improved water quality and runoff reductions, with associated public recognition so the community is a leader and is also a highly desirable place to live.
- Work with MCWMA cities and counties to ensure local stormwater ordinances effectively protect surface and groundwater resources with modern, evidence-based performance standards (rate, volume, timing, quality).
- Work with MCWMA cities to encourage the use of Low Impact Development and Green Infrastructure in all new and re-development.
- Work with watershed members to develop wellhead protection plans for all municipal wells.
- Create early implementation successes with initial projects and practices to demonstrate value of the MCWMA. This will build confidence in stakeholders that the MCWMA can deliver positive outcomes with its resources.

Phase two education and outreach at the HUC-12 subwatershed scale centers on raising awareness within the specific subwatershed where projects are underway and practices are actively being implemented. Educating the key stakeholders about cost-share opportunities, and the specific goals of the local projects, will be important messages to convey. The following activities will require frequent communication with partners, locating event space, and conducting outreach to the public. In addition to resources spent organizing the events, additional costs will be incurred to pay for the event space, provide food and refreshments, and pay guest speakers. This is also the time when a concerted and well-funded media campaign will be needed to inform landowners of cost-share opportunities, which will involve designing and printing posters, brochures, and other educational materials. Merchandise could also be designed and printed on hats, t-shirts, mugs, etc.

HUC-12 scale education and outreach strategies for rural areas:

- Host two field days per season with organizations that have common goals, such as Iowa Learning Farms, Iowa Soybean Association, and Practical Farmers of Iowa.
- Host five “Open House” meetings that include background information on the project, eligible practices, land characterization maps, and distribution materials.
- Prepare for five to six informal meetings with farmers. Create a map of farmers that have shown interest in the watershed and stop by their farms. Offer them small gestures of candy bars and soda, fruit and sports drinks, or a sack lunch/warm meal.
- Create a public recognition/reward campaign to incentivize agricultural landowners’ desire to preserve their soils and lands.
- Increase adoption by promoting the message that while conservation practices are voluntary, they should not be thought of as optional. Ask leaders in conservation and sustainable farming to be leaders in delivering this message.
- Partner with state and local tourist organizations and chambers of commerce to promote the watershed as a recreational destination.
- Create aspirational goals/vision of improved water quality and runoff reductions, with associated public recognition so the watershed is a leader and is also a highly desirable place to live.

HUC-12 scale education and outreach strategies for urban areas:

- Host five "Open House" meetings that include food, snacks, and/or drinks. Bring background information on the watershed, flood and water quality practices, share stories, and get a sense of expertise in the room. Bring maps! People love gathering around maps and talking about the landscape, where they live, where their neighbors live, and any relevant history. Distribute educational materials and ask that they be shared with other community members.
- Run two demonstration workshops per season to familiarize residents with best management practices, such as rain gardens, bioswales, and permeable pavers. City stormwater coordinators or public works staff can assist with getting people to the event and any resources needed for the event.
- Recognize cities and urban sites that voluntarily go above and beyond the minimum standards.

Phase Three: Evaluation Projects and events can only be truly successful if they are evaluated for effectiveness. Conducting thorough evaluations will involve follow up on projects and previous participants to understand what worked and what did not. In addition to the time incurred engaging residents, printed materials, such as surveys, will also require financial resources, particularly if they are mailed to residents and businesses. Examples of applicable surveys and follow-up project questionnaires are located in Appendix J.

Stakeholder engagement (Photo Credit: IVRCD)

10. MONITORING & EVALUATION STRATEGIES

Stream and lake monitoring provides valuable information which can be used to detect trends over time and support future resource management decisions. These decisions may be based on a comparison of monitored conditions to standards, changes detected from completed restoration and protection measures, or changing climate and land uses. The ability of future monitoring efforts to detect such changes and the reliability of comparisons depends upon the nature and design of the recommended monitoring program.

10.1. Existing Monitoring Efforts

10.1.1. Automated Stream Stage and Discharge

Water levels of the Cedar River and its tributaries are currently monitored on an hourly basis at numerous locations. The existing monitoring sites are funded and maintained by a variety of state and federal organizations including: the United States Geological Service (USGS), National Oceanic & Atmospheric Administration (NOAA), National Weather Service (NWS), Cedar Rapids Water Department, City of Palo, Linn County, and the Iowa Flood Center (IFC). Stream stage data collected at these locations is uploaded in real-time to publicly available websites.

10.1.2. Real-time Water Quality Sensors

There are currently seven real-time water quality sensors deployed in the Middle Cedar Watershed (MCW). Two of the sensors are operated by USGS and are located on the Cedar River at Palo and the Cedar River at Cedar Rapids. Five additional water quality sensors are operated by University of Iowa IIHR—Hydroscience & Engineering (IIHR) on Lime Creek at Brandon, McLoud Run at Cedar Rapids, Miller Creek near Gilbertville, Mud Creek at Vinton, and Wolf Creek at Dysart. Data collected by the water quality sensors include the following parameters depending upon the specific configuration of the station; nitrate (NO3-N) + nitrite (NO2-N), chlorophyll-A, dissolved oxygen, pH, specific conductance, temperature and turbidity.

10.1.3. Water Quality Grab Sample Monitoring Stations

The Iowa Soybean Association (ISA), City of Cedar Rapids, and Coe College have collaborated to collect more than 400 stream water samples for nitrates, phosphorus, total suspended solids, and *Escherichia coli (E. coli)* from 60 locations in the Middle Cedar watershed beginning in April of 2017. More information, including results from the 2018 monitoring season can be found by visiting the Middle Cedar Watershed 2018 Tributary Monitoring Results Story Map. Additionally, the Iowa Department of Natural Resources (Iowa DNR) has conducted water quality sampling for nitrates, phosphorus, total suspended solids, and *E. coli* from 2000 to 2017 at four monitoring stations located on Beaver Creek, Black Hawk Creek, Wolf Creek, and the Cedar River.

10.1.4. Volunteer Monitoring

Volunteer (citizen) led water monitoring efforts have been a primary means for the DNR to empower local citizens to take ownership and increase resident awareness of the health of local waterbodies since 1998. Volunteer water monitoring is best able to inform local water quality goals if the decision-making and coordination is locally-led. Interested communities, watersheds, and counties can learn more about the Iowa DNR's approach to volunteer water monitoring at Iowa DNR Volunteer Monitoring Program.

Furthermore, agricultural producers can help improve their bottom line by measuring nitrates in ditches/draintile outflow as a way of seeing first-hand how much nitrogen is leaving their fields. This information is valuable to producers looking to reduce capital investments in fertilizers. There is a trial program to test a phone-app tool for this purpose Citizen Science Water Monitoring. This app makes it easy for people to quickly measure nitrate concentrations to a tenth of a milligram with no need for prior knowledge or expensive equipment and the app compiles user data to track nitrate concentrations throughout the MCW.

10.2. Monitoring Implementation Activities

Future monitoring in the MCW will fully incorporate and augment existing monitoring efforts, already in progress. The following paragraphs outline four tiers of watershed monitoring including description of data collection procedures, and type of monitoring equipment to be used. References to existing monitoring efforts are indicated throughout.

10.2.1. Sentinel Site Monitoring

Sentinel sites have been selected within the MCW to detect trends in streamflow and water quality as shown in **Figure 10-1** . In most cases, these sites have been selected because of their history of monitoring. Many have existing USGS stream gages and have had consistent water quality measurements historically (**Table 10-1**). These sites will be useful in detecting long-term trends. Other sites, specifically Sentinel Site 6 Cedar Creek and Sentinel Site 7 Outlet Creek are recommended as stations to be used in evaluating the effectiveness of Middle Cedar Watershed Management Authority (MCWMA) water quality improvement efforts. These stations are located at the outlet of priority implementation HUC-12 subwatersheds.

Monitoring at sentinel Sites will consist of automated flow/stage measurements using either year-round USGS or IIHR/IFC stream gages. Stream stage and flow measurements at sentinel sites will be used to detect long-term changes in streamflow, will provide a valuable tool for flood preparedness and will allow the MCWMA to evaluate effectiveness of their flood level reduction efforts.

Sentinel sites will also be equipped with water quality sensors provided by either the USGS or IIHR. Data collected by the water quality sensors include the following parameters depending upon the specific configuration of the station; nitrate (NO3-N) + nitrite (NO2-N), chlorophyll-A, dissolved oxygen, pH, specific conductance, temperature and turbidity. The sensors are typically deployed in the spring and removed from the stream in the fall to prevent damage from ice. Data from the water quality sensors deployed at sentinel sites will be used to detect long-term trends and seasonal variability, provide nitrate drinking water standard exceedance alerts and to develop pollutant load calculations.

In addition to the use of water quality sensors, bi-monthly water quality grab sampling will be conducted throughout the growing season at sentinel sites. The following parameters will be included; nitrate, total phosphorus, dissolved phosphorus, turbidity or TSS, and *E. coli* bacteria.

Table 10-1. Sentinel Monitoring Site Configurations

Monitoring Site	Existing Stream Gage	Existing Water Quality Monitoring
Sentinel 1: Cedar River at Cedar Rapids - Cedar River, USGS Gauge 05464500 at Cedar Rapids	USGS Gage	USGS WQ Sensor 5464500
Sentinel 2: Prairie River Outlet to Middle Cedar - Prairie River Outlet to Middle Cedar	Needed	Needed
Sentinel 3: McLoud Run, Cedar Rapids - McLoud Run (Iowa's only Urban Coldwater Stream) Water Quality Gauge (IIHR)	Needed	IIHR WQ Sensor WQS0052 (Discontinued in 2017)
Sentinel 4: Cedar River at Palo - Cedar River at Palo long term monitoring station	USGS Gage	USGS WQ Sensor 5464420
Sentinel 5: Mud Creek at Vinton - Mud Creek, Vinton Water Quality Gauge (IIHR)	IIHR Gage	IIHR WQ Sensor WQS0071 Existing Coe College Monitoring Site – Mud Creek
Sentinel 6: Lime Creek at Brandon – Lime Creek, Brandon Water Quality Gauge (IIHR)	IIHR Gage	IIHR WQ Sensor WQS0027 Existing Coe College & ISA Monitoring Site – "Lime"
Sentinel 7: Wolf Creek at La Porte – Wolf Creek, La Porte Stream Gauge (IIHR)	IIHR Gage	Existing ISA Monitoring Station – "CR15"
Sentinel 8: Wolf Creek at Dysart – Wolf Creek, Dysart Water Quality Gauge (IIHR)	USGS Gage	IIHR WQ Sensor WQS0070
Sentinel 9: Miller Creek near Gilbertville – Miller Creek, Gilbertville Water Quality Gauge (IIHR)	USGS Gage	IIHR WQ Sensor WQS0035 Existing ISA Monitoring Station – "CR22"
Sentinel 10: Cedar River at Waterloo – Cedar River, USGS Gauge 05464000 at Waterloo	USGS Gage	Needed
Sentinel 11: Black Hawk Creek at Waterloo – Black Hawk Creek long term monitoring location	Needed	Needed
Sentinel 12: Black Hawk Creek at Hudson – Black Hawk Creek USGS Gauge US05463500 at Hudson	USGS Gage	Needed
Sentinel 13: Beaver Creek near Cedar Falls – Black Hawk Creek at Cedar Falls long term monitoring station	Needed	Existing ISA Monitoring Station – "CR36"
Sentinel 14: Morgan Creek at Cedar Rapids- Morgan Creek near Covington USGS Gage	USGS	Needed

Future sentinel site monitoring will require the following additional monitoring above existing efforts:

- New IFIS Level Gages at:
  - Sentinel Site 2 Prairie River Outlet to Middle Cedar.
  - Sentinel Site 3 McLoud Run, Cedar Rapids.
  - Sentinel Site 11 Black Hawk Creek at Waterloo.
  - Sentinel Site 13 Beaver Creek near Cedar Falls.
- New IIHR Water Quality Sensors at:
  - Sentinel Site 2 Prairie River Outlet to Middle Cedar.
  - Sentinel Site 10 Cedar River at Waterloo.
  - Sentinel Site 11 Black Hawk Creek at Waterloo.
  - Sentinel Site 12 Black Hawk Creek at Hudson.
  - Sentinel Site 14 Morgan Creek near Covington.
- Expanded Water Quality Sampling:
  - Additional parameters (TP, DP, TSS, and *E. coli*) & Events (bi-monthly growing season)

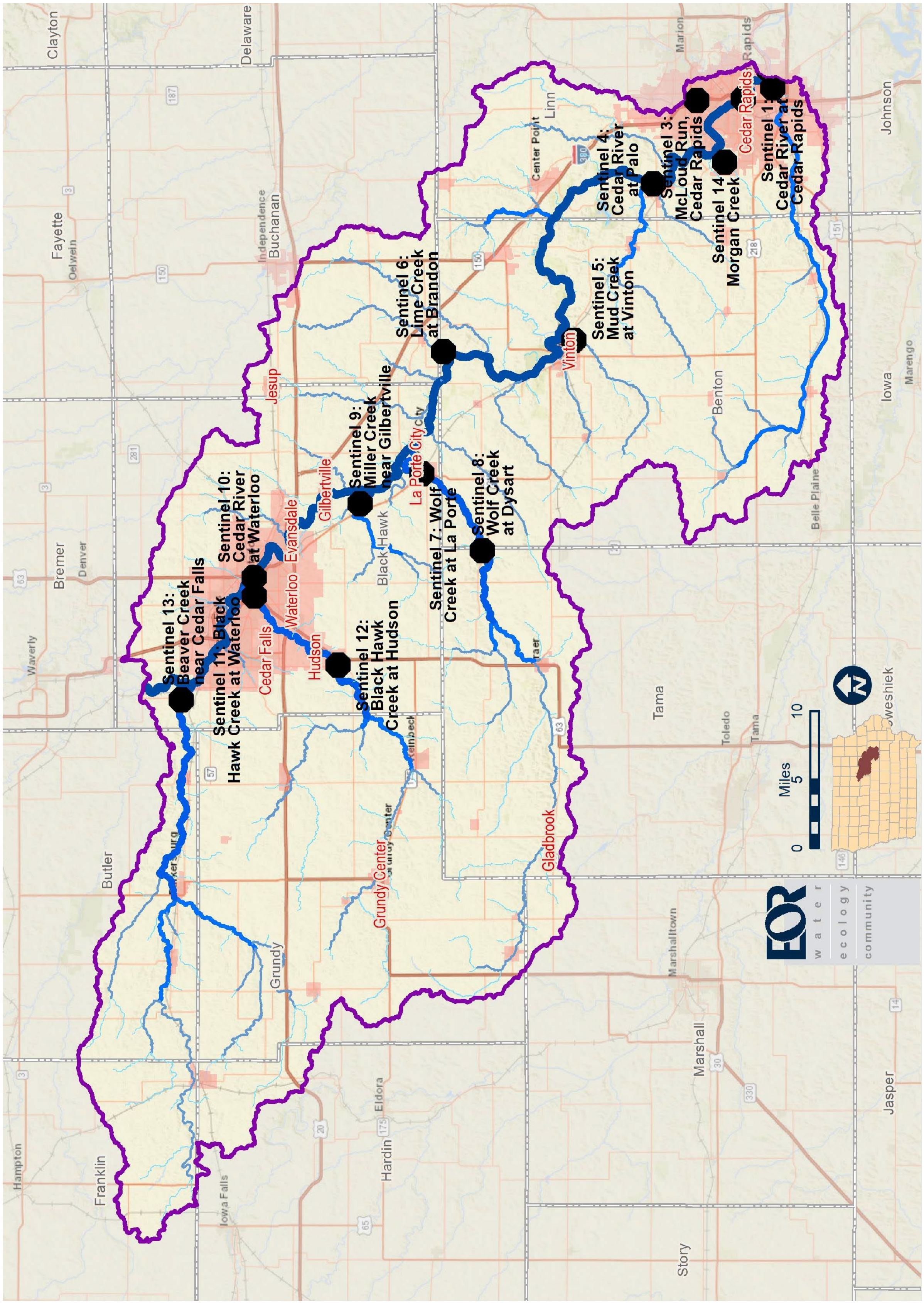

Figure 10-1. Middle Cedar Watershed—Sentinel Site Monitoring Locations.

10.2.2. Snapshot Water Quality Monitoring

The second tier of monitoring to be conducted in the watershed is based on the ISA tributary monitoring program. The ISA tributary monitoring program sampling consists of monthly nitrates, phosphorus, total suspended solids, and *E. coli* measurements from May through August from locations in the MCW. The rationale behind the program is to collect data to inform watershed management efforts in the Middle Cedar and prioritization of HUC-12s for additional planning and implementation. This monitoring program has helped to develop an understanding of the conditions of streams in the MCW and will be instrumental in the future as the program expands. Frequent sampling events over many years covering a broad extent of the watershed is the best way to assess the state of the watershed and measure the progress of MCWMA's initiatives. Proposed expansion of the snapshot monitoring program is shown in **Table 10-2** and **Figure 10-2**. Monitoring at snapshot locations should be augmented with stream flow measurements as possible. At a minimum, stream stage measurements should be taken at the time a snapshot sample is taken. Preferably, a stream gage would be established at each site to allow for stream flow and pollutant load calculations.

Future snapshot monitoring will require the following additional monitoring above existing efforts:

- New Snapshot monitoring stations at the outlet of unnamed tributary to Cedar River, Miller Creek, and Virden Creek.
- Four new Snapshot monitoring stations on tributaries to Wolf Creek.
- Stream stage measurement at all proposed water quality snapshot stations.

Table 10-2 .Snapshot Monitoring Site Configuration

Monitoring Site	Existing Stream Gage	Existing Water Quality Monitoring
Snapshot 1 Otter Creek		ISA Snapshot CR03
Snapshot 2 Little Bear Creek		ISA Snapshot CR02
Snapshot 3 Unnamed Trib. to Bear Creek		ISA Snapshot CR04
Snapshot 4 Bear Creek Headwaters		ISA Snapshot CR05
Snapshot 5 East Branch Blue Creek		ISA Snapshot CR06
Snapshot 6 Unnamed Trib. to Cedar River		ISA Snapshot CR08
Snapshot 7 Unnamed Trib. to Cedar River		ISA Snapshot CR10
Snapshot 8 Pratt Creek		ISA Snapshot CR11
Snapshot 9 Bear Creek		ISA Snapshot CR12
Snapshot 10 Bear Creek		Coe College – North Bear
Snapshot 11 Lime Creek		ISA Snapshot CR51
Snapshot 12 Lime Creek		ISA Snapshot CR48
Snapshot 13 Unnamed Trib. to Lime Creek		ISA Snapshot CR46
Snapshot 14 Lime Creek		ISA Snapshot CR47
Snapshot 15 Lime Creek		ISA Snapshot CR01
Snapshot 16 Spring Creek		ISA Snapshot CR14
Snapshot 17 Unnamed Trib. to Cedar River		N/A
Snapshot 18 Wolf Creek		ISA Snapshot CR15
Snapshot 19 Wolf Creek		ISA Snapshot CR16
Snapshot 20 Wolf Creek		ISA Snapshot CR18
Snapshot 21 Wolf Creek		N/A

Monitoring Site	Existing Stream Gage	Existing Water Quality Monitoring
Snapshot 22 Coon Creek at Traer	IFIS Sensor	ISA Snapshot CR17
Snapshot 23 Wolf Creek Trib		N/A
Snapshot 24 Wolf Creek		N/A
Snapshot 25 Wolf Creek		N/A
Snapshot 26 Wolf Creek		N/A
Snapshot 27 Miller Creek		N/A
Snapshot 28 Elk Run		ISA Snapshot CR24
Snapshot 29 Virden Creek		N/A
Snapshot 30 Black Hawk Creek		ISA Snapshot CR27
Snapshot 31 Black Hawk Creek		ISA Snapshot CR28
Snapshot 32 N. Fork Black Hawk Creek		ISA Snapshot CR29
Snapshot 33 N. Fork Black Hawk Creek		ISA Snapshot CR37
Snapshot 34 N. Fork Black Hawk Creek		ISA Snapshot CR38
Snapshot 35 Reinbeck Creek - Black Hawk Creek		N/A
Snapshot 36 Reinbeck Creek Headwaters		N/A
Snapshot 37 Black Hawk Creek		ISA Snapshot CR30
Snapshot 38 Black Hawk Creek		ISA Snapshot CR31
Snapshot 39 Black Hawk Creek Headwaters		ISA Snapshot CR39
Snapshot 40 Black Hawk Creek Headwaters		ISA Snapshot CR40
Snapshot 41 Unnamed Creek		ISA Snapshot CR26
Snapshot 42 Cedar River		ISA Snapshot CR41
Snapshot 43 Beaver Creek		ISA Snapshot CR45
Snapshot 44 Unnamed Tributary		ISA Snapshot CR43
Snapshot 45 South Beaver Creek		ISA Snapshot CR47
Snapshot 46 Middle Fork South Beaver Creek		ISA Snapshot CR46
Snapshot 47 Beaver Creek		ISA Snapshot CR50


Stream monitoring station on Pratt Creek (Photo Credit: EOR)

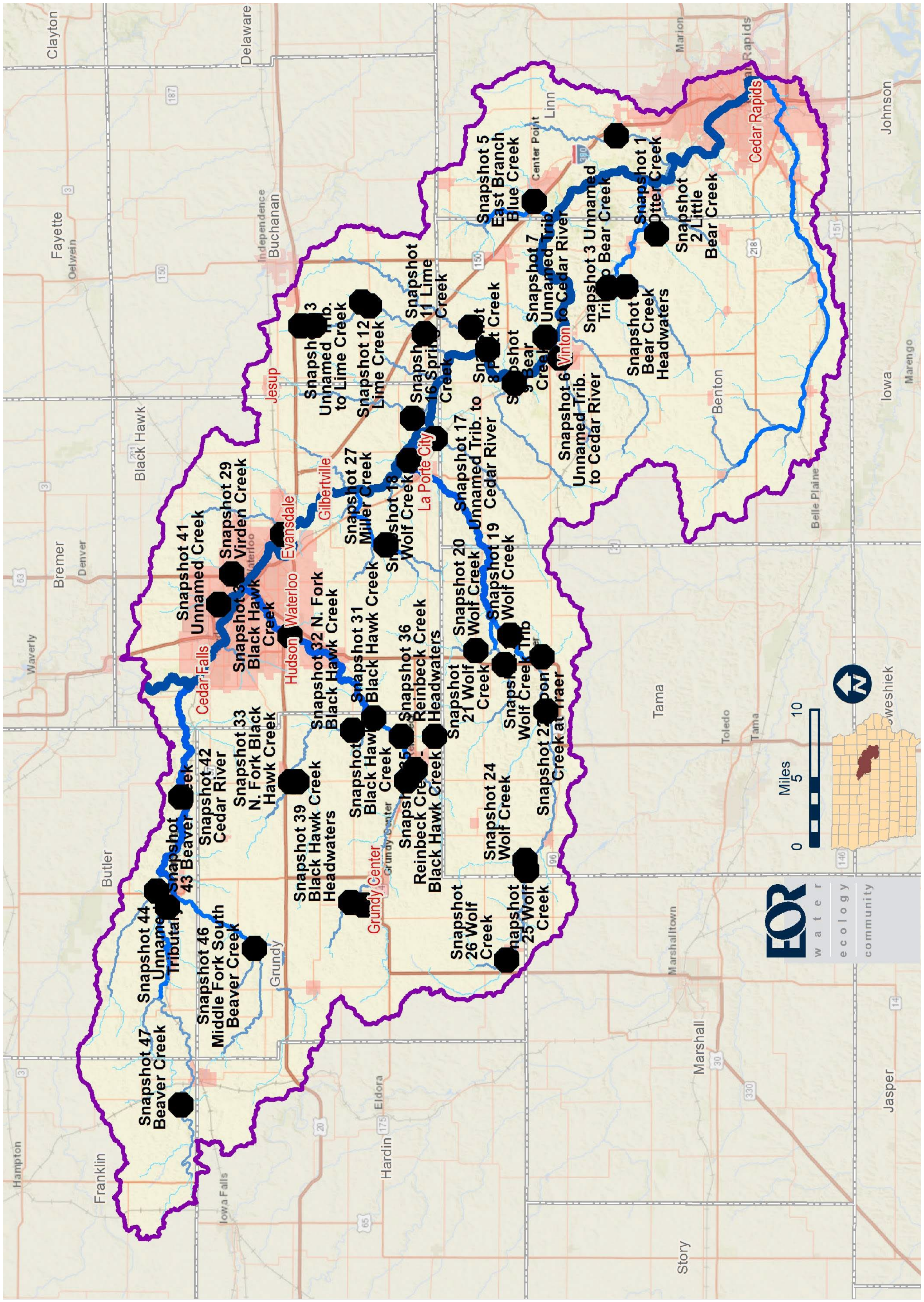

Figure 10-2. Middle Cedar Watershed—Snapshot Monitoring Locations

10.2.3. Flood Preparedness Monitoring

Flood preparedness monitoring includes the existing network of stream sensors along with proposed sensor at sites near communities or other infrastructure (roads) that currently do not have a flood gauge but which have experienced recent flooding events. The following list contains existing and proposed stream sensor locations based in input from partners with localized flood experiences, knowledge of information gaps, and who are actively engaged in their area flood response (**Table 10-3** and **Figure 10-3**). As floods continue to impact the safety and economic stability of Iowa's communities, infrastructure, and valuable farmland, the Iowa Flood Center (IFC) has expressed interest in obtaining this information from local communities to demonstrate the need and show support for expansion of the statewide stream sensor network. If funding becomes available, the IFC may be able to provide financial or technical assistance with the installation of the stream sensors.

IFC maintains the Iowa Flood Information System (IFIS), a one-stop web-platform to access community-based flood conditions, forecasts, visualizations, inundation maps and flood-related information, visualizations and applications. All flood preparedness monitoring sites should be added to IFIS. The addition of these sites to IFIS will allow communities within the MCW to visualize data from multiple stream gauges to follow flooding condition along a river. IFIS helps communities make better-informed decisions on the occurrence of floods, and alerts communities in advance to help minimize damage of floods. http://ifis.iowafloodcenter.org/ifis/app/.

Future flood preparedness monitoring will require the following additional monitoring above existing efforts. Additional stream sensors at the following locations:

- Prairie Creek at Norway
- Bear Creek at Shellsburg
- Spring Creek near I380
- Wolf Creek at Traer
- Wolf Creek at Gladbrook
- Cedar River at Gilbertville
- Headwaters Black Hawk Creek at Reinbeck
- Hinkle Creek above Village of Reinbeck
- Headwaters Black Hawk Creek at Grundy Center
- Headwaters Black Hawk Creek at Dike
- South Beaver Creek at Parkersburg
- Beaver Creek at Aplington

Table 10-3. Flood Preparedness Monitoring Configuration

Monitoring Site	Existing Stream Sensor
Flood Site 2 Prairie Creek at Fairfax	IFIS Sensor
Flood Site 3 Prairie Creek at Norway	N/A
Flood Site 4 Otter Creek above Cedar Flood Plain	IFIS Sensor
Flood Site 5 Dry Creek at Palo	IFIS Sensor
Flood Site 6 Dry Creek at Atkins	IFIS Sensor
Flood Site 7 Bear Creek Near Confluence	IFIS Sensor
Flood Site 8 Bear Creek at Shellsburg	N/A
Flood Site 9 Blue Creek at Center Point	IFIS Sensor
Flood Site 10 Cedar River at Vinton	IFIS Sensor
Flood Site 11 Bear Creek near I380	IFIS Sensor
Flood Site 12 Spring Creek near I380	N/A
Flood Site 13 Wolf Creek at Traer	N/A
Flood Site 14 Wolf Creek at Gladbrook	N/A
Flood Site 15 Middle Cedar at Gilbertville	N/A
Flood Site 16 Elk Run at Evansdale	IFIS Sensor
Flood Site 17 Headwaters Black Hawk Creek at Reinbeck	N/A
Flood Site 18 B. Hinkle Creek above Village of Reinbeck	N/A
Flood Site 19 Headwaters Black Hawk Creek at Grundy Center	N/A
Flood Site 20 Headwaters Black Hawk Creek at Dike	N/A
Flood Site 21 Dry Run Creek above Confluence	IFIS Sensor
Flood Site 22 Cedar River at Cedar Falls, IA	IFIS Sensor
Flood Site 23 Beaver Creek at New Hartford	IFIS Sensor
Flood Site 24 Beaver Creek at Parkersburg	IFIS Sensor
Flood Site 25 South Beaver Creek at Parkersburg	N/A
Flood Site 26 Drainage Ditch at Aplington	IFIS Sensor
Flood Site 27 Beaver Creek at Aplington	N/A
Flood Site 28 Gran Creek at Aplington	IFIS Sensor

10.2.4. Monitoring Data Analysis

Monitoring results should be reported as quickly as possible, particularly in the case of stream stage/flow data which is made available in real time. The monitoring program detailed above, includes real-time reporting of stream stage and water quality conditions through existing systems. An annual report summarizing all monitoring data for the year should be developed. The annual report focuses on general observations based on the data collected including, review of compliance against water quality standards and reference conditions, comparisons between sites, trends throughout the year, and reporting of any unexpected results or difficulties in monitoring activities. The calculation of annual pollutant loads will be conducted for sites with adequate data. A more detailed monitoring report should be developed every five years that will focus on trend detection and progress towards goals. The need for continued monitoring and "course corrections" to monitoring strategies should also be evaluated every five years in response to monitoring results.

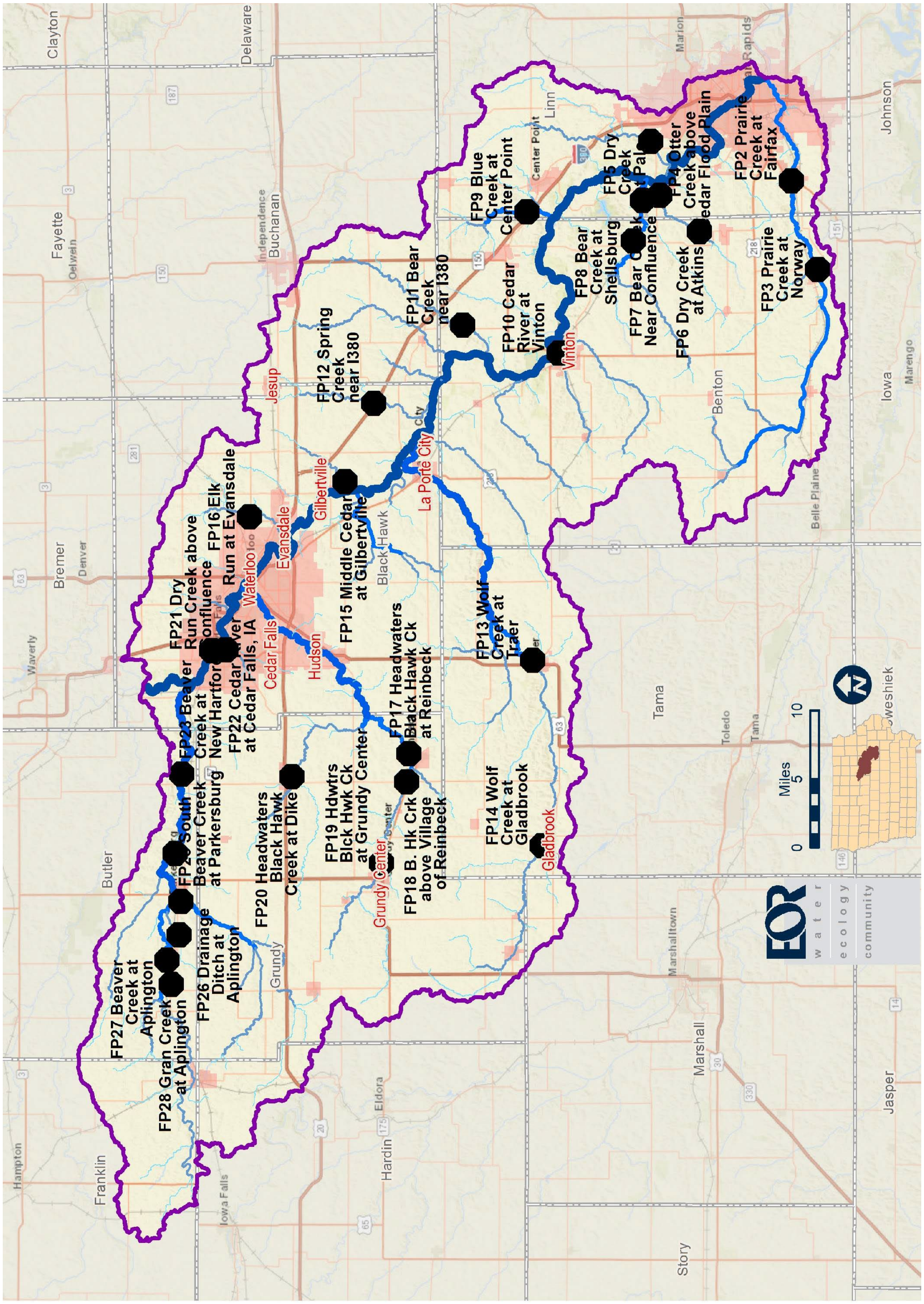

Figure 10-3. Middle Cedar Watershed—Flood Preparedness Monitoring Locations

10.3. Evaluation Implementation Activities

Recommended evaluation methodologies have been developed for each of the goals and objectives established through the watershed management planning process and can be found in **Table 10-4**.

Additionally, some key self-evaluation questions the organization can use to verify that its course of action is appropriate is summarized below:

1. Is uncontrolled water runoff a problem to be addressed and/or are there opportunities to reap benefits from improved water management?
    a. Is there flooding and damage, displacing or disrupting residents and businesses?
    b. Does it put at risk the quality of water supplies and quality of life?
    c. Can we enhance our community's quality of life and prosperity with cleaner and safer waters?
2. Is the MCWMA the appropriate organization to undertake water planning and coordination?
    a. Who else is addressing flooding, water quality, and erosion issues and are these issues being effectively resolved already?
    b. Is a WMA, defined on watershed boundaries, a better format to address water management challenges than other local jurisdictions?
3. Are the initiatives based on good information, sound practices, and open/responsive leadership?
4. Is the process open and inclusive, such that input from everyone is considered and respected?

Corn stover bales, Grundy Center, Iowa (Photo Credit: EOR)

Table 10-4. Evaluation Activities for Goals and Objectives

	Goals	Objectives	Evaluation Procedures
Flooding/ Water Quantity	***Reduce flood risk and damage to local communities/ neighborhoods.***	Establish action plans to protect vulnerable and low-income communities from flood risk and damages.	To be evaluated by the flood reduction benefits being provided by the conservation practices installed in areas draining to vulnerable and low-income communities. Evaluation will be accomplished using the Conservation Practice Scenario Tool described in the watershed management plan by setting the Target Adoption Rate to the actual quantity of each practice implemented in each HUC-12 Subwatershed. The tool will calculate the water quality improvement and flood reduction benefits being achieved. Flood reduction benefits will be reported by the selected, actual flood event (approximately 10 year) for each subwatershed. Refer to flood reduction benefit for further description.
		Target low-income and vulnerable communities with flood prevention and reduction projects and services. Target the causes of the high flood risk in these areas with risk reduction/resiliency projects and initiatives, expanded funding, and outreach and engagement programs.	To be evaluated by the flood reduction benefits being provided by the conservation practices installed in areas draining to vulnerable and low-income communities. Evaluation will be accomplished using the Conservation Practice Scenario Tool described in the watershed management plan by setting the Target Adoption Rate to the actual quantity of each practice implemented in each HUC-12 Subwatershed. The tool will calculate the water quality improvement and flood reduction benefits being achieved. Flood reduction benefits will be reported by the selected, actual flood event (approximately 10 year) for each subwatershed. Refer to flood reduction benefit for further description.
	Reduce causes of flooding potential.	Prioritize structural and non-structural BMPs to implement upstream (both urban and rural) to reduce peak flows and volume.	To be evaluated by the flood reduction benefits being provided by the conservation practices installed. Evaluation will be accomplished using the Conservation Practice Scenario Tool described in the watershed management plan by setting the Target Adoption Rate to the actual quantity of each practice implemented in each HUC-12 Subwatershed. The tool will calculate the water quality improvement and flood reduction benefits being achieved. Flood reduction benefits will be reported by the selected, actual flood event (approximately 10 year) for each subwatershed. Refer to flood reduction benefit for further description.
		Advocate flooding solutions that do not lead to problems in another location.	To be evaluated by number of flood reduction projects submitted to the MCWMA for review of potential impacts
		Explore utilizing existing floodway to provide additional temporary flood storage.	To be evaluated by the number of floodway storage feasibility studies conducted
		Leverage recreational areas to provide protective flood buffers between land uses and water resources	To be evaluated by the number of floodway storage feasibility studies conducted
	Protect life and property from flood damage	Encourage that the local floodplain management policies and ordinances currently in effect in the watershed are fully implemented and enforced.	To be evaluated by the number of communities within the watershed that have adopted comprehensive floodplain management policies and by the effectiveness of their enforcement procedures.
		Encourage the use of flood insurance by watershed residents by encouraging participation in the National Flood Insurance Program (NFIP).	
		Assist watershed communities in achieving the goals identified in their Hazard Mitigation Plans.	To be evaluated by the number of contacts made between watershed staff and local communities to coordinate on Hazard Mitigation Plan goals.
	Improve stormwater management at local levels	Encourage coordination among jurisdictions within the watershed in developing consistent approaches to stormwater management.	To be evaluated by the number of communities within the watershed that have developed consistent approaches for stormwater management.
		Encourage jurisdictions throughout the watershed to update local regulations, design practices, and infrastructure to more effectively manage changing precipitation patterns.	To be evaluated by the number of communities within the watershed that have updated ordinances, design practices and infrastructure to account for changing precipitation patterns.
		Encourage use of Low Impact Development and Green Infrastructure in all new and re-development.	To be evaluated by the number of communities within the watershed that have adopted low impact and green infrastructure practices in new and re-developments

	Goals	Objectives	Evaluation Procedures
		Encourage adoption of local stormwater ordinances that effectively protect surface and groundwater resources with modern, evidence-based performance standards (rate, volume, timing, quality)	To be evaluated by the number of communities within the watershed that have developed consistent approaches for stormwater management.
	Increase watershed awareness related to water quantity	Help watershed landowners better understand the connections between land use management practices and both local and downstream flooding	Evaluating the effectiveness of the education & outreach plan will be accomplished through a series of surveys to be conducted in Phase 3 of the Watershed Planning Period.
		Encourage communication and cooperation among jurisdictions within the watershed on land use changes and water-related projects.	To be evaluated by number of land use changes and water related projects submitted to the MCWMA for review of potential impacts
Recreation	***Enhance the watershed's existing water-based recreational areas***	Improve standard of living of watershed residents by supporting high quality recreational opportunities on the watershed streams, lakes and riparian corridors.	To be evaluated by the number of requests for assistance from watershed communities on recreational opportunities.
	Develop new recreational opportunities on lakes and streams across the watershed	Support partnerships between public and private organizations to increase recreational opportunities in the watershed including connections between communities.	To be evaluated by the number of requests for assistance from watershed communities on recreational opportunities.
		Include a wildlife habitat component in water quality & flooding projects.	To be evaluated by whether or not the MCWMA develops the policy.
		Partner with state and local tourist organizations and chambers of commerce to promote the watershed as a recreational destination.	Evaluating the effectiveness of the education & outreach plan will be accomplished through a series of surveys to be conducted in Phase 3 of the Watershed Planning Period.
		Support recreational development projects being considered by communities within the watershed including: - Water trails - White-water parks - Riparian Recreational Trails - Access Areas	To be evaluated by the number of requests for assistance from watershed communities on recreational opportunities.
	Improve the health of the watershed ecosystem.	Support efforts in the watershed that emphasize the use of recreational areas to improve ecosystem health, provide habitat and movement corridors for insects and wildlife, increase soil health, and control invasive species.	To be evaluated by the number of requests for assistance from watershed communities on recreational opportunities.
Funding and Organization	***Identify and obtain funding sources that are reliable and sufficient to meet the goals identified in the watershed management plan.***	Establish a stable funding model and method for the watershed and continue a sustainable funding mechanism for a Middle Cedar watershed Coordinator.	To be evaluated by whether or not the MCWMA develops a stable funding source capable of supporting the level of activity needed to implement the watershed management plan.
		Create early implementation successes to demonstrate value of the MCWMA and build confidence in stakeholders that the MCWMA can deliver positive outcomes with its resources.	Evaluating the effectiveness of the education & outreach plan will be accomplished through a series of surveys to be conducted in Phase 3 of the Watershed Planning Period.
	Effectively manage the MCWMA through implementation of this watershed management plan & appropriate governance structure.	Include staffing resources in the mid and long term organization plan for the MCWMA for continuity, ability to find and acquire funding, implement projects, and coordination hub for stakeholders.	To be evaluated by whether or not the MCWMA develops a stable funding source capable of supporting the level of activity needed to implement the watershed management plan.
Watershed Policy	***Encourage communities with regulations in place that protect water resources to improve oversight and enforcement of those regulations.***	Improve the quality of discharges from small municipal wastewater facilities up to the level of modern wastewater standards.	To be evaluated by the number of communities within the watershed that have updated their wastewater treatment systems.
		Explore pollutant credit trading between various partners to allow new methods for rural and urban dischargers to meet higher goals/standards.	To be evaluated by whether or not the MCWMA develops a stable funding source capable of supporting the level of activity needed to implement the watershed management plan. .
		Where urban development is expanding into rural areas, promote stewardship of farm lands.	To be evaluated by the number of communities within the watershed that have developed a policy related to stewardship of fallow lands awaiting development.
		In urban settings, encourage local jurisdictions to adjust regulations to promote Low Impact Development, Green Infrastructure and other natural mechanisms as the preferred/mandatory stormwater management method..	To be evaluated by the number of communities within the watershed that have adopted low impact and green infrastructure practices in new and re-developments
Partnerships	***Work cooperatively to achieve mutual watershed management objectives.***	Identify stakeholders and resources and facilitate partnerships to implement the watershed plan.	To be evaluated by the level of involvement the MCWMA has with partner organizations and the effectiveness of these partnerships
		Identify opportunities for the MCWMA to assist the cities, counties, SWCDs and other stakeholders on their watershed management and conservation efforts.	

	Goals	Objectives	Evaluation Procedures
		Utilize existing State and non-profit watershed management and conservation related initiatives.	
		Cultivate and expand upon existing private/public partnerships that have been developed in the watershed.	
		Bring in additional partners that may have vested interests in the watershed not already at the table. Specifically conservation and recreation partnerships	
		Cultivate additional partnerships with industries within the watershed with an emphasis on agribusiness.	
		Explore unique approaches for crops and methods that are less impactful to the system hydrology and water bodies.	
Education Outreach	***Increase awareness of the watershed & its resources***	Utilize diverse approaches to build awareness of watershed issues.	Evaluating the effectiveness of the education & outreach plan will be accomplished through a series of surveys to be conducted in Phase 3 of the Watershed Planning Period.
	Inspire watershed stewardship and ownership	Assist stakeholders in understanding what it means to be a resident of the watershed and the downstream impacts of common land uses and new development.	
		Attempt to provide increased resources to partner and member organizations such as SWCDs, County Conservations, and ISU Extension for education services.	
	Disseminate water-resource information and materials	Implement the goals, objectives, and action steps for the early project outreach period as identified in the Middle Cedar Watershed Education and Outreach Action Plan prepared by Iowa State University Extension (refer to Appendix J).	
		Help locals understand that mitigation funds (FEMA's PDM and FMA and HMGP) are available.	
		Involve youth groups, including FFA and 4H, in outreach to parents and other family members. Incorporate family-focused programming to foster multi-generational discussions at home.	
	Encourage all stakeholders in the watershed to be included in activities and programs.	Identify and support a water conservation/soil health champion in every subwatershed.	
		Increase voluntary action by promoting the message that while conservation practices are voluntary, they should not be thought of as optional. Ask leaders in conservation and sustainable farming to be leaders in delivering this message.	
		Develop and implement a rewards program to encourage stakeholder action	
		Collaborate with leaders to expand watershed education resource access and availability	
	Identify and empower local watershed stewards to build watershed management ethic at grassroots level	Create a public recognition/reward campaign to incentivize agricultural landowners' desire to preserve their soils and lands.	
		Recognize cities and urban sites that voluntarily go above and beyond the minimum standards.	
Monitoring Evaluation	***Evaluate temporal trends in water quality and quantity in the watershed.***	Continue to work with watershed partners to conduct sentinel site monitoring on the Cedar River and major tributaries.	To be evaluated by whether or not the ISA snapshot monitoring program is conducted throughout the plan period.
		Use hydrologic and water quality models to estimate stream discharge and loading.	To be evaluated by whether or not the ISA snapshot monitoring program is conducted throughout the plan period.
	Determine the water quality and quantity conditions of streams and lakes within the watershed.	Continue to work with the Iowa Soybean Association, Coe College and the City of Cedar Rapids to conduct snapshot monitoring on streams throughout the watershed.	To be evaluated by whether or not the ISA snapshot monitoring program is conducted throughout the plan period.
	Evaluate the effectiveness of MCWMA management efforts.	Evaluate the effectiveness of MCWMA activities using the approach outlined in the Monitoring and Effectiveness section and this table.	To be evaluated by whether or not recommended evaluation procedures are adhered to.

	Goals	Objectives	Evaluation Procedures
Water Quality	***All waters within the Middle Cedar Watershed meet their designated uses.***	Improve water quality of currently impaired waters (as well as those determined to be impaired in the future) to a level where they meet State water quality standards based on designated uses.	The goal of all waters within the Middle Cedar Watershed meeting their designated uses will be evaluated by review of the Iowa DNR biannual reporting: Impaired Waters List and Integrated Report which is based on Iowa DNR assessment monitoring procedures. Additional qualitative evaluation of this goal can be done by review of the Iowa Soybean Association snapshot monitoring results. Evaluation of progress being made on the MCWMA implementation efforts related to decreasing nutrient and bacteria loading to waters of the Middle Cedar watershed will be accomplished using the Conservation Practices Scenario Tool by setting the Target Adoption Rate to the actual quantity of each practice implemented in each HUC-12 Subwatershed. The tool will calculate the water quality improvement in terms of pounds of Nitrogen and Phosphorus removed.
		Work towards meeting the reductions targets identified in the existing TMDLs within the watershed.	Evaluation of progress being made on the MCWMA implementation efforts related to decreasing nutrient and bacteria loading to waters of the Middle Cedar watershed will be accomplished using the Conservation Practices Scenario Tool by setting the Target Adoption Rate to the actual quantity of each practice implemented in each HUC-12 Subwatershed. The tool will calculate the water quality improvement in terms of pounds of Nitrogen and Phosphorus removed.
		Maintain water quality within waters that currently meet State water quality standards based on their designated uses.	The goal of maintaining water quality of waters within the Middle Cedar watershed, including meeting their designated uses will be evaluated by review of the Iowa DNR biannual reporting: Impaired Waters List and Integrated Report which is based on Iowa DNR assessment monitoring procedures. Additional qualitative evaluation of this goal can be made by review of the Iowa Soybean Association snapshot monitoring results. Evaluation of progress being made on the MCWMA implementation efforts related to decreasing nutrient and bacteria loading to waters of the Middle Cedar watershed will be accomplished using the Conservation Practices Scenario Tool by setting the Target Adoption Rate to the actual quantity of each practice implemented in each HUC-12 Subwatershed. The tool will calculate the water quality improvement in terms of pounds of Nitrogen and Phosphorus removed.
		Encourage the Iowa DNR to conduct Use Assessment and Use Attainability Analysis (UA/UAA) for priority streams within the watershed.	To be evaluated by the number of UA/UAA developed on waters within the Middle Cedar watershed.
		Track changes in water quality through a watershed-wide monitoring program	To be evaluated by whether or not the ISA snapshot monitoring program is conducted throughout the plan period.
	Promote management activities to protect high quality drinking water sources	Prioritize water quality BMPs in areas identified as being highly susceptible to groundwater pollution	Prioritization of areas identified as being highly susceptible to groundwater pollution was accomplished during the watershed management planning process. Evaluation of progress being made on the MCWMA implementation efforts related to decreasing nitrate concentrations in drinking water sources in the Middle Cedar watershed will be accomplished using the Conservation Practices Scenario Tool by setting the Target Adoption Rate to the actual quantity of each practice implemented in each HUC-12 subwatershed. The tool will calculate the water quality improvement in terms of pounds of Nitrogen and Phosphorus removed.

	Goals	Objectives	Evaluation Procedures
	Meet the Iowa Nutrient Reduction Strategy goals for non-point source nitrogen (41%) and phosphorus (29%) reduction at the HUC-8 scale.	Work with watershed land owners to utilize soil health, in-field, edge of field and riparian area management practice to reduce nutrient and sediment loading from agricultural areas.	To be evaluated using the Conservation Practices Scenario Tool by setting the Target Adoption Rate to the actual quantity of each practice implemented in each HUC-12 subwatershed. The tool will calculate the water quality improvement in terms of pounds of Nitrogen and Phosphorus removed and will track the adoption rates for soil health, in-field, edge of field and riparian area management practices.
		Work with watershed residents and developers to utilize green infrastructure practices to reduce nutrient loading from urban stormwater.	To be evaluated using the Conservation Practices Scenario Tool by setting the Target Adoption Rate to the actual quantity of each practice implemented in each HUC-12 subwatershed. The tool will calculate the water quality improvement in terms of pounds of Nitrogen and Phosphorus removed and will track the adoption rates for green infrastructure practices.
		Prioritize water quality improvement practices that: -Preserve topsoil and reduce sediment runoff -Promote volume control -Provide habitat value, particularly for pollinator species -Provide greater return on investment.	To be evaluated using the Conservation Practices Scenario Tool by setting the Target Adoption Rate to the actual quantity of each practice implemented in each HUC-12 subwatershed. The tool will calculate the water quality improvement in terms of pounds of Nitrogen and Phosphorus removed and will track the adoption rates for water quality improvement practices that preserve topsoil, reduce sediment runoff, and promote volume control.
		In urban settings, promote Low Impact Development, Green Infrastructure and other natural mechanisms as the preferred stormwater management method.	To be evaluated by the number of communities within the watershed that have adopted low impact and green infrastructure practices in new and re-developments
		Promote the integration of conservation practice language into rental agreements between leasing land operators and landowners regarding motivation/incentives to protect and preserve agricultural soils and runoff and incorporate long-term practices.	Evaluating the effectiveness of the education & outreach plan will be accomplished through a series of surveys to be conducted in Phase 3 of the Watershed Planning Period.
		In urban and rural communities, promote aspirational goals/vision of improved water quality and runoff reductions.	Evaluating the effectiveness of the education & outreach plan will be accomplished through a series of surveys to be conducted in Phase 3 of the Watershed Planning Period.

11. PARTNERS IN WATERSHED MANAGEMENT

The many groups and organizations that have partnered with the Middle Cedar Watershed Management Authority (MCWMA) are instrumental in guiding the success of this effort to restore the watershed. With numerous overlapping missions, goals and responsibilities among these groups, the coordination of efforts can result in greater productivity and a reduced financial burden. Working with these partners can also provide access to unfamiliar parts of the watershed for incorporating conservation practices and insight on various perspectives on new technologies and innovative approaches. The MCWMA will work with these partners to ensure the sustainability and success of this effort. The following descriptions of these organizations have been taken directly from their websites.

11.1. Watershed Partners

The Iowa Flood Center: Thanks to the Iowa Legislature's leadership and foresight in creating the Iowa Flood Center (IFC) in 2009, Iowans have access to the latest technology and resources to help them prepare for floods and become more resilient to their effects. The center's outward-facing philosophy focuses on providing direct services to benefit the people of Iowa. The IFC is actively engaged in flood-related projects that help Iowans understand their flood risks and make better flood-related decisions. https://iowafloodcenter.org/

ISU Extension: Iowa State University Extension and Outreach carries Iowa State's land-grant mission throughout the state -- everywhere for all Iowans. We serve as a 99-county campus, connecting the needs of Iowans with Iowa State University research and resources. We provide education and partnerships designed to solve today's problems and prepare for the future. https://www.extension.iastate.edu/

Iowa Water Center: The Iowa Water Center brings together researchers from across Iowa institutions to study issues related to the quality, quantity, and human dimensions of Iowa's water resources. Knowledge gained through these studies helps shape policies and everyday practices that can improve and sustain Iowa's water for future generations—both here in Iowa and for our downstream neighbors. http://www.water.iastate.edu/

United States Geological Services (USGS): USGS provides science about the natural hazards that threaten lives and livelihoods, the water, energy, minerals, and other natural resources we rely on, the health of our ecosystems and environment, and the impacts of climate and land-use change. Their scientists develop new methods and tools to enable timely, relevant, and useful information about the Earth and its processes. https://www.usgs.gov/

Iowa Nutrient Research Center: The Iowa Nutrient Research Center was established by the Iowa Board of Regents in response to legislation passed by the Iowa Legislature in 2013. The center pursues science-based approaches to areas that include evaluating the performance of current and emerging nutrient management practices, and providing recommendations on implementing the practices and developing new practices. https://www.cals.iastate.edu/nutrientcenter

The Nature Conservancy: Since 1963, The Nature Conservancy in Iowa has worked to preserve our state's natural landscapes through the advancement of land and water conservation. TNC has project managers across the state who know and work within their own communities to protect and conserve private lands and work with agricultural producers and companies on best management practices.
https://www.nature.org/en-us/about-us/where-we-work/united-states/iowa/

Tallgrass Prairie Center: Mission: Restoring native vegetation for the benefit of society and the environment, with research, education and technology transfer.
Goals: 1) Increase the capacity of the partners and stakeholders to establish and protect native perennial vegetation and restore ecosystem services in the tallgrass prairie region. 2) Increase awareness and appreciation of the Tallgrass Prairie Ecosystem, and understanding of its significance to society. 3) Build a stronger and more resilient organization
https://tallgrassprairiecenter.org/

Iowa Department of Natural Resources: The Iowa DNR manages fish and wildlife programs, ensures the health of Iowa's forests and prairies, and provides recreational opportunities in Iowa's state parks. Just as importantly, the Iowa DNR carries out state and federal laws that protect air, land and water through technical assistance, permitting and compliance programs. The Iowa DNR also encourages the enjoyment and stewardship of natural resources among Iowans through outreach and education.
Mission: To conserve and enhance our natural resources in cooperation with individuals and organizations to improve the quality of life in Iowa and ensure a legacy for future generations. https://www.iowadnr.gov/

Iowa Department of Homeland Security and Emergency Management: Vision: A state prepared, with coordinated capabilities to prevent, protect against, respond to, and recover from all hazards.
Mission: To lead, coordinate, and support homeland security and emergency management functions, as outlines in Iowa Code 29c, in order to establish sustainable communities and ensure economic opportunities for Iowa and its citizens.

https://www.homelandsecurity.iowa.gov/

Iowa Agriculture Water Alliance: Mission: To increase the pace and scale of farmer-led efforts to improve water quality. Furthermore, the Iowa Agriculture Water Alliance (IAWA) works with farmers and convenes partners to drive the adoption of conservation practices and other innovations that will improve water quality. While they raise awareness and facilitate activity statewide, they also take specific action in our priority watersheds. As a result, their efforts bolster existing watershed activities by providing funding, unique outreach approaches and conservation expertise.
https://www.iowaagwateralliance.com/

Iowa Soybean Association: Vision: ISA is recognized for excellence in enhancing long term sustainability of Iowa soybean farmers.
Mission: Expanding opportunities and delivering results for Iowa soybean farmers.
https://www.iasoybeans.com/about/

Iowa Rivers Revival: Mission: Helping Iowans restore, protect and enjoy our rivers.
Vision: Iowa Rivers revival envisions clean, free-flowing Iowa rivers teeming with life, surrounded by diverse landscapes, and connecting vibrant communities.
http://iowarivers.org/

Iowa Learning Farms: Building a Culture of Conservation: Farmer to Farmer and Iowan to Iowan. https://www.iowalearningfarms.org/

Soil and Water Conservation Society: The Soil and Water Conservation Society is driven by their desire to help conservationists and land managers identify and implement the best conservation systems to protect soil and water resources and to achieve global sustainability.
https://www.swcs.org/

Practical Farmers of Iowa: Vision: An Iowa with healthy soil, healthy food, clean air, clean water, resilient farms and vibrant communities.
Mission: Equipping farmers to build resilient farms and communities.
https://practicalfarmers.org/

Clean Water Iowa: The Iowa Water Quality Initiative (WQI) is the action plan for the INRS established in 2013. The WQI improves water quality through a collaborative, research-based approach that is evaluated and reported by a team of independent researchers from multiple institutions, led by Iowa State University. This comprehensive approach allows farmers and cities alike to adopt conservation practices that fit their unique needs, lands, and budgets.

Cedar Valley Paddlers:
The Cedar Valley Paddlers Club is a group of paddling enthusiasts. The mission of the club is to promote recreational opportunities for its members, encourage paddle sport safety and to encourage and advocate for the care of our natural resources.
http://cedarvalleypaddler.wixsite.com/home

11.2. Partnership Strategies

The following strategies will be used to develop and maintain partnerships in the watershed and to take full advantage of the various skills and resources they possess.

- Identify stakeholders with financial resources and pursue collaborations with the most willing and committed parties.
- Identify opportunities for the MCWMA to assist the cities, counties, SWCDs and other stakeholders on their watershed management and conservation efforts.
- Organize annual meetings with urban and rural watershed communities to support and advocate for their watershed management and conservation efforts.
- Utilize existing State and non-profit watershed management and conservation related initiatives.
- Cultivate and expand upon existing private/public partnerships that have been developed in the watershed.

- Continue relationship with the Iowa Agriculture Water Alliance as a long-term financial partner in implementing in-field conservation practices in the watershed.
- Bring in additional partners that may have vested interests in the watershed not already at the table. Specifically conservation and recreation partnerships.
- Cultivate additional partnerships with industries within the watershed with an emphasis on agribusiness.
- Stay current on research for unique and innovative practices for implementation within the watershed.
- Explore unique approaches for crops and methods that are less impactful to the system hydrology and water bodies.

Watershed meeting (Photo Credit: EOR)

12. IMPLEMENTATION SCHEDULE

The following implementation plan summarizes the activities to be taken by the Middle Cedar Watershed Management Authority (MCWMA), with assistance from their many partnering organizations, over the next 20 years. The activities are aimed at meeting the goals and objectives the MCWMA established during the watershed management planning process. The foundation of the plan is to implement conservation practices throughout the watershed in an effort to reduce flooding and improve water quality. Additional implementation activities are identified for each of the primary issues facing the watershed.

The following implementation tables summarize the activities and, in many cases, are grouped by issue area. Further detail on the specific actions to be taken can be found in the relevant section. For instance, the implementation tables do not list each of the recommended education & outreach activities but a list of these activities is provided in Section 9: Education and Outreach Strategies.

The annual costs presented for the conservation practices represent the estimated costs for implementing both agricultural and urban conservation practices to meet the nutrient reduction strategy goals for nitrogen and phosphorus reduction and flood reduction in the prioritized subwatersheds. There is significant variation in costs for the subwatershed with size and inclusion of urban areas being the largest determining factors. Refer to Appendix E for a summary of how the costs were developed. The implementation plan has been divided into three phases.

Phase One: Start Up: The primary focus during the start up phase for the plan will be to complete the implementation element of the Watershed Approach project and to transition the MCWMA to a stable, self-sufficient and effective organization. Phase One implementation plan activities focus on:

- Establishing a strong organization and developing a stable funding mechanism.
- Working with member organizations to educate them about the MCWMA and water resource management opportunities and related policies.
- Continuing/initiating implementation of conservation practices in the High Priority Subwatersheds.

Phase Two: Implementation: The second phase (years 4-18) is essentially the main portion of the implementation plan where most of the recommendation activities will occur. The focus of the activities transitions from the organizational and regulatory initiatives of the first phase into higher rates of conservation practice implementation. Phase Two implementation plan activities focus on:

- Additional feasibility studies.
- Ramping up to 100% of annual expenditures for implementation of conservation practices in High Priority Subwatersheds, shown in **Table 6-2**.
- Phasing in implementation of conservation practices in the Priority Subwatersheds.

Phase Three: Evaluation: The focus of the final phase of the implementation plan, which included the final two years of the 20-year plan, is on:

- Continued implementation of conservation practices.
- Evaluating the effectiveness of MCWMA activities.

Table 12-1. Index to Implementation Activities and Issues Addressed.

Activity #	Implementation Activity Description	Issues Addressed
1	Implement the Subwatershed Conservation Practices Plan	
2	Implement the Education Outreach Implementation Activities	
5	Conduct a Feasibility Study to explore opportunities to utilize the floodway of the Cedar River and other watershed streams (including areas that are currently used for recreation) for temporary storage. Included could be opportunities to utilize areas that have been effectively disconnected from the river.	
6	Serve as a resource for communities within the watershed to achieve the goals identified in their Hazard Mitigation Plans (refer to Hazard Mitigation Plan Goals included as Appendix to this Plan). MCWMA assistance could include; investigating funding opportunities, providing supporting documentation from the watershed plan, or providing maps and data from the watershed assessment.	
7	Serve as a resource to local communities on recreational improvement projects on watershed streams, lakes and riparian corridors and recreational development projects being considered. Assistance from MCWMA could come in the form of promoting partnerships between public and private organizations, providing letters of support, data or mapping on grant applications, or advocating for the value in using recreational areas as opportunities for watershed education.	
8	Complete implementation of conservation practices being installed as part of the Iowa Watershed Approach funding`	
9	Stay up-to-date with Nutrient Reduction Exchange meetings to establish an understanding of tools needed to take advantage of this trading option.	
10	Establish a funding allocation mechanism as described in the Funding & Organizational Strategies Section	
11	Implement the high priority bacteria reduction strategies not addressed by other implementation actions for all subwatersheds; 40% Cattle exclusion from streams and construction of alternative watering supplies.	
12	Encourage the Iowa DNR to develop TMDLs on impaired waters within the watershed as identified in the watershed management plan by submitting a written request.	
13	Encourage the Iowa DNR to conduct Use Assessment and Use Attainability Analysis (UA/UAA) for streams identified in the watershed management plan by submitting a written request.	
14	Continue to partner with Iowa Soybean Association, Coe College, and the City of Cedar Rapids to conduct Snapshot monitoring of streams within the watershed.	
15	Conduct comprehensive Sentinel Site and Flood Preparedness monitoring to evaluate effectiveness of watershed management activities. Provide resources for monitoring.	

Activity #	Implementation Activity Description	Issues Addressed
16	Evaluate the effectiveness of MCWMA activities using the approach outlined in the Monitoring and Effectiveness section.	
17	Serve as a resource to MCWMA members to encourage improved oversight of water-related issues. Assistance could include providing staff resources or technical assistance.	
18	Conduct a Feasibility Study to evaluate upland flood control option including regional detention. Feasibility analysis will be needed to determine, at a minimum, the potential flood reduction benefits to be achieved (presumably only applicable to smaller flood events), costs, and any potential negative impact.	

Key to Issues Icons

Flooding

Water Quality

Recreation

Partnerships

Funding and Organization

Education

Evaluation and Monitoring

Watershed Policy

Table 12-2. Phase 1: Start Up Implementation Schedule

Action	2020	2021	2022	Milestone	Responsible Parties and Partners
Implement the Subwatershed Conservation Practices Plan - Phased in: 7% Year 1, 14% Year 2, 21% Year 3 High Priority Subwatersheds: Black Hawk Park-Cedar River Dry Run Lime Creek Morgan Creek Prescott's Creek-Black Hawk Creek Village of Reinbeck - Black Hawk Creek Wolf Creek	$1,038,000	$2,075,000	$3,113,000	Progress to be tracked using BMP Tracking Tool	Watershed Coordinator, SWCDs, IAWA, DNR, TNC, ISU Extension Outreach, Iowa Flood Center, North Iowa Agronomy Partners
Complete implementation of conservation practices being installed as part of the Iowa Watershed Approach funding	$3,000,000	$0	$0	Fulfillment of HUD Grant Requirements	Watershed Coordinator, SWCDs, DNR, Iowa Flood Center
Serve as a resource for communities within the watershed to achieve the goals identified in their Hazard Mitigation Plans (refer to Hazard Mitigation Plan Goals included as Appendix B to this Plan). MCWMA assistance could include; investigating funding opportunities, providing supporting documentation from the watershed plan, or providing maps and data from the watershed assessment.	$3,000	$3,000	$3,000	Participate in meetings and other activities related to HMP development / updates	Watershed Coordinator, IIHR, HSEMD
Implement the high priority bacteria reduction strategies not addressed by other implementation actions for all subwatersheds;	$16,000	$16,000	$16,000	Progress to be tracked using BMP Tracking Tool	Watershed Coordinator, SWCDs, IAWA, DNR, TNC, ISU Extension Outreach, Iowa Flood Center, North Iowa Agronomy Partners
Encourage the Iowa DNR to develop TMDLs on impaired waters within the watershed as identified in the watershed management plan by submitting a written request.	nom	nom	nom	Yearly request letters	Watershed Coordinator, DNR
Encourage the Iowa DNR to conduct Use Assessment and Use Attainability Analysis (UA/UAA) for streams identified in the watershed management plan by submitting a written request.	nom	nom	nom	Yearly request letters	Watershed Coordinator, DNR
Serve as a resource to local communities on recreational improvement projects on watershed streams, lakes and riparian corridors and recreational development projects being considered. Assistance from MCWMA could come in the form of promoting partnerships between public and private organizations, providing letters of support, data or mapping on grant applications, or advocating for the value in using recreational areas as opportunities for watershed education.	$3,000	$3,000	$3,000	Participate in local meetings as they arise to provide technical assistance	Watershed Coordinator, DNR, Cedar Valley Paddlers
Implement the Education Outreach Implementation Activities	$75,000	$75,000	$75,000	Completion of an annual Education Outreach Workplan	Watershed Coordinator, SWCDs, DNR, ISU Extension Outreach
Serve as a resource to MCWMA members to encourage improved oversight of water-related issues. Assistance could include providing staff resources or technical assistance.	$50,000	$50,000	$50,000	Provide assistance to local communities as requested	Watershed Coordinator, Education Outreach Coordinator, ISWEP, ISU Extension Outreach
Establish a funding allocation mechanism and organizational structure as described in the Funding & Organizational Strategies Section	$30,000			Funding mechanism adopted in 2020	Watershed Coordinator, DNR
Stay up-to-date with Nutrient Reduction Exchange meetings to establish an understanding of tools needed to take advantage of this trading option.	$3,000	$3,000	$3,000	On-going	Watershed Coordinator
Continue to partner with Iowa Soybean Association, Coe College, and the City of Cedar Rapids to conduct Snapshot monitoring of streams within the watershed.	$65,000	$65,000	$65,000	Completion of annual monitoring reports	Iowa Soybean Association, Coe College
Conduct comprehensive Sentinel Site and Flood Preparedness monitoring to evaluate effectiveness of watershed management activities. Provide resources for monitoring	$40,000	$40,000	$40,000	Completion of annual monitoring reports	Iowa Soybean Association, Coe College, DNR, USGS
Evaluate the effectiveness of MCWMA activities using the approach outlined in the Monitoring and Effectiveness section.	$0	$0	$10,000	Evaluation reports in 2022, 2025, 2028	Watershed Coordinator
Phase 1 Implementation Activities Totals	**$4,323,000**	**$2,330,000**	**$3,378,000**		
Total Phase 1		**$10,031,000**			

Nom: nominal cost associated with this action.

Table 12-3. Phase 2: Implementation Schedule

Action	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	Milestone	Responsible Parties
Implement the Subwatershed Conservation Practices Plan High Priority Subwatersheds phased in to 100% by 2026 Priority Subwatersheds start phasing in 2027 Refer to **Table 6-2** Subwatershed Conservation Practices Plan for further detail.	$4,150,000	$5,188,000	$6,225,000	$7,263,000	$8,252,000	$9,241,000	$10,230,000	$11,219,000	$12,208,000	$13,197,000	$14,186,000	$15,175,000	$16,164,000	$17,153,000	$18,142,000	Progress to be tracked using BMP Tracking Tool	Watershed Coordinator, SWCDs, IAWA, DNR, TNC, ISU Extension Outreach, Iowa Flood Center, North Iowa Agronomy Partners
Serve as a resource for communities within the watershed to achieve the goals identified in their Hazard Mitigation Plans (refer to Hazard Mitigation Plan Goals included as Appendix B to this Plan). MCWMA assistance could include; investigating funding opportunities, providing supporting documentation from the watershed plan, or providing maps and data from the watershed assessment.	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	Participate in meetings and other activities related to HMP development / updates	Watershed Coordinator, IIHR, HSEMD
Conduct a Feasibility Study to evaluate upland flood control option including regional detention. Feasibility analysis will be needed to determine, at a minimum, the potential flood reduction benefits to be achieved (presumably only applicable to smaller flood events), costs, and any potential negative impact.				$250,000												Study completion in 2026	Watershed Coordinator, IIHR
Conduct a Feasibility Study to explore opportunities to utilize the floodway of the Cedar River and other watershed streams (including areas that are currently used for recreation) for temporary storage. Included could be opportunities to utilize areas that have been effectively disconnected from the river. Feasibility analysis will be needed to determine, at a minimum, the potential flood reduction benefits to be achieved (presumably only applicable to smaller flood events), costs, and any potential negative impact.	$100,000															Study completion in 2023	Watershed Coordinator, IIHR

Action	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	Milestone	Responsible Parties
Implement the high priority bacteria reduction strategies not addressed by other implementation actions for all subwatersheds; 40% Cattle exclusion from streams and construction of alternative watering supplies.	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	Progress to be tracked using BMP Tracking Tool	Watershed Coordinator, SWCDs, IAWA, DNR, TNC, ISU Extension Outreach, Iowa Flood Center, North Iowa Agronomy Partners
Encourage the Iowa DNR to develop TMDLs on impaired waters within the watershed as identified in the watershed management plan by submitting a written request.	nom	nom	nom	nom	nom	nom	nom	nom	nom	nom	nom	nom	nom	nom	nom	Yearly request letters	Watershed Coordinator, DNR
Encourage the Iowa DNR to conduct Use Assessment and Use Attainability Analysis (UA/UAA) for streams identified in the watershed management plan by submitting a written request.	nom	nom	nom	nom	nom	nom	nom	nom	nom	nom	nom	nom	nom	nom	nom	Yearly request letters	Watershed Coordinator, DNR
Serve as a resource to local communities on recreational improvement projects on watershed streams, lakes and riparian corridors and recreational development projects being considered. Assistance from MCWMA could come in the form of promoting partnerships between public and private organizations, providing letters of support, data or mapping on grant applications, or advocating for the value in using recreational areas as opportunities for watershed education.	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	Participate in local meetings as they arise to provide technical assistance	Watershed Coordinator, DNR, Cedar Valley Paddlers
Implement the Education Outreach Implementation Activities	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	Completion of an annual Education Outreach Workplan	Watershed Coordinator, SWCDs, DNR, ISU Extension Outreach
Serve as a resource to MCWMA members to encourage improved oversight of water-related issues. Assistance could include providing staff resources or technical assistance.	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	Provide assistance to local communities as requested	Watershed Coordinator, Education Outreach Coordinator, ISWEP, ISU Extension Outreach
Continue to partner with Iowa Soybean Association, Coe College, and the City of Cedar Rapids to conduct Snapshot monitoring of major tributaries within the watershed.	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000	Completion of annual monitoring reports	Iowa Soybean Association, Coe College

Action	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	Milestone	Responsible Parties
Conduct comprehensive water quality and quantity monitoring in a select subwatershed to evaluate effectiveness of watershed management activities.	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	Completion of annual monitoring reports	Iowa Soybean Association, Coe College, DNR, USGS
Evaluate the effectiveness of MCWMA activities using the approach outlined in the Monitoring and Effectiveness section.	$10,000			$10,000												Evaluation reports in 2022, 2025, 2028	Watershed Coordinator
Phase 2 Implementation Activities	**$4,477,000**	**$5,405,000**	**$6,442,000**	**$7,740,000**	**$8,469,000**	**$9,458,000**	**$10,447,000**	**$11,436,000**	**$12,425,000**	**$13,414,000**	**$14,403,000**	**$15,392,000**	**$16,381,000**	**$17,370,000**	**$18,359,000**		
Total Phase 2	**$172 Million**																

Nom: nominal cost associated with this action.

Table 12-4. Phase 3: Evaluation Implementation Schedule

Implementation Action	2038	2039	Milestone	Responsible Parties
Implement the Subwatershed Conservation Practices Plan 100% implementation in High Priority and Priority Subwatersheds Refer to **Table 6-2**, Subwatershed Conservation Practices Plan for further information.	$19,131,000	$20,120,000	Progress to be tracked using BMP Tracking Tool	Watershed Coordinator, SWCDs, IAWA, DNR, TNC, ISU Extension Outreach, Iowa Flood Center, North Iowa Agronomy Partners
Serve as a resource for communities within the watershed to achieve the goals identified in their Hazard Mitigation Plans (refer to Hazard Mitigation Plan Goals included as Appendix B to this Plan). MCWMA assistance could include; investigating funding opportunities, providing supporting documentation from the watershed plan, or providing maps and data from the watershed assessment.	$3,000	$3,000	Participate in meetings and other activities related to HMP development / updates	Watershed Coordinator, IIHR
Implement the high priority bacteria reduction strategies not addressed by other implementation actions for all subwatersheds; 40% Cattle exclusion from streams and construction of alternative watering supplies.	$16,000	$16,000	Development of a Memorandum of Agreement with Watershed Communities in 2020	Watershed Coordinator, IIHR
Encourage the Iowa DNR to develop TMDLs on impaired waters within the watershed as identified in the watershed management plan by submitting a written request.	nom	nom	Progress to be tracked using BMP Tracking Tool	Watershed Coordinator, SWCDs, IAWA, DNR, TNC, ISU Extension Outreach, Iowa Flood Center, North Iowa Agronomy Partners
Encourage the Iowa DNR to conduct Use Assessment and Use Attainability Analysis (UA/UAA) for streams identified in the watershed management plan by submitting a written request.	nom	nom	Yearly request letters	Watershed Coordinator, DNR
Serve as a resource to local communities on recreational improvement projects on watershed streams, lakes and riparian corridors and recreational development projects being considered. Assistance from MCWMA could come in the form of promoting partnerships between public and private organizations, providing letters of support, data or mapping on grant applications, or advocating for the value in using recreational areas as opportunities for watershed education.	$3,000	$3,000	Participate in local meetings as they arise to provide technical assistance	Watershed Coordinator, DNR
Implement the Education Outreach Implementation Activities	$40,000	$40,000	Completion of an annual Education Outreach Workplan	Education Outreach Coordinator, SWCDs, DNR, ISU Extension Outreach
Serve as a resource to MCWMA members to encourage improved oversight of water-related issues. Assistance could include providing staff resources or technical assistance.	$50,000	$50,000	Development of a Memorandum of Agreement with Watershed Communities in 2020	Watershed Coordinator, Education Outreach Coordinator, ISWEP, ISU Extension Outreach
Continue to partner with Iowa Soybean Association, Coe College, and the City of Cedar Rapids to conduct Snapshot monitoring of major tributaries within the watershed.	$65,000	$65,000	Completion of annual monitoring reports	Iowa Soybean Association, Coe College
Conduct comprehensive water quality and quantity monitoring in a select subwatershed to evaluate effectiveness of watershed management activities.	$40,000	$40,000	Completion of annual monitoring reports	Iowa Soybean Association, Coe College, DNR, USGS
Evaluate the effectiveness of MCWMA activities using the approach outlined in the Monitoring and Effectiveness section.	$10,000	$10,000	Evaluation reports in 2022, 2025, 2028	Watershed Coordinator
Phase 3 Implementation Activities	**$19,358,000**	**$20,347,000**		
Total Phase 3	**$39,705,000**			

Nom: nominal cost associated with this action.

Cumulative Cost 2020-2039: $221,354,000

13. ACRONYMS

ACPF	Agricultural Conservation Planning Framework
ADBNET	Iowa Department of Natural Resources Water Quality Database
ARS	Agricultural Research Service
AFO	Animal Feeding Operation
BMIBI	Benthic Macroinvertebrate Index of Biotic Integrity
BMP	Best Management Practice
BOD_5	5-day biochemical oxygen demand
BWW	Warm Water Aquatic Use
Chl-*a*	Chlorophyll-*a*
CIS	Connected Impervious Surfaces
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CRW	Cedar River Watershed
CWA	Clean Water Act
Deg C	Degrees Celsius
DEP	Daily Erosion Project
DHS	Department of Homeland Security
DNR	Department of Natural Resources
DO	Dissolved Oxygen
DRP	Dissolved Reactive Phosphorus
E. coli	*Escherichia coli*
EPA	Environmental Protection Agency
EPS	Iowa Soybean Association Environmental Programs and Services
FEMA	Federal Emergency Management Agency
FIBI	Fish Index of Biotic Integrity
FRM	Flood Risk Map
FRR	Flood Risk Report
GHOST	Generic Hydrologic Overland Subsurface Toolkit
GIS	Geographic Information Systems
GPM	Gallons per minute
GU	General Use
HSEMD	Iowa Department of Homeland Security and Emergency Management
HH	Human Health
HSG	Hydrologic Soils Groups
HSPF	Hydrologic Simulation Program Fortran
HUC	Hydrologic Unit Code
HUD	Department of Housing and Urban Development
IAC	Iowa Administrative Code
IBI	Index of Biological Integrity
IFC	Iowa Flood Center
IFIS	Iowa Flood Information System
IIHR	University of Iowa's Hydroscience and Engineering
INRS	Iowa Nutrient Reduction Strategy

IR	Impaired Resource
ISA	Iowa Soybean Association
ISTS	Individual Sewage Treatment System
ISU	Iowa State University
ISWEP	Iowa Storm Water Education Partnership
ISWMM	Iowa Stormwater Management Manual
IWA	Iowa Watershed Approach
IWC	Iowa Water Center
IWQIS	Iowa Water-Quality Information System
km^2	square kilometer
LA	load allocation
Lb	pound
lb/day	pounds per day
lb/yr	pounds per year
m	meter
MAP	Mapping, Assessment, and Planning
MCL	maximum contaminant level
MCW	Middle Cedar Watershed
MCWMA	Middle Cedar Watershed Management Authority
mg/L	milligrams per liter
MH	multi-habitat sample
mL	milliliter
MMP	Manure Management Plan
MPCA	Minnesota Pollution Control Agency
MPN	Most Probable Number
MRCC	Midwest Row Crop Collaborative
NEXRAD	Next Generation Weather Radar
NLCD	National Land Cover Dataset
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OIW	Outstanding Iowa Water
P	Phosphorus
REAP	Rural Energy for America Program
RNR	River Nutrient Region
SFHA	Special Flood Hazard Area
SH	standar-habitat sample
SSTS	Subsurface Sewage Treatment Systems
SSURGO	Soil Survey Geographic
STRIPS	Science-based Trails of Rowcrops Integrated with Prairie Strips
SWAT	Soil and Water Assessment Tool
SWCD	Soil and Water Conservation District
SWP	Source water protection
TDS	Total dissolved solids
TMDL	Total Maximum Daily Load
TP	Total phosphorus
TSS	Total Suspended Solids

UAA	use attainability analysis
UI CEA	University of Iowa Center for Evaluation and Assessment
UNI	University of Northern Iowa
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UV	Ultraviolet
WASCOB	Waster and Sediment Control Basins
WGA	West Growth Area
WLA	Wasteload Allocation
WMA	Watershed Management Authority
WRP	Wetland Reserve Program
WWTP	Wastewater Treatment Plant
µg/L	Microgram per liter

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