Prepared by: EOR/IVRCD/ISA

For the Middle Cedar Watershed Management Authority

Headwaters Prairie Creek HUC-12 Subwatershed Plan

March 2020

Cover Image:

Prairie Creek at 16th Avenue near Keystone, Iowa (Photo Credit: Emmons and Olivier Resources).

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1. INTRODUCTION

The following subwatershed plan was developed as a component of the Middle Cedar Watershed Management Plan (MCWMP). The MCWMP was funded using federal funds from the U.S. Department of Housing and Urban Development pursuant to Title I of the Housing and Community Development Act of 1974. The Iowa Economic Development Authority (IEDA) was awarded a Community Development Block Grant National Disaster Resilience (CDBG-NDR) Federal award B-13-DS-19-0001 and awarded a portion of those funds to Benton County through grant 13-NDRI-006 to develop the MCWMP.

As a component of the overall watershed management planning process, development of this subwatershed plan used an abbreviated stakeholder engagement process consisting of two meetings with local representatives to discuss issues facing the watershed and approaches for improvements. This subwatershed plan includes a general overview of the physical conditions of the area with references to more detailed information that can be found in the MCWMP.

The planning team, Emmons & Olivier Resources (EOR), Iowa Valley Resource Conservation and Development (IVRCD) and the Iowa Soybean Association (ISA), would like to extend a sincere thank you to the following organizations, agencies, and individuals: Iowa State University Extension and Outreach for Benton County, Greg Walston, County Extension Program Director. Iowa Natural Resources and Conservation Services Vinton Field Office staff, Becky Van Wey, State Technician. Meeting attendees Sam Franzenburg, Randy Franzenburg, Matt Becke, Duane and Pam England, Robert Ritzeter, Gary Thompson, Tom Harty, Harold Klug, Darold Laackmann, Josh and Todd Hennings, Justin Kaiser, Sherwin Kuch, Dean and Nancy Jensen, Tim Sage, Seth Newton, Dowald Jensen, Tyler Franzenburg, Reta Westercamp, Gary Bierschenk, Evan Brehm, Tanner Brecht, and Justin Clark.

The following plan provides a snapshot of information that will assist watershed planners, resource conservationists, and organized groups in creating targeted strategies for improving this subwatershed. **Section 2** of this report describes the stakeholder engagement process used to develop this plan. **Section 3** outlines general watershed characteristics, such as, demographics, geographic and political boundaries, and land use. The section also provides an overview of the water resources within and downstream of the subwatershed including any stream impairments. A detailed analysis of pollutant sources within the subwatershed is also included.

A narrative describing the issues facing the Middle Cedar Watershed (MCW) and the specific issues facing this subwatershed is provided in **Section 4** of this plan. The summary of issues was developed after the series of meetings with subwatershed residents. The flood mitigation and water quality conservation practices and the recommended adoption rates needed to meet the Iowa Nutrient Reduction Strategy (INRS) targets are summarized in **Section 6**. A cost benefit analysis of the recommended conservation practice adoption rates is provided in **Section 7**. Recommendations for practices and areas within the subwatershed to prioritize implementation are also provided in **Section 7** along with maps that can be found in **Appendix A**.

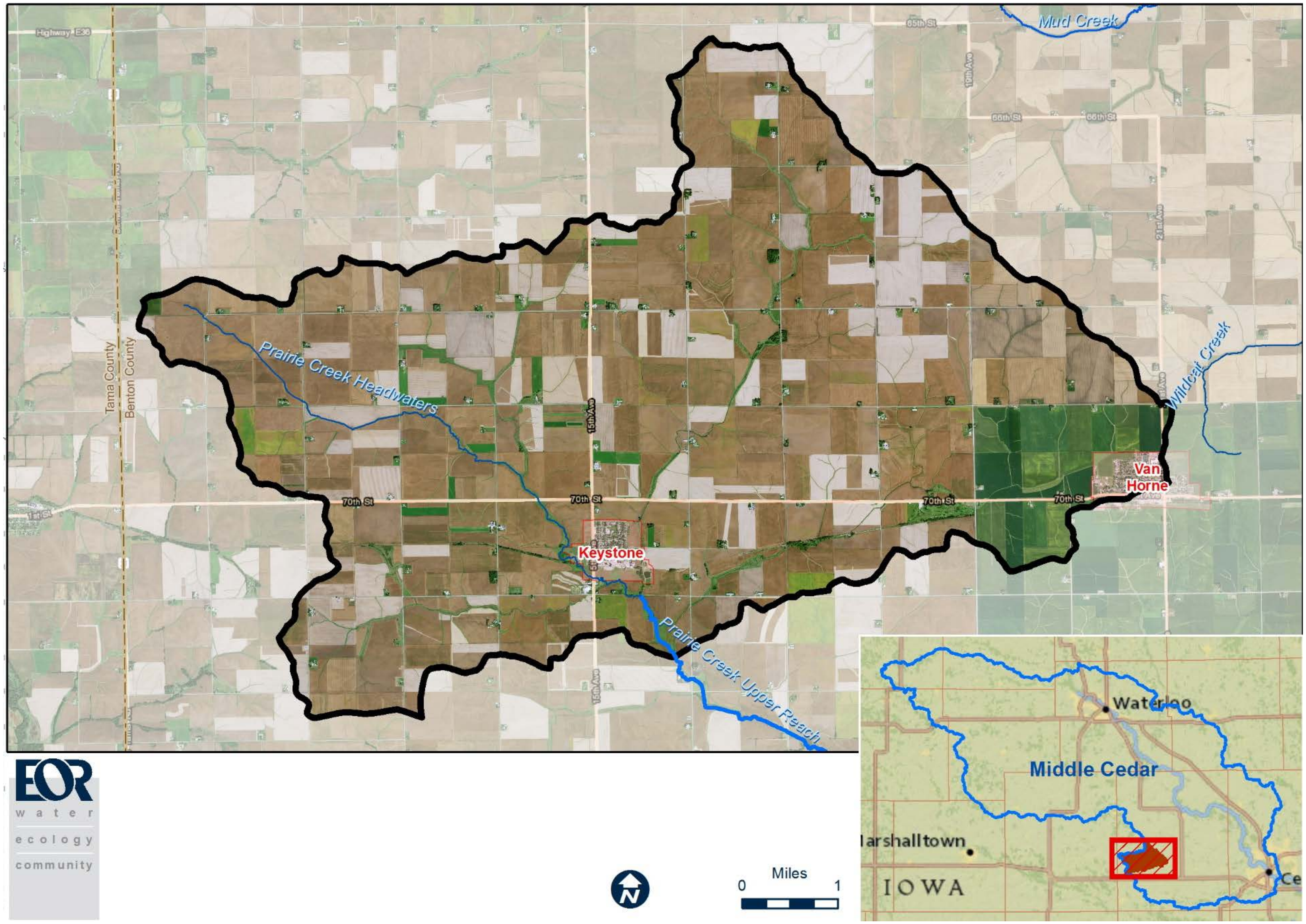

Figure 1. Headwaters Prairie Creek Subwatershed.

2. STAKEHOLDER ENGAGEMENT PROCESS

Partnering with the Iowa Soybean Association (ISA), the planning team hosted two separate meetings to engage local landowners and residents. Both meetings were held in the City of Van Horne at the Van Horne Community Building. Meeting dates were February 26 and March 19, 2018.

The planning team executed these outreach practices to reach residents:

- A letter was sent via U.S. postal mail inviting more than 225 Iowa Soybean Association members in the subwatershed to join the input sessions.
- Handouts and fliers were mailed to the City of Van Horne to be posted in local gathering places, such as City Hall and the Public Library.
- Phone calls were made to all attendees of the first meeting, in order to gauge interest and to encourage attendance at the second meeting.

The initial meeting had 25 participants, including farmers, landowners, agricultural retailers, and soil and water professionals. The first portion of the meeting covered basic watershed information, such as how a watershed is delineated on the landscape and how different land uses impact water quality and soil health. In order to provide context for the series of input meetings, the planning team described the larger MCWMP and outlined the upcoming timeline and deliverables.

During the second portion of the meeting, the team walked participants through two ranking exercises, where attendees submitted anonymous ballot sheets to be tallied and analyzed after the meeting. The first exercise provided a list of priorities, such as the INRS, water quality, and flood risk, and asked attendees to rank them according to importance. During this section of the discussion, one farmer remarked that there was less water in streams year-round. He remembered water in the creek decreasing later in the summer back in the 1970s, but now it's happening in June. The farmer believed it was due to tile drainage and hasn't reported seeing higher flows in the springtime. One farmer asked if there are any practices that are better than others for nutrient reduction, and staff responded that several options were optimal and that research is continually evolving conservation practices. When asked to rank wildlife habitat, a few farmers expressed interest in including butterfly or pollinator habitat.

A significant issue remarked by attendees was flooding. Several farmers stated that they suffer an economic loss from flooding and while Cedar Rapids complains about their flooding/economic loss, farmers are similarly impacted. One farmer commented that he was getting two to three floods back in the 1980s and couldn't do anything about it, "I had to laugh otherwise I'd start crying!", he stated. There was tension around Cedar Rapids' ability to build an engineered dike system. In the end, the participants agreed that flooding and flood management would be best managed through collaborative ideas.

The second exercise had participants rank conservation practices that would have a high adoption rate in the watershed. The planning team walked the group through each item on the list, which included practices such as grassed waterways, saturated buffers, and nitrification inhibitors. Participants were asked to describe the specific benefits and challenges of each practice. For instance, grassed waterways effectively reduce phosphorous runoff and provide beneficial wildlife habitat, but do not increase soil health, reduce flooding, or improve aquatic life. The group response to the list of conservation practices was fairly mixed, and the overall concern was cost as a central decision-making factor. Another question that was raised centered on research that spoke to the effectiveness of nutrient management, one of the coop technicians stated that weather can have a substantial impact on it. One area that generated quite a bit of discussion was bioreactors. Several farmers wanted to know if there were many installed in Iowa and how well they are working. Staff responded that roughly 60 are in the state and even though they are a relatively new practice, there has been quite a bit of monitoring and research. There is an oxbow restoration near Blairstown and it was noted that this would be a good opportunity to host a field day so landowners and farmers could see the practice in person. Cost was the main topic of interest, with many farmers wanting to know if there were cost-share opportunities. Natural Resources Conservation Service (NRCS) staff commented that they would be able to provide a list of practices available for cost-share.

The second meeting invited all of the original invitees that ISA had contacted for the first meeting, and previous attendees received personal, follow-up phone calls or emails. There were 10 participants at the meeting. The purpose of this meeting was:

1. Report and verify the initial ranking results for priorities and practices.
2. Introduce modeling data to assist the group in visualizing the impacts of their prioritized practices.
3. Create achievable practice implementation goals that meet the INRS.

The planning team kicked off the meeting by going through each priority and conservation practice and asking if the collective, individual rankings accurately reflected the general experience of the subwatershed. The group agreed that the results of the prioritization were accurate with their experience, with the top three priorities noted as Agricultural Sustainability/Profitability, Soil Health, and Urban-Rural Collaboration. Much of the conversation surrounded the importance of the urban area making just as much of an effort to protect waterways from contamination as rural areas. One participant noted that while farmers are required to get certification to apply chemicals to their farms, lawns and roadways in urban areas drain all of the grit and grime right into the rivers and creeks.

When reviewing the results of the prioritized practices, grassed waterways, nutrient management, and buffers were the top three highest priorities. Attendees expressed a desire to keep the practices to familiar, in-field practices, and only if there was additional funding provided to the farmer.

In order to achieve the INRS goals of a 41 percent load reduction in nitrogen and 29 percent load reduction in phosphorus to meet the overall 45 percent reduction goal, the planning team introduced the Agricultural Conservation Planning Framework (ACPF). This framework is a data-modelling tool that processes high-resolution topographic data to identify field-scale and edge-of-field practices that can be installed in the subwatershed. The ACPF helps planners and stakeholders visualize where certain practices can be strategically located to create the greatest benefit to the watershed.

One of the few practices that was seen as feasible was an increase in wetland practices in the subwatershed. Overall farmers and landowners had a difficult time working with the data presented because they did not have adequate cost estimates for installation.

3. WATERSHED CHARACTERIZATION

3.1. General Background

The Headwaters Prairie Creek Subwatershed is located in the southwest corner of Benton County (see **Figure 1)**. According to the 2010 US Census Bureau Data the subwatershed has an estimated population of 1,415 with the majority of those residents living within the City of Van Horne and the City of Keystone. The population density of the subwatershed is 56 people per 1,000 acres. The Headwaters Prairie Creek subwatershed population represents less than 1.0 percent of the total population of the Middle Cedar Watershed.

The 25,321-acre area is classified as a HUC-12 Subwatershed in the United States Geological Survey (USGS) hierarchical system. It is a subdivision of the Prairie Creek HUC-10 Watershed and the Middle Cedar HUC-8 Subbasin.

3.2. Land Cover

The predominant land cover of the Headwaters Prairie Creek Subwatershed is row crop agriculture. According to the High Resolution Landcover of Iowa 2009 (HRLC) data set the subwatershed is 88 percent row crop agriculture. The HRLC data was derived from three dates of aerial imagery and elevation information derived from LiDAR (Light Detection and Ranging). The HRLC has a spatial resolution of one meter, and a class resolution of 15 classes, which were combined into the five general categories shown in **Figure 2**. Additional information, including a link to download the actual data, on the HRLC can be found at https://geodata.iowa.gov/dataset/high-resolution-land-cover-iowa-2009

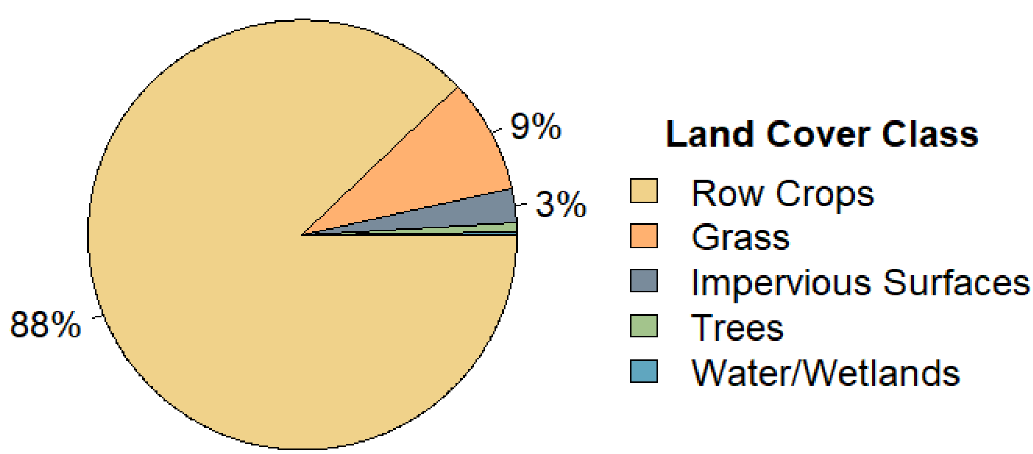

Figure 2. Land Cover of the Headwaters Prairie Creek Subwatershed.

3.3. Streams

The Headwaters Prairie Creek Subwatershed, as the name suggests, is home to the headwaters, or origin of Prairie Creek. It also includes two unnamed creeks.

Upper Reach of Prairie Creek. The creek is defined as the following segment: from the confluence with Mud Creek (S21, T82N, R9W, Benton Co.) to the confluence with unnamed tributary in S13, T83N, R12W, Benton Co. While the waterway extends much further into the subwatershed (as shown on **Figure 3**) this is the Iowa Designated Stream Reach portion of the stream.

Unnamed Creek. This small tributary to the upper reach of Prairie Creek runs along the southern edge of the subwatershed (**Figure 3**) and is defined as: Mouth (S. line, S13, T83N, R12W, Benton Co.) to Railroad Street (SE1/4, S13, T83N, R12W, Benton Co.).

Unnamed Creek. This very small stream segment is defined as: Mouth (SE 1/4, S24, T83N, R12W, Benton Co.) to the Van Horne WWTP outfall (SW 1/4, S11, T83N, R11W, Benton Co.).

The Upper Reach of Prairie Creek has a designated use classification of A1 B(WW-2) and the two unnamed streams within the subwatershed have a Designated Use classification of A2 B(WW-2). The Designated Uses are defined as follows:

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.

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.

Warm water Type 2: Class BWW-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.

3.4. Lakes

There are no lakes in the Headwaters Prairie Creek Subwatershed.

3.5. Ground Water

The Headwaters Prairie Creek Subwatershed does not contain a Highly Susceptible Community Water Supply or a Priority Community Water Supply System. Refer to the Middle Cedar Watershed Management Plan (MCWMP) for information related to source water quality and groundwater sensitivity.

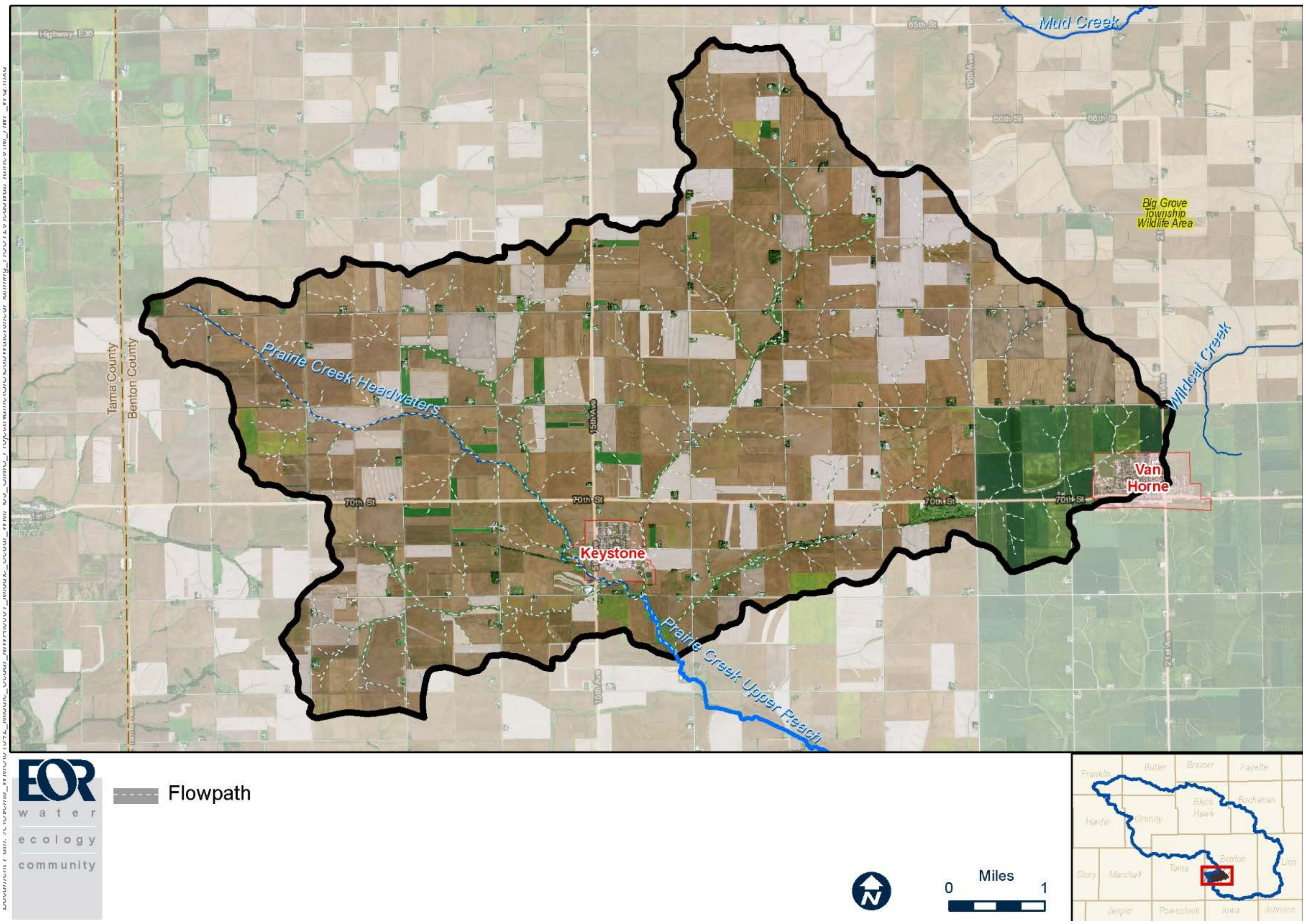

Figure 3. Water Resources of the Headwaters Prairie Creek Subwatershed.

3.6. Flooding

Flooding occurs within the subwatershed along the entire reach of Prairie Creek, the unnamed creek in the southern portion of the subwatershed, and many of the local waterways. **Figure 4** shows the areas that become inundated during a 100-year flood event. This information was developed by the Iowa Flood Center. Further information and interactive tools to display flooding information can be viewed at the Iowa Flood Information System: http://ifis.iowafloodcenter.org/ifis/.

The financial impact to buildings and their content as a result from the 100-year storm event within the subwatershed is estimated at $ 1,073,394 according to the Flood Risk Report for the Middle Cedar Watershed developed by the Federal Emergency Management Agency (FEMA) (2015). This loss is equivalent to roughly $750 per resident of the subwatershed. The Headwaters Prairie Creek Subwatershed has the 34th highest financial losses due to the 100-year flood event of the 68 subwatersheds within the MCW. **Figure 4** shows areas within the subwatershed that have been determined to have high to very high risk for flood damages according to the FEMA study.


Prairie Creek (Photo credit: EOR)

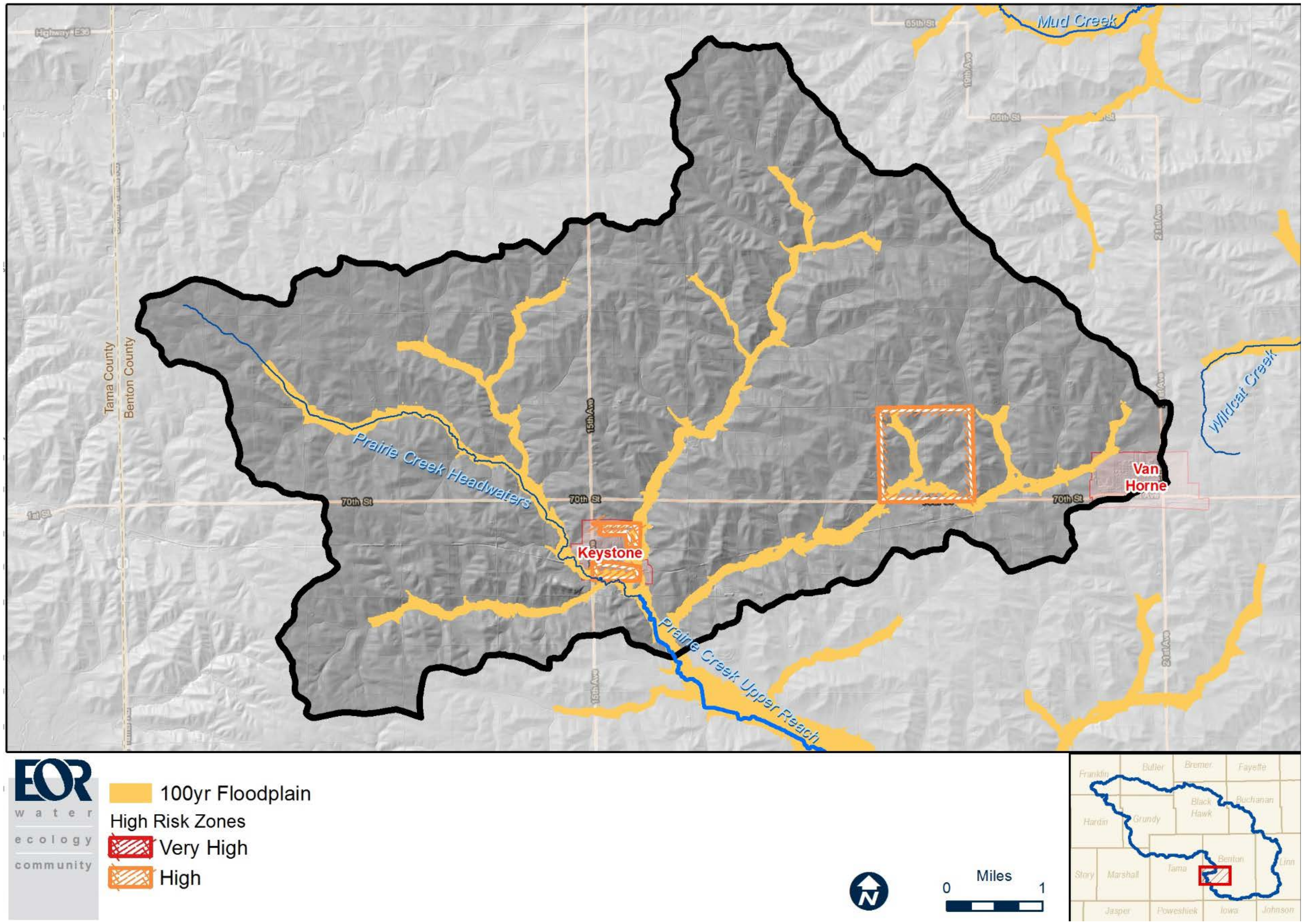

Figure 4. Flooding within the Headwaters Prairie Creek Subwatershed.

3.7. Water Quality

Nonpoint source pollutants traditionally addressed in watershed management plans include sediment, fecal bacteria, 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, as well as a suite of pollutants that are typically referred to as contaminants of emerging concern (CECs), which include pharmaceuticals and personal care products.

In Iowa, sediment is the leading nonpoint source pollutant. Most sediment in Iowa comes from erosion on agricultural land, but high levels of sediment also come from 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.

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 Escherichia coli (*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 our waters are diverse and include wildlife populations, livestock, pets, and even human sewage. High levels of bacteria have been found in several segments of the Cedar River (refer to the Cedar River Watershed Bacteria TMDL discussion) including a segment downstream of the Prairie Creek confluence.

Nutrients, especially nitrogen and phosphorus, are other major nonpoint pollutants in Iowa. Nutrients are naturally occurring within our soils and plant matter, but excess nutrients can be added to our waters from fertilizers (both on agricultural land and on residential lawns, golf courses, etc.) 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 our 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. Algal blooms can reach harmful levels when they pose significant health concerns. Harmful algal 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 are more likely to wade into lakes with algal scum; several have died from blue-green algae exposure.

There is no State standard for phosphorus in Iowa. Minnesota has established standards for phosphorus in streams that are unique to nutrient regions across the State (https://www.revisor.mn.gov/rules/?id=7050.0222). The total phosphorus standard for streams in the Southern region of Minnesota is 0.15 mg/l. This number can be used as a reference point for reviewing water quality measurements in the subwatershed. Total phosphorus is made up of several forms of phosphorus; dissolved reactive phosphorus, particulate inorganic phosphorus, dissolved organic phosphorus, and particulate organic phosphorus. Not all of these forms of phosphorus are routinely measured. As shown in **Table 1**, the Iowa Soybean Association (ISA) currently monitors dissolved reactive phosphorus. A relationship can be established between this form and total phosphorus so a reference point could be developed for comparison to the Minnesota derived reference point described above.

High levels of nutrients can also cause water to be unfit for drinking. A segment of the Cedar River within Cedar Rapids has been designated by the State as a drinking water supply, however, this segment of the Cedar River is above the confluence of Prairie Creek.

3.7.1. Subwatershed Monitoring Data

ISA conducted snapshot monitoring during 2018 at several tributaries to the Middle Cedar River, including a site on Prairie Creek south of Keystone at 16th Avenue. Data was collected once a month during the months May, June, July, and August. The average of the four samples from the ISA snapshot monitoring for 2017 is shown in **Table 1**. Monitoring results show elevated levels of Phosphorus and *E. coli*. A final report summarizing the findings of the 2018 monitoring will be completed and will be available from the City of Cedar Rapids.

Table 1. ISA Snapshot Monitoring Results, 2017.

Parameter	Concentration
Total Suspended Solids (mg/L)	24
E.coli (MPN/100mL)	3,478
Nitrate as N (mg/L)	6.19
Dissolved Reactive Phosphorus as P (mg/L)	0.51

3.7.2. Impaired Waters

The State of Iowa has developed State Water Quality Standards that are found in Chapter 61 of the Iowa Administrative Code (https://www.legis.iowa.gov/docs/ACO/chapter/567.61.pdf.) 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 or not 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 US Environmental Protection Agency (US EPA). This list, referred to as the Impaired Waters List includes information on impaired use, the source of impairment and whether or not a Total Maximum Daily Load (TMDL) will be required. A TMDL is the calculation of the maximum amount of a pollutant allowed to enter a waterbody so that the waterbody will meet and continue to meet water quality standards for that particular pollutant. A TMDL also determines a pollutant reduction target and allocates load reductions necessary to the source(s) of the pollutant. Further detail on TMDL content can be found in TMDL Studies section below.

The upper segment of Prairie Creek was assessed by the Iowa Department of Natural Resources (Iowa DNR and was determined to be impaired. A summary of the assessment can be found in **Table**

2. The impaired segment has been on the State's list of impaired waters since 2008. Details on the assessment and resulting impairment listing can be found on Iowa Department of Natural Resources website at: https://programs.iowadnr.gov/adbnet/Segments/510.

Table 2. Prairie Creek Segment 510 Assessment Summary.

Impairment Code	4d - Pollutant-caused fish kill. No TMDL needed and administrative action taken against responsible party.
Cause Magnitude	Moderate
Status	Continuing
Source	Agriculture: Animal Feeding Operations
Source Confidence	N/A
Cycle Added	2004
Impairment Rationale	Pollutant-caused fish kill
Data Source	Fish kill investigation: Iowa DNR

The presumptive Class A1 (primary contact recreation) uses remain "not assessed" (IR 3a) due to a lack of water quality information upon which to base an assessment. The Class B(WW-2) aquatic life uses remain assessed (monitored) as "not supported" (IR 4d) due to fish kills in July 2006, October 2006, and October 2012.

The first fish kill occurred on or before July 18, 2006 and was attributed to runoff from an open feedlot on a small tributary of Prairie Creek. Rainfall from the previous night washed manure and corn glucose from the feedlot into the tributary to Prairie Creek. Approximately 108,882 dead fish including carp, white suckers, smallmouth bass, and minnows were found up to 14 miles downstream of the tributary. The estimated value of the dead fish was $18,306.78. The party responsible for the kill was identified, and restitution was sought and received.

The second fish kill occurred on or before October 20, 2006 and was caused by hog manure that entered the creek when a coupler on an umbilical line failed while it was draining a hog facility. The kill occurred southeast of Keystone and affected 3.4 miles of the stream. Approximately 22,809 fish were killed. No information on types of fish was provided. The estimated value of the dead fish was $8,484.01. The party responsible for the kill was identified, and restitution was sought and received.

The third kill occurred on October 25, 2012 and was caused by manure runoff from on open cattle feedlot following a rainfall event. An estimated 20,800 fish were killed over approximately 3 miles of Prairie Creek near Blairstown. The value of the fish killed was estimated at $2,950. The party responsible for the kill was identified, and restitution was sought and received by Iowa DNR.

According to Iowa DNR's assessment methodology for Section 305(b) reporting, occurrence of a single pollution-caused fish kill during an assessment period indicates "partial support" of the aquatic life uses. If, however, a consent order has been issued to the party responsible for the kill and monetary restitution has been sought for the fish killed, the affected waterbody should be placed in IR Category 4d (impaired but TMDL not required). Thus, based on the two kills that occurred in 2006, this assessment segment was moved from Category 5b of Iowa's 2008 Integrated Report to Category 4d of Iowa’s 2010 Integrated Report based on updated information regarding restitution for this fish kill. Due to the fish kill in October 2012, and due to the recovery of restitution of the value of the fish killed and the cost of the Iowa DNR fish kill investigation, the aquatic life uses of this stream will remain assessed as impaired (not supporting) and placed in Category 4d of Iowa’s Integrated Report.

3.7.3. Total Maximum Daily Load (TMDL) Studies

The Headwaters Prairie Creek Subwatershed drains to one impaired stream segment for which a (TMDL) has been developed. 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). TMDLs determine a pollutant reduction target and allocate a portion of the needed reductions to each source of pollutant. 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.

Cedar River Watershed Bacteria TMDL

EPA Region 7 developed the *Total Maximum Daily Load Cedar River Watershed, Iowa for Indicator Bacteria, Escherichia coli (E. Coli)* (EPA 2010). The TMDL covers the entire Cedar River Watershed and includes four impaired segments of the Cedar River within the Middle Cedar Watershed. Two additional segments of the Cedar River downstream of the Middle Cedar Watershed are included in the TMDL which is relevant because the entire Middle Cedar Watershed drains to these impaired segments and, therefore, is subject to the TMDL. The primary contact recreation (Class A1) uses for each stream segment were determined to be impaired by the indicator bacteria *Escherichia coli* (*E. coli)*. Based on a review of the flow and water quality data available throughout the watershed, it was determined that bacteria 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.

3.8. Recreational Opportunities

There are currently no formal water-based recreational uses of Prairie Creek within the subwatershed. There are several recreation opportunities in the region, particularly on the downstream Cedar River. More information on the Cedar River, including maps and access points, see the Cedar Falls Tourism website at:

http://www.cedarfallstourism.org/webres/File/Trails/Cedar-Valley-Paddlers-Trail-Map-Iowa-DNR.pdf.

3.9. Pollutant Source Assessment

Three separate tools have been developed for the MCW to estimate pollutant loading at the HUC-12 Subwatershed level. These tools allow for a comparison between subwatersheds and are used to prioritize subwatersheds for future implementation.

3.9.1. SWAT Model

The World Wildlife Federation (WWF) along with researchers at the University of Minnesota (UMN) developed a Soil and Water Assessment Tool (SWAT) model for the MCW. SWAT is a river basin scale model developed to quantify the impact of land management practices in large, complex watersheds. SWAT is a public domain software enabled model actively supported by the USDA Agricultural Research Service. It is a hydrology model with the following components: weather, surface runoff, return flow, percolation, evapotranspiration, transmission losses, pond and reservoir storage, crop growth and irrigation, groundwater flow, reach routing, nutrient and pesticide loading, and water transfer.

The Middle Cedar SWAT model simulates a 10-yr period from 1/1/2004 to 12/31/2013 and has a fairly course level of resolution. Limited data was available at the time of model construction for use in calibration so the most appropriate use of this model is for making comparisons between subwatersheds. The loading rates estimated by the SWAT Model are appropriate for evaluating relative differences between subwatershed and not for determining absolute values. The SWAT model is well suited for rural watersheds. It does not adequately simulate hydrology or nutrient loading dynamics that occur in urban areas.

The SWAT model estimates loading rates at the subwatershed scale for total nitrogen, nitrate from tile drainage, phosphorus and sediment with results reported in terms of average annual loads per acre. **Table 3** summarizes the SWAT model loading estimates for the Headwaters Prairie Creek Subwatershed along with the relative ranking of this subwatershed within the MCW.

Table 3. SWAT Model Results for the Headwaters Prairie Creek Subwatershed.

Total Nitrogen		Total Phosphorus		Tile Nitrate		Sediment	
Load (lbs/ac/yr)	MCW Rank (# of 68)	Load (lbs/ac/yr)	MCW Rank (# of 68)	Load (lbs/ac/yr)	MCW Rank (# of 68)	Load (lbs/ac/yr)	MCW Rank (# of 68)
33.6	9	2.1	27	21.4	16	1.3	26

3.9.2. Daily Erosion Project

The Daily Erosion Project (DEP) is a tool developed by the Department of Agronomy at Iowa State University that allows users to understand how fast soil is being lost off the land. 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 the amount of hillslope soil loss using the Water Erosion

Prediction Project (WEPP) Model. Further documentation of the DEP can be found at: https://dailyerosion.org/docs/.

The DEP was run for the 68 HUC-12 subwatersheds in the MCW for the ten year period 2008-2017. The output from the DEP analysis was used to show the average annual soil detachment and hillslope soil loss in terms of tons/acre. Note that this is a different measurement than the sediment loading estimate derived from the SWAT model. Average annual soil detachment and hillside soil loss estimated by the DEP for the Headwaters Prairie Creek Subwatershed along with the relative ranking within the MCW is shown in **Table 4.**

Table 4. Daily Erosion Project Results for the Headwaters Prairie Creek Subwatershed.

Average Annual Soil Detachment		Average Annual Hillslope Soil Loss	
Tons/Acre	MC Rank (# of 68)	Tons/Acre	MC Rank (# of 68)
2.6	46	2.4	49

3.9.3. Bacteria Source Assessment

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 natural and man-made mechanisms. Bacteria fate and transport is affected by 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 light exposure and detention time.

According to the Iowa DNR Animal Feeding Operations (AFO) permit database, there are an estimated 7,808 animal units within the subwatershed. This number does not include any animals that are not included on AFO permits. There are two wastewater treatment facilities in the subwatershed (**Figure 5**). The City of Keystone and the City of Van Horne operate waste water treatment plants under Iowa NPDES Permits which set performance standards for discharge limits for several pollutants including; *E. coli*, CBOD5, total suspended solids, nitrogen, dissolved oxygen and pH.

An assessment of bacteria sources was conducted as part of the *Total Maximum Daily Load Cedar River Watershed, Iowa for Indicator Bacteria, Escherichia coli (E. Coli)* (EPA 2010) . The assessment concluded that the predominant source of bacteria (82 percent) to the Cedar River segment IA 02-CED-0020_3 (the segment to which the Headwaters Prairie Creek Subwatershed drains) was from open feedlots.

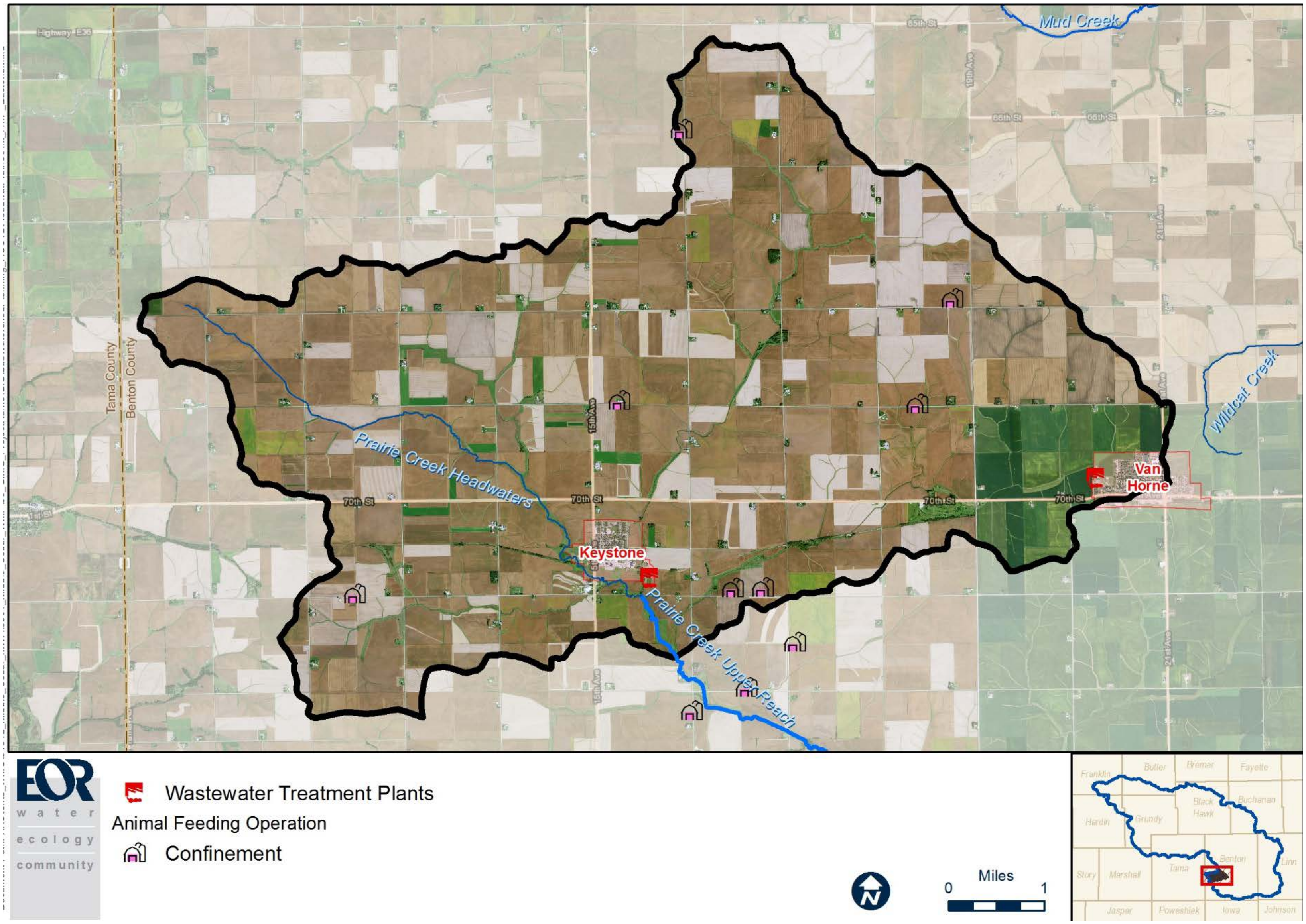

Figure 5. Wastewater Treatment Plants, Unsewered Communities and Animal Feeding Operations in the Headwaters Prairie Creek Subwatershed.

4. ISSUES

An overall analysis of the Middle Cedar Watershed (MCW) shows that the watershed experiences a number of issues that have an effect on the Headwaters Prairie Creek Subwatershed.

4.1. Middle Cedar Watershed Issues

- Flooding/Water Quantity: Though the watershed experiences flooding primarily along the Cedar River, it also experiences flooding on many of the smaller tributaries. Specifically, Prairie Creek flooding impacts portions of Blairstown, Norway and Fairfax. Flood levels, rates of streamflow and flood frequency have become more severe in recent years.
- Water Quality: Water quality of the Cedar River is degraded by high levels of fecal bacteria that pose a threat to public health. The Cedar River also has elevated levels of nitrate. Refer to the watershed characterization section for further description of these water quality issues.
- 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.
- Funding & Organization: Effective watershed management is contingent on organizational structure and internal capacity of the MCWMA as well as the security of adequate funding sources in the future. It has been shown repeatedly that there needs to be a long-lasting organizational structure, accountability to the public, along with a stable funding mechanism.
- Policy: While there are stormwater regulations in place for municipal separate storm sewer systems, construction activities and industrial activities, much of the land use activities in the MCW are unregulated. This creates a 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.
- 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.
- Evaluation & Monitoring: In order to assess performance and communicate achievements at the local, state and federal level, the MCWMA needs to establish a monitoring program. Not only should this monitoring program establish baseline conditions on resource health but it should continue to collect the information needed to establish trends and evaluate projects and programs to better inform future management decisions.
- 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 financial resources, regulatory authority, or knowledge needed to meet the challenge of managing the watershed.

4.2. Headwaters Prairie Creek Subwatershed Specific Issues

As noted in the Stakeholder Engagement Process section, participants in both input meetings helped to identify important issues to them and their community. In particular, in both meetings, participants emphasized the importance of increased communication with the community at-large in regards to the watershed planning underway and future watershed-related projects. Participants noted that it is important that community members are asked for their input early on, as demonstrated with the first in-put meeting with stakeholders. Other important issues brought up and identified by participants were:

- Low-flow nutrient testing environment: Several farmers thought it was difficult to get an accurate account of nutrients in the waterways due to the severe decrease of water flowing through the creek over the past few decades.
- Grass filter strips/buffer strips: Participants believed there are less barriers to implementing this practice and therefore feel that they are more likely to be adapted. There was not enough financial assessment available for implementing other, more impactful practices; and thus, attendees were unwilling to seriously consider adopting them.
- Link downstream/upstream communities: Similar to other subwatershed discussions, participants would like to see innovative projects that are linking downstream and municipal partners with upstream farmers and landowners. In particular, an avenue of communication with Cedar Rapids that would allow them to showcase rural best management practices.
- Regular Communication: Farmers and landowners would like to see a regular newspaper column or some other form of media that discusses current practices and serves as a resource for upcoming water quality events/ research findings.

5. GOALS AND OBJECTIVES

5.1. Middle Cedar Watershed Management Plan

Goals and objectives have been established for the Middle Cedar Watershed (MCW) based on the general issues that were identified during the planning process. These goals and objectives are used to guide the implementation plan for the Middle Cedar Watershed Management Plan (MCWMP) and will be used to set the framework for the Headwaters Prairie Creek HUC-12 Subwatershed Plan.

In order to address the issues identified in the MCW, the following primary goals have been established:

Flooding/Water Quantity Goals: Reduce flood risk and damage to local communities/ neighborhoods; Reduce causes of flooding potential; Protect life and property from flood damage; Improve stormwater management at local levels; and Increase watershed awareness related to water quantity.

Water Quality Goals: All waters within the MCW meet their designated uses, promote management activities to protect high quality drinking water sources, and meet the INRS goals for nitrogen and phosphorus reduction at the HUC-8 scale.

Recreation Goals: Enhance the watershed's existing water-based recreational areas, develop new recreational opportunities on lakes and streams across the watershed, and improve the health of the watershed ecosystems.

Monitoring and Evaluation Goals: Evaluate temporal trends in water quality and quantity, determine the water quality and quantity conditions of water sources within the watershed, and evaluate the effectiveness of the Middle Cedar Watershed Management Authority (MCWMA) management efforts.

Funding and Organizational Goals: Identify and obtain funding sources that are reliable and sufficient to meet the goals identified in the watershed management plan, and effectively manage the MCWMA through implementation of the plan and appropriate governance structure.

Watershed Policy Goal: Encourage communities with regulations in place that protect water resources to improve oversight and enforcement of those regulations.

Education and Outreach Goals: Increase awareness of the watershed and its resources, inspire watershed stewardship and ownership, disseminate water-resource information and materials, ensure all stakeholders in the watershed are included in activities and programs, and identify and empower local watershed stewards to build watershed management ethic at the grassroots levels.

Partnership Goal: Work cooperatively to achieve mutual watershed management objectives.

Each of these goals has a set of specific objectives to practice in order to meet the goal. For more on the goals and objectives, please refer to the MCWMP.

5.2. Headwaters Prairie Creek Subwatershed Specific Goals

The following specific goals and objectives have been identified for the Headwaters Prairie Creek Subwatershed. These goals and objectives were developed through input received by local subwatershed residents in stakeholder engagement meetings, the goals and objectives framework established for the Middle Cedar WMP, and goals established in approved Total Maximum Daily Load (TMDL) Studies.

5.2.1. Flooding/Water Quantity Goals

Flooding in the Headwaters Prairie Creek results in significant financial losses. Over $1 million dollars in damage to buildings and their content results from the 100-year (1 percent annual chance) flooding event within the watershed (see **Flooding** section for further information). The goal for this subwatershed is to reduce flooding and minimize financial losses due to flooding.

The GHOST hydrologic & hydraulic model, developed by IFC, was used to estimate the flood reduction benefits resulting from implementation of the recommended suite of conservation practices for the subwatershed defined in the Recommended Conservation Practice Adoption Rates Section.

Evaluating the flood reduction benefits provided through implementation of the recommended suite of conservation practices was accomplished by comparing flood stage estimate from the GHOST model to the peak flood stage that occurred on Prairie Creek within the City of Norway during the July 1, 2014 flooding event.

5.2.2. Water Quality Goals

The INRS serves as a foundation for the water quality goals in the MCW. Specifically, the load reduction goal for nitrogen is a 41 percent reduction from non-point sources and the load reduction goal for phosphorus is a 29 percent reduction from non-point sources by the year 2035.

The Middle Cedar WMP established a goal of having all waters within the watershed meet their designated uses. Currently, the following Cedar River stream segment, that receives drainage from the Headwaters Prairie Creek Subwatershed, does not meet its designated use.

Cedar River from Highway 30 Bridge at Cedar Rapids to Confluence with Prairie Creek

This segment of the Cedar River is impaired due to elevated levels of E. coli bacteria. A TMDL was developed for all impaired reaches of the Cedar River in 2010. The TMDL includes an informational implementation plan. The Environment Protection Agency (EPA) Region 7 developed a Hydrologic Simulation Program Fortran (HSPF) model to test potential scenarios. The model determined that the following scenario will result in the river segments 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.

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

6. IMPLEMENTATION PLAN

6.1. Existing Conservation Practices

The Iowa Department of Natural Resources, Iowa Department of Agriculture and Land Stewardship, Iowa Nutrient Research Center at ISU, National Laboratory for Agriculture and the Environment and Iowa Nutrient Research and Education Council are currently developing an inventory of the conservation practices across the State. The effort is referred to as the Iowa Best Management Practice (BMP) Mapping Project. The goal of the 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, Grassed Waterways, Pond Dams, Contour Strip Cropping and Contour Buffer Strips. The Iowa BMP Mapping Project data can be accessed at https://athene.gis.iastate.edu/consprac/consprac.html

The existing conservation practices of the Headwaters Prairie Creek Subwatershed are shown in **Figure 6.** Conservation practice locations provided by participants in the stakeholder engagement meetings are also shown.

Vegetable stand, Melbourne Iowa. Photo credit: EOR)

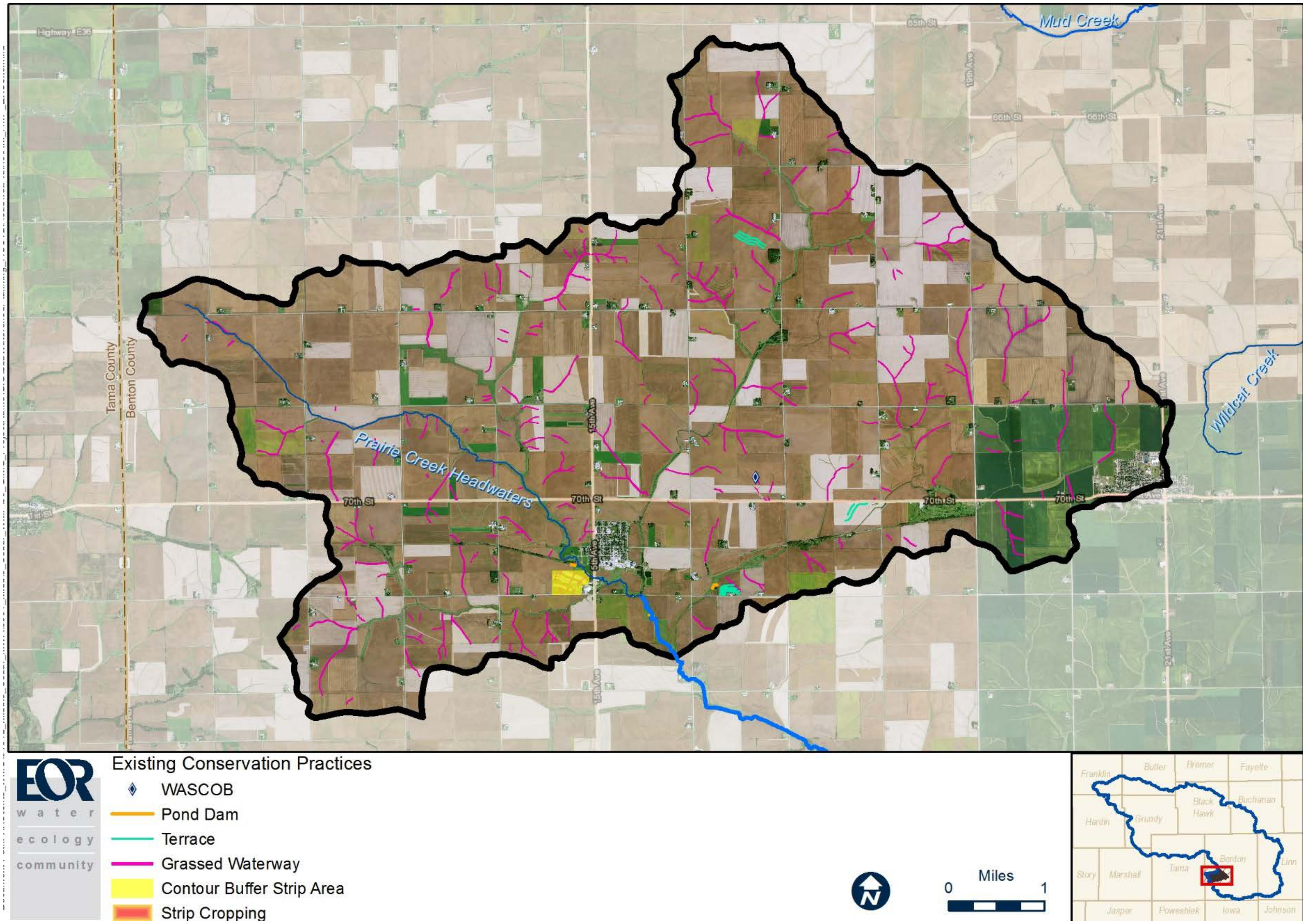

Figure 6. Existing Conservation Practices in the Headwaters Prairie Creek Subwatershed.

6.2. Agricultural Conservation Practices

The Agricultural Conservation Planning Framework (ACPF) Version 2.2 was run for the Headwaters Prairie Creek Subwatershed by the IFC. The ACPF is a GIS-based tool developed by the Agricultural Research Service that analyzes "soils, land use, and high-resolution topographic data to identify a broad range of opportunities to install conservation practices in fields and in watersheds." The ACPF tools identify suitable locations for terrain-dependent conservation practices.

- Contour Buffer Strips
- Nutrient Removal Wetlands
- Edge-of-Field Bioreactors
- Water and Sediment Control Basins (WASCOB)
- Drainage Water Management
- Saturated Buffers
- Riparian Buffers

Additional conservation practices that are not terrain-dependent have also been identified as potential options for reducing nutrient and sediment loading within the subwatershed. The following section describes the suite of conservation practices recommended for implementation in the Headwaters Prairie Creek Subwatershed organized by tier of the conservation pyramid as shown in **Figure 7**. The conservation practices sited by the ACPF analysis are shown in **Figure 8.**

Recommended adoption rates for each of these conservation practices designed to meet the nutrient reduction goals of the subwatershed are provided in the **Recommended Conservation Practice Adoption Rates** section.

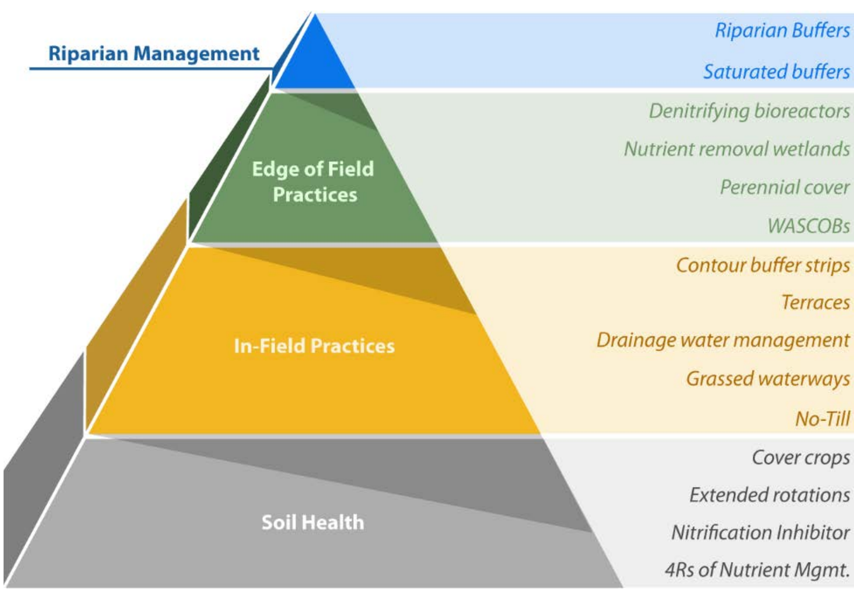

Figure 7. Conservation Pyramid (adapted from Tomer et al. 2013)

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.

Cover Crops: Cover crops is a term to describe any crop grown primarily for the benefit of the soil rather than the crop yield. Cover crops are typically grasses or legumes (planted in the fall between harvest and planting of spring crops) but may be comprised of other green plants. Cover crops prevent erosion, improve the physical and biological properties of soil, supply nutrients, suppress weeds, improve the availability of soil water, and break pest cycles, in addition to a wide range of additional benefits. More information on cover crop use in Iowa can be found at:

https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_005818.pdf

Extended Crop Rotations: An extended crop rotation is a farming practice that includes a rotation of corn, soybean, and two to three years of alfalfa or legume-grass mixtures managed for hay harvest. Extended rotations reduce the application and loss of both nitrate and phosphorus. By growing nitrogen-fixing legumes three years in a row, very little, if any nitrogen needs to be applied in the subsequent corn year. Additional information can be found at:

https://www.cleanwateriowa.org/extended-crop-rotation/

Nitrification Inhibitors: When ammonia or ammonium nitrogen is added to the soil, it is subject to a process called nitrification. Soil bacteria converts the ammonia (NH_3) or ammonium (NH_4) to nitrate (NO_3). This conversion is strongly temperature dependent and occurs quickly under warm soil temperature conditions. Using a nitrification inhibitor with applications of ammonia or ammonium nitrogen will slow the conversion to nitrate until it can be readily used by crops. This will allow the crop to uptake more of the nitrogen at critical times in the growing season. To learn more, visit: https://www.cleanwateriowa.org/new-page-1.

4Rs of Nutrient Management: The 4Rs of nutrient management refer to fertilizer application techniques focused on minimizing the risk of nutrient loss from the field. The principles of the 4R framework include:

- Right Source – Ensure a balanced supply of essential nutrients, considering both naturally available sources and the characteristics of specific products, in plant available forms.
- Right Rate – Assess and make decisions based on soil nutrient supply and plant demand.
- Right Time – Assess and make decisions based on the dynamics of crop uptake, soil supply, nutrient loss risks, and field operation logistics.
- Right Place – Address root-soil dynamics and nutrient movement, and manage spatial variability within the field to meet site-specific crop needs and limit potential losses from the field.

Recently a program called 4R Plus was developed by a coalition of organizations dedicated to conservation stewardship for Iowa's farmers. 4R Plus is a nutrient management and conservation program to make farmers aware of practices that bolster production, build soil health and improve water quality in Iowa. The program is guided by a coalition of more than 25 organizations, including agribusinesses, conservation organizations, commodity and trade associations, government agencies and academic institutions. To learn more, visit: https:www.4RPlus.org/.

Soil health practices can be implemented on areas of row crop production throughout the subwatershed regardless of topographic setting.

In the Headwaters Prairie Creek Subwatershed, there are currently approximately 21,981 row crop acres. Soil health practices are already in place on many of these acres. Assumptions for existing adoption rates for soil health practices within this subwatershed are shown in **Table 5**. These assumptions are based on professional judgement, communication with local Soil and Water Conservation District and Natural Resources Conservation Service staff members, and input from local farmers who participated in the stakeholder engagement meetings.

Table 5. Soil Health Management Conservation Practice Existing Adoption Rate Assumptions for the Headwaters Prairie Creek Subwatershed.

Conservation Practice		Existing Adoption Rate	Existing Adoption Acres
	Cover crops	2%	440
	Extended rotations	1%	220
	Nitrogen management: nitrification inhibitor	50%	10,991
4Rs	Nitrogen management: rate control	10%	2,198
	Nitrogen management: source control	18%	3,956
	Nitrogen management: timing control	26%	5,715
	Phosphorus management: placement control	50%	10,991
	Phosphorus management: rate control	50%	10,991
	Phosphorus management: source control	18%	3,956

6.2.2. In-field Conservation Practices

The following conservation practices are categorized as in-field management practices because they are implemented directly within the actively farmed area of a field. Note that in the case of no-till, this practice can also improve soil health. 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.

Contour Buffer Strips: Contour buffer strips are strips of grass, or a mixture of grasses and legumes, that run along the contour of a farmed field. Buffer strips are installed in rows down the slope of a field, alternating with wider cropped strips. Established contour buffer strips can significantly, reduce sheet and rill erosion, slow runoff, and trap sediment. Contaminants such as sediment, nutrients, and pesticides are removed from the runoff as they pass through a buffer strip. Buffer strips may also provide food and nesting cover for wildlife and pollinators. Additional information can be found at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/null/?cid=nrcseprd413956

Terraces: A terrace is an earth embankment, channel, or a combination ridge and channel constructed across the slope to intercept runoff water. This practice generally applies to cropland but may also be used on other areas where field crops are grown such as wildlife or recreation lands. Terraces serve several purposes, including reducing slope length for erosion control, intercepting and directing runoff, and preventing gully development. Additional information can be found at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_026229.pdf

Drainage Water Management: Controlled drainage describes the practice of installing water level control structures within the drain tile system. This practice reduces nitrogen loads by raising the water tables during part of the year, thereby reducing overall tile drainage volume and nitrate load. The water table is controlled through the use of gate structures that are adjusted at different times during the year. When field access is needed for planting, harvest or other operations, the gate can be opened fully to allow unrestricted drainage. When the gate is used to raise local water table levels after spring planting season, this may allow more plant water uptake during dry periods, which can increase crop yields. Controlled drainage may be used on fields with flat topography, typically one percent or less slope. Additional information can be found at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1081603.pdf

Grassed Waterways: Grassed waterways are constructed channels, seeded with grass, that drain water from areas of concentrated flow. The vegetation slows down the water and the channel conveys the water to a stable outlet at a non-erosive velocity. Grassed waterways should be used where gully erosion is a problem. These areas are commonly located between hills and other low-lying areas on hills where water concentrates as it runs off the field (USDA-NRCS 2012). The size and shape of a grassed waterway is based on the amount of runoff that the waterway must carry, the slope, and the underlying soil type. Although a limited function, it is important to note that grassed waterways also have an ability to trap sediment entering them via field surface runoff and in this manner performs similarly to riparian buffer strips. Additional information on grassed waterways can be found at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_026051.pdf

No-till: No-till is a way of growing crops or pasture from year to year without disturbing the soil through tillage. No-till increases the amount of water that infiltrates into the soil, the soil's retention of organic matter and its cycling of nutrients. It can also reduce or eliminate soil erosion and increase the amount and variety of life in and on the soil. The most powerful benefit of no-tillage is improvement in soil biological fertility, making soils more resilient to degradation and erosion (NWRM 2015). Additional information on the use of no-till can be found at:

https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs141p2_015627.pdf

The current extent of in-field management practices in this subwatershed was estimated by reviewing the Iowa DNR BMP Mapping Project (**Figure 6**), and through professional judgement as described for the soil health management practices (**Table 6**).

Table 6. In-field Conservation Practice Existing Adoption Rate Assumptions for the Headwaters Prairie Creek Subwatershed.

Conservation Practice	Existing Adoption Rate	Adoption Rate Estimate Source
Contour buffer strips	0%	Comparison of ACPF output to BMP Mapping Project findings
Terraces	100%	Comparison of ACPF output to BMP Mapping Project findings
Drainage Water Management	0%	Professional Judgement
Grassed Waterways	20%	Comparison of ACPF output to BMP Mapping Project findings
No-Till	20%	Professional Judgement

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.

Denitrifying bioreactors: Denitrifying bioreactors are trenches in the ground packed with carbonaceous material, such as wood chips, which allow colonization of soil bacteria that convert nitrate in drainage water to nitrogen gas. Installed at the outlet of tile drainage systems, bioreactors are typically capable of treating 40-60 acres of farmland. These have limited benefits for flood mitigations, but they can be highly beneficial for water quality improvement. According to the INRS, bioreactors can achieve an average nitrate reduction of 43 percent for water going through the bioreactor. Additional information on denitrifying bioreactors can be found at: https://www.nrcs.usda.gov/wps/portal/nrcs/ia/newsroom/factsheets/NRCSEPRD414822/

Nutrient Removal Wetlands: This conservation practice is a shallow depression created in the landscape where aquatic vegetation is typically established. Nutrient removal wetlands can be a cost-effective approach to reducing nitrogen loadings in watersheds dominated by agriculture and tile drainage. A 0.5 percent to 2 percent range in wetland pool-to-watershed ratio permits the wetlands to efficiently remove nitrogen runoff from large areas and data has shown that at times 40 percent to 90 percent of the nitrate flowing into the wetland can be removed. These wetlands and surrounding grassland buffers also provide environmental benefits beyond water quality improvement such as increases in wildlife habitat, carbon sequestration, and minor flood water retention (Crumpton et al. 2006). Additional information on nutrient removal wetlands can be found at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_025770.pdf

Perennial Cover: Perennial cover refers to the practice of converting cropland to a permanent perennial vegetative cover and/or trees to accomplish any of the following: reduce soil erosion and sedimentation, improve water quality and quantity, improve infiltration, enhance wildlife habitat, improve soil quality, or manage plant pests. Additional information on the use of perennial cover for conservation can be found at: https://store.extension.iastate.edu/product/The-Iowa-Watershed-Approach-Perennial-Cover

Water and Sediment Control Basin (WASCOB): Water and sediment control basins are small earthen ridge-and-channel or embankments built across a small watercourse or area of concentrated flow within a field. They are designed to trap agricultural runoff water, sediment and sediment-borne phosphorus as it flows down the watercourse; this keeps the watercourse from becoming a field gully and reduces the amount of runoff and sediment and phosphorus leaving the field. WASCOB's are usually created through construction of a small, grassed berm that is just long enough to bridge an area of concentrated flow. The runoff water detained in a WASCOB is released slowly, usually via infiltration or a pipe outlet and tile line. These practices also have benefits for water storage/flood risk reduction. Additional information on WASCOBs can be found at:
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_025622.pdf

The current extent of edge of field conservation practices in this subwatershed was estimated by reviewing the Iowa DNR BMP Mapping Project (**Figure 6)** and through professional judgement as described for the soil health management practices. (**Table 7**),

Table 7. Edge of Field Conservation Practice Existing Adoption Rate Assumptions for the Headwaters Prairie Creek Subwatershed.

Conservation Practice	Existing Adoption Rate	Adoption Rate Estimate Source
Denitrifying bioreactors	0%	Professional Judgement
Nutrient removal wetlands	0%	Comparison of ACPF output to BMP Mapping Project findings
Perennial cover	1%	Professional Judgement
WASCOBs	2%	Comparison of ACPF output to BMP Mapping Project findings

6.2.4. Riparian Area Management

The final tier of the conservation pyramid is management practices within the areas adjacent to existing waterways. These practices are commonly referred to as riparian area conservation practices. An evaluation of the existing riparian area throughout the subwatershed was conducted. The land cover types within 50 feet on either side of each stream (the riparian area) within the subwatershed were inventoried to determine the current condition. Areas where natural land cover types (forests, wetlands, etc.) were found within the riparian area were determined to have an existing buffer. The existing adoption rates shown in **Table 8** are the percentage of natural cover types within each type of riparian area management as sited in the ACPF tools.

Riparian Buffers: The ACPF tools identify a variety of riparian buffers types based on the primary function they serve. The riparian buffer types are as follows:

- Critical Zone- sensitive areas: identified as areas with a high level of surface runoff delivery
- Deep-rooted Vegetation – for areas with saturated soils
- Multi-species – for water uptake, nutrient and sediment trapping
- Stiff stemmed grasses – for areas with overland runoff where sediment can be trapped
- Stream stabilization – for areas where bank stability is the emphasis

Additional information on riparian buffer types can be found at:
https://www.cleanwateriowa.org/stream-buffers

Saturated Buffers: Saturated buffers are vegetated areas, typically in a riparian area along a stream or ditch where drain tile water is dispersed in a manner that maximizes its contact with the soils and vegetation of the area. Drain tile lines that typically discharge directly to the ditch or stream are intercepted and routed into a new drain tile pipe that runs parallel to the ditch or stream. This allows drain water to exfiltrate and saturate the buffer area. The contact with soil and vegetation results in denitrification. Additional information on saturated buffers can be found at:
https://www.ars.usda.gov/midwest-area/ames/nlae/news/what-are-saturated-buffers/

Table 8. Riparian Area Management Practice Existing Adoption Rate Assumptions for the Headwaters Prairie Creek Subwatershed.

Conservation Practice	Existing Adoption Rate	Adoption Rate Estimate Source
Critical zone riparian buffer	61 percent	Evaluation using High Resolution Land Cover Mapping Data and Stream Riparian Areas
Deep-rooted vegetation riparian buffer	69 percent	
Multi-species riparian buffer	72 percent	
Stiff stem grass riparian buffer	72 percent	
Stream stabilization riparian buffer	65 percent	
Saturated buffers	0 percent	Professional Judgement

The conservation practices described in the previous section were compiled for the Headwaters Prairie Creek Subwatershed and processed using a custom set of scripts written in the R programming language. Essentially, these scripts aggregated the individual BMP features and created a summary for the Headwaters Prairie Creek HUC-12 containing the total potential extent for each BMP type along with the total footprint and drainage area served (**Table 9**).

A tool was developed in Microsoft Excel that uses the BMP summaries to apply pollutant loading values to the drainage areas, along with pollutant reduction values that are unique to each BMP. The pollutant reduction estimates were derived from a combination of sources, but were primarily taken from the INRS. Existing BMP adoption rates were estimated using a combination of sources, including feedback for specific watersheds from the Benton County NRCS staff and ISA, as well as using the results from the Iowa BMP Mapping Project as described in the previous section. After consideration of the existing pollutant reductions provided by BMPs currently in place, the Excel tool provides an overall estimate for the subwatershed of the expected maximum nitrogen and phosphorus reduction potential assuming a 100 percent implementation rate of each individual BMPs. The results of this analysis are shown below in **Table 9.**

Table 9. Maximum Potential Load Reduction by BMP for the Headwaters Prairie Creek Subwatershed.

	Conservation Practice	Existing Adoption	Full Adoption	Load Reduction	
				N	P
Soil Health Management	Cover crops	2%	100%	26.6%	24.9%
	Extended rotations	1%	100%	36.5%	0.0%
	Nitrogen management: nitrification inhibitor	50%	100%	3.9%	0.0%
	Nitrogen management: rate control	10%	100%	7.9%	0.0%
	Nitrogen management: source control	20%	100%	2.9%	0.0%
	Nitrogen management: timing control	50%	100%	3.9%	0.0%
	Phosphorus management: placement control	50%	100%	0.0%	13.2%
	Phosphorus management: rate control	50%	100%	0.0%	7.5%
	Phosphorus management: source control	50%	100%	0.0%	33.1%
In-Field Management	Contour buffer strips	0%	100%	0.0%	21.2%
	Terraces	100%	100%	0.0%	0.0%
	Drainage water management	0%	100%	2.8%	0.0%
	Grassed waterways	20%	100%	0.0%	44.9%
	No-Till	20%	100%	0.0%	63.1%
Edge-of-Field Management	Denitrifying bioreactors	0%	100%	11.6%	0.0%
	Nutrient removal wetlands	0%	100%	22.0%	0.0%
	Perennial cover	1%	100%	62.5%	29.5%
	WASCOBs	2%	100%	0.0%	2.9%
Riparian Management	Riparian buffer: Critical zone buffer	61%	100%	0.0%	0.0%
	Riparian buffer: Deep-rooted vegetation buffer	69%	100%	0.1%	0.0%
	Riparian buffer: Multi-species buffer	72%	100%	0.2%	0.1%
	Riparian buffer: Stiff stem grass buffer	72%	100%	0.0%	0.2%
	Riparian buffer: Stream stabilization buffer	65%	100%	0.0%	0.1%
	Saturated buffers	0%	100%	17.0%	0.0%

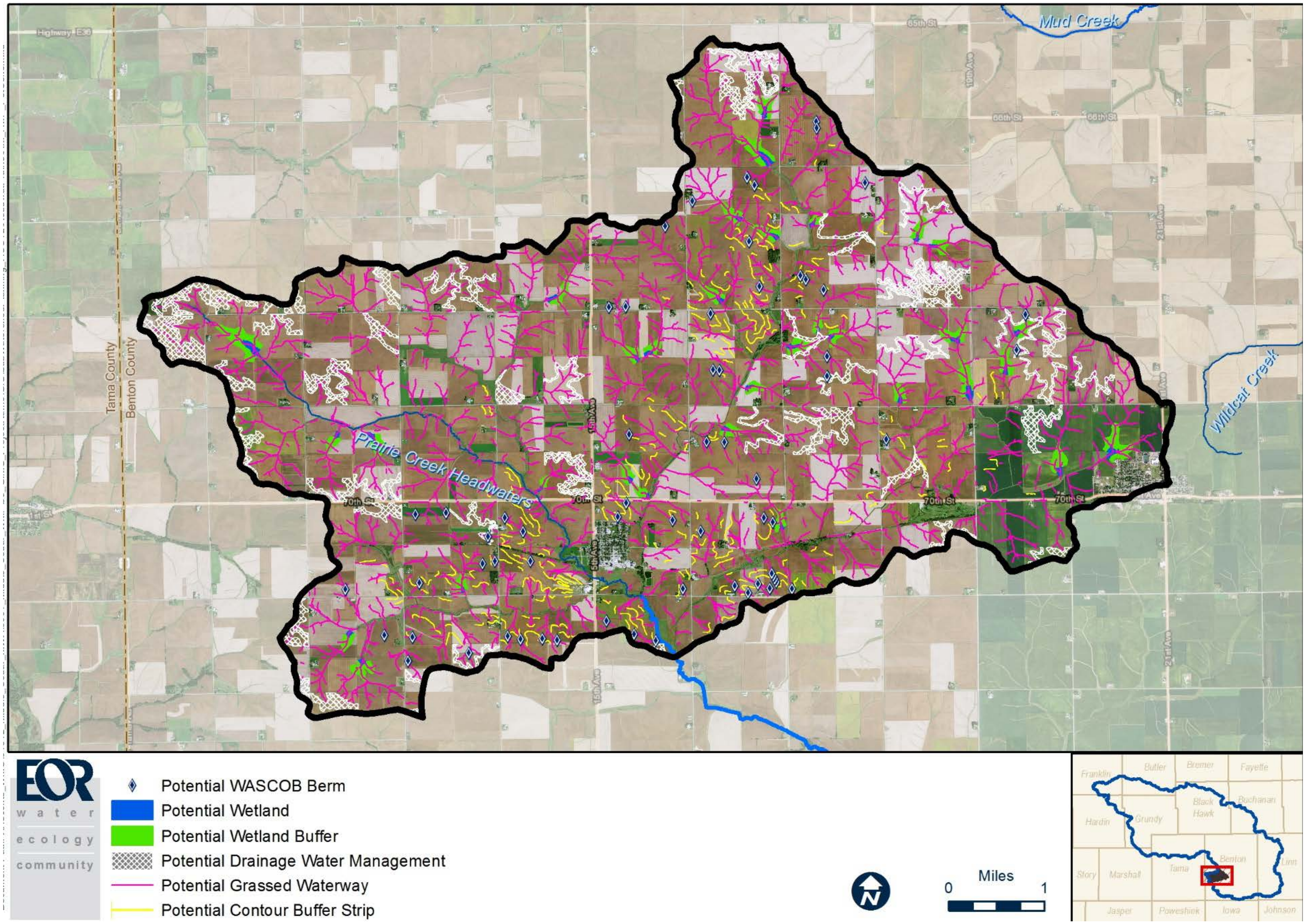

Figure 8. Potential Conservation Practices in the Headwaters Prairie Creek Subwatershed.

6.3. Strategies to Address Bacteria Loading

Identify, map, and monitor sources: The most important step is to identify potential and known sources of bacteria. Determining the most likely sources is typically a desktop exercise using mapping to identify where bacteria could be introduced to waterbodies such as pastures/agricultural land where manure is applied, feedlots, and residential onsite wastewater treatment system near waterbodies, at dog parks and areas where wildlife congregate near waterbodies such as fields and golf courses. Mapping bacteria conveyance systems (e.g. stormwater and ditches) is also important. Mapping known and potential sources will ensure that these areas are regularly monitored and inspected. Field monitoring will also identify sources and should be conducted to regularly inspect known sources. A cursory mapping of potential sources of bacteria in the subwatershed is presented in the **Pollutant Source Assessment** section of this plan but additional investigation would be beneficial in refining the bacteria source assessment and to guide future management decisions.

Federal, State, and Local Requirements: Ensuring state laws and local ordinances are up-to-date and enforced is also a cost effective and efficient way to reduce bacteria loading into waterbodies. Specifically, local ordinances that address manure management and land use regulations should be coordinated with State-level water resource regulations that protect water resources and minimize potential release of bacteria.

Outreach/Education: It is very important that residents are aware of and understand the state and local water and land use regulations, as well as steps they can take to reduce bacteria entering water resources. For example, outreach and education can ensure that landowners and residents understand the regulations governing water resources such as collection of pet waste or bans on wildlife feeding in order to comply with them. Residents should also be aware of the best management practices and opportunities available to minimize sources of bacteria on their property.

Best Management Practices that Limit Introduction of Bacteria: 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. Source control activities that reduce bacteria releases from direct sources include excluding livestock from surface waterbodies, effective manure management, regular onsite wastewater treatment system maintenance, pet waste collection, and green infrastructure practices.

Best Management Practices that Reduce Bacteria Loading to Waters: 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 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 pre-treatment, 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 strategies described above provide a general outline and description for the first steps of reducing bacterial loads through source controls. However, there are inherent differences in how to reduce bacteria loadings from urban as opposed to rural subwatersheds. The MCWMP provides more detailed explanations of source controls and BMPs that are applicable more specifically to urban and rural areas. The measures and BMPs described in the MCWMP are not the only available methods for reducing bacteria, but they are the actions most recommended and applicable to the Middle Cedar Watershed (MCW) and the Headwaters Prairie Creek Subwatershed.

6.4. Recommended Conservation Practice Adoption Rates

A specific scenario for conservation practice implementation/adoption rates was developed for each of the 68 subwatersheds of the MCW. The objective for the scenario was to meet the nutrient reduction targets established in the INRS for non-point sources of 41 percent reduction in nitrogen and 29 percent reduction for phosphorus for each subwatershed. The specific conservation scenario developed for the Headwaters Prairie Creek Subwatershed is shown in **Table 10**. The table indicates the recommended adoption rate of each practice with the corresponding acreage or quantity, and the percentage of the subwatershed 'treated' by that practice. The table also includes the estimated subwatershed nutrient load reduction provided as a result of the recommended adoption rate of each specific practice. The conservation practice scenario was developed through an iterative process using a cost-benefit analysis that is described in the MCWMP. Nearly 60 percent of the nitrogen removal and over 80 percent of the phosphorus removal in this subwatershed is achieved through the use of soil health practices. The recommended conservation practice scenario results in an estimated total reduction of over 348,000 pounds per year of nitrogen and over 15,000 pounds per year of phosphorus.

Table 10. Recommended Adoption Rates for Conservation Practices in the Headwaters Prairie Creek Subwatershed.

Conservation Practice	Existing Adoption	Target Adoption Rate	Target Adoption Quantity		Load Reduction (lbs./year) N	Load Reduction (lbs./year) P
Cover crops	2%	63%	13,273	acres	138,422	7,905
Extended rotations	1%	2%	218	acres	3,074	0
Nitrogen management: nitrification inhibitor	50%	75%	5,440	acres	16,470	0
Nitrogen management: rate control	10%	50%	8,704	acres	29,280	0
Nitrogen management: source control	18%	36%	3,917	acres	5,270	0
Nitrogen management: timing control	26%	51%	5,549	acres	11,200	0
Phosphorus management: placement control	50%	60%	2,176	acres	0	1,341
Phosphorus management: rate control	50%	60%	2,176	acres	0	760
Phosphorus management: source control	18%	36%	3,917	acres	0	3,700
Contour buffer strips	0%	7%	3	miles	0	756
Terraces	100%	100%	0	miles	0	0
Drainage water management	0%	50%	27	fields	11,778	0
Grassed waterways	20%	21%	2	miles	0	190
No-Till	20%	25%	1,088	acres	0	2,011
Denitrifying bioreactors	0%	25%	34	reactors	24,228	0
Nutrient removal wetlands	0%	40%	13	wetlands	73,502	0
Perennial cover	1%	2%	222	acres	5,378	155
WASCOBs	2%	2%	0	basins	0	6
Riparian buffer: Critical zone buffer	61%	100%	0.4	miles	66	3
Riparian buffer: Deep-rooted vegetation buffer	69%	100%	4.6	miles	429	17
Riparian buffer: Multi-species buffer	72%	100%	2.0	miles	1,991	77
Riparian buffer: Stiff stem grass buffer	72%	72%	0.0	miles	0.00	0.71
Riparian buffer: Stream stabilization buffer	65%	66%	0.2	miles	0.00	0.68
Saturated buffers	0%	50%	19.2	miles	72,575.22	0.00

6.5. Flood Benefits

To demonstrate the flood damage reduction benefits achieved through implementing the recommended suite of conservation practices throughout the MCW, a series of flood damage reduction reporting locations were established. The objective in developing this network of locations was to decentralize the evaluation. The traditional approach for demonstrating flood damage reduction benefits is to look at the downstream-most area within the watershed or at a few key locations in the watershed that experience the largest impacts due to flooding. The approach developed for the MCWMP is to look at several locations throughout the watershed, including upper portions of headwaters subwatersheds as well as main-stem Cedar River sites.

The flood damage reduction reporting location for the Headwaters Prairie Creek Subwatershed is located at Prairie Creek at Norway, Iowa.

Selection of the flood damage reduction reporting locations was based on the following:

- Areas within the watershed identified as having high or very high flood risk according to the Risk MAP for the Middle Cedar Watershed (FEMA 2015) and were associated with easily recognizable locations (Cities, road intersection).
- Stream segments that were explicitly included in the GHOST Hydrologic and Hydraulic Model (IIHR 2018) and where both stream flow data and stage/elevation data were available.
- Sites on tributaries near the Cedar River were located far enough upstream to avoid the impact of Cedar River flooding on the flow and/or stage of the given tributary.

The flood damage reduction benefits associated with BMP implementation were estimated using results from modeling that was performed as part of the Iowa Flood Center (IFC) / IIHR - Hydroscience & Engineering's Middle Cedar Watershed Hydrologic Assessment. As a continuous simulation was used for these model runs – in part because design storm simulations lose their meaningfulness at such a large scale – for each location a specific simulated flood event was chosen for analysis.

The events were chosen to be as close to the 10-year recurrence interval (return period) as possible for several reasons: first, the most significant flood events (e.g. floods with magnitudes equal to or above the 100-year recurrence interval) may not be significantly impacted by the types of controls that the proposed BMPs provide; second, minor flood events (e.g. floods with magnitudes equal to or below the 5-year recurrence interval) are perhaps not significant enough in terms of damages to be meaningful for reporting risks and/or benefits. Conversely, the ~10-year recurrence interval flood is both large enough to have significant flood damages and small enough to show significant flood damage reductions resulting from BMP implementation, and as such provides a convenient metric that will be meaningful to stakeholders. The flood event used for the Headwaters Prairie Creek Subwatershed was July 1, 2014.

By implementing the recommended adoption rates for each of the conservation practices, the flood benefits that would have been achieved during this particular flood event is $156,000 in reduced losses and a 0.2-foot flood stage reduction. Therefore, it is inferred that this reduction in losses would be achieved if an event similar to this one were to happen in the future, assuming all recommended conservation practices were implemented. Maintaining the assumption of full implementation, it is also estimated that the subwatershed would see annual reduced flood losses of $25,300 if annual flood events conform to predicted patterns.

6.6. Prioritized Implementation

The prioritization of conservation practice implementation within the subwatershed is determined using two primary criteria: 1) the existing threat of land topography on water quality, and 2) the value of the land's resource production capacity. The first criteria guides practice implementation toward areas that will produce the most benefit to the overall subwatershed, while the second criteria guides it toward areas that will minimize financial barriers to implementation.

For the first criterion, runoff risk was applied to the landscape to expose regions with the greatest need for practice implementation. Runoff risk is a function of the proximity to a stream and the steepness of a slope. The proximity to a stream establishes the potential conveyance of sediment into the water – ultimately leading to increased pollution. A higher runoff risk indicates a higher priority for implementation. The runoff risk for this subwatershed is shown below in **Figure 9**.

For the second criterion, the Corn Suitability Rating 2 Index (CSR2) tool was used. This is a rating applied to different soils based on row-crop productivity. This information indicates the value certain land has to a farmer's productivity. The values are ranked from high to low based on their relation to other land within the subwatershed. A lower CSR2 indicates a higher priority for implementation. The CSR2 for this subwatershed is shown below in **Figure 10.**

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

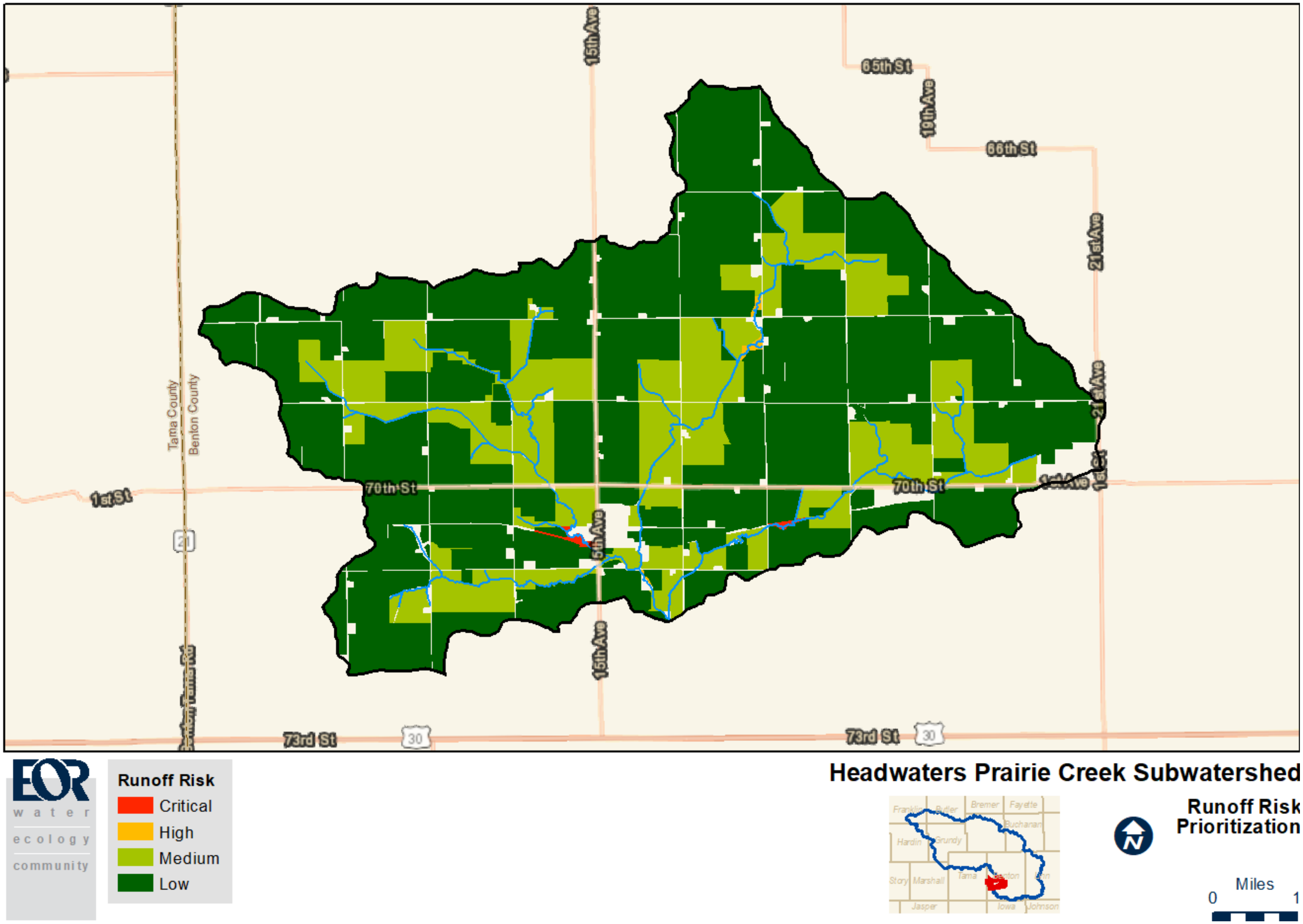

Figure 9: Runoff Risk for Headwaters Prairie Creek Subwatershed.

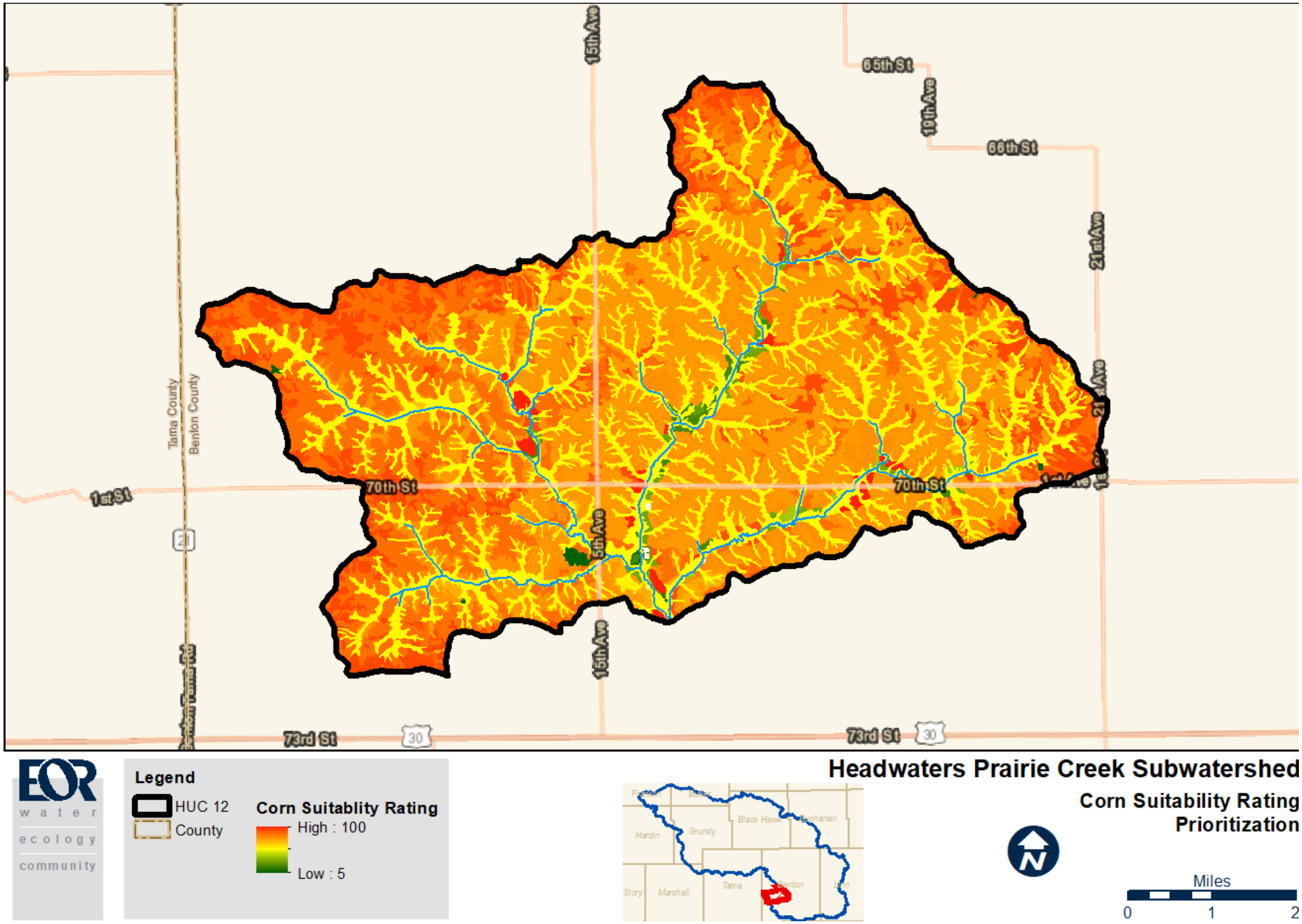

Figure 10: Corn Suitability Rating 2 for Headwaters Prairie Creek Subwatershed.

Four maps are provided as a guide for implementation within the Headwaters Prairie Creek Subwatershed. Each map contains information for the prioritization of different conservation practices. These maps are located in **Appendix A**. The implementation process for this subwatershed should utilize these maps and tables as a guide for conservation practice prioritization.

Map #1 includes practices with a specified location, but no rank. These include drainage water management practices (in-field), denitrifying bioreactors (edge of field), and saturated buffers (riparian area management). These practices do not have a specific criteria that would provide a helpful guide for implementation. However, the CSR2 map may serve as a first step for assessing implementation potential of the practices. The locations suitable for implementing each of these practices, as determined by the ACPF analysis are shown in this map.

Map #2 includes practices with a specified location that have been ranked individually using different parameters. These practices include grassed waterways (in-field), nutrient removal wetlands (edge of field), and riparian buffers (riparian area management).

- 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 were ranked in highest priority. All grass waterways shown in red should be prioritized for implementation.
- Riparian buffers are ranked based on the relative runoff risk associated with the area draining to each practice. Riparian buffers located in areas of relatively high runoff risk should be prioritized over those in areas with a smaller runoff risk.
- The nutrient removal wetlands are ranked based on the CSR2 because of the large cost and amount of land associated with wetlands. These wetlands are labeled based on CSR2 mean, starting with the lowest CSR2 mean at #1. The ranked wetlands are listed in **Table 11**.

Map #3 includes practices ranked based on the relative slope steepness within the subwatershed. These include contour buffer strips (in-field) and terraces (in-field). 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.

Map #4 prioritizes practices based on runoff risk. These practices include all the soil health practices (cover crops, extended rotations, nitrogen management, and phosphorus management), no-till (in-field), perennial cover (edge of field), and WASCOBs (edge of field). 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

Table 11: Nutrient removal wetland rankings for Headwaters Prairie Creek Subwatershed.

Rank	Mean CSR2	Basin Size (HA)	Drainage Area (HA)	Rank	Mean CSR2	Basin Size (HA)	Drainage Area (HA)
1	72.35	4.99	91.95	18	75.53	5.07	127.23
2	73.23	7.95	186.48	19	75.96	6.80	95.43
3	73.49	4.16	99.62	20	76.10	5.86	105.62
4	73.49	1.83	60.58	21	76.14	3.09	72.59
5	73.62	6.37	123.12	22	76.15	7.09	112.77
6	73.66	5.64	186.72	23	76.22	5.85	172.53
7	73.70	4.33	84.72	24	76.48	5.50	93.82
8	73.87	10.78	204.30	25	76.58	14.41	195.40
9	74.32	5.83	174.30	26	77.19	4.75	86.78
10	74.83	4.56	108.20	27	77.84	4.40	87.70
11	74.91	4.74	72.76	28	78.85	7.89	227.03
12	75.12	19.36	263.35	29	78.90	14.05	344.45
13	75.20	8.08	139.32	30	79.03	3.86	76.78
14	75.23	7.78	207.34	31	79.78	3.01	102.72
15	75.25	4.28	90.69	32	80.28	3.09	72.20
16	75.36	6.13	86.03	33	80.28	4.80	99.76
17	75.49	5.05	84.18				

Only one wetland per wetland train should be implemented in the initial process. Use **Table 12** to determine which wetlands to implement first. In addition, the area of each wetland and drainage area can be used a secondary measure for prioritization. Note that an additional very large (78 HA) wetland was sited by the ACPF at the mouth of the subwatershed that would provide treatment for the entire subwatershed. This wetland was not included in the above analysis or in the map in Appendix A because it was determined to be infeasible.

Table 12: Prioritization of wetlands based on groupings.

Grouping	Implement first
2, 25	2
5,23	5
8, 13	8
11, 24	11
14, 20	14
15, 31	15
17, 33	17
19, 29	19
26, 21, 28	21
22, 27	22

7. FUNDING NEEDS

Table 13 shows the total implementation costs by conservation practice over a 20-year period for meeting the Iowa Nutrient Reduction Strategy (INRS) targets for nitrogen and phosphorus for the Headwaters Prairie Creek Subwatershed. The annualized total cost for meeting the INRS targets within the Headwaters Prairie Creek Subwatershed is $617,000. This total annual cost includes conservation practice expenditures of $1,415,000 per year and conservation practices that result in a savings of $798,000 per year. Note that the cost provided are for conservation practices only. Cost associated with additional implementation activities to meet the goals of the subwatershed can be found in the MCWMP.

Table 13. 20 Year Total Implementation Costs by Conservation Practices.

BMP Name	Target Adoption			Total Cost
	(%)	Quantity		
Cover crops	63%	13,273	acres	$8,840,000
Extended rotations	2%	218	acres	$88,700
Nitrogen management: nitrification inhibitor	75%	5,440	acres	-$222,000
Nitrogen management: rate control	50%	8,704	acres	-$10,200,000
Nitrogen management: source control	36%	3,917	acres	
Nitrogen management: timing control	51%	5,549	acres	
Phosphorus management: placement control	60%	2,176	acres	
Phosphorus management: rate control	60%	2,176	acres	
Phosphorus management: source control	36%	3,917	acres	
Contour buffer strips	7%	3	miles	$47,600
Terraces	100%	0	miles	$0
Drainage water management	50%	27	fields	$147,000
Grassed waterways	21%	2	miles	$242,000
No-Till	25%	1,088	acres	$177,000
Denitrifying bioreactors	25%	34	reactors	$229,000
Nutrient removal wetlands	40%	13	wetlands	$1,210,000
Perennial cover	2%	222	acres	$1,180,000
WASCOBs	2%	0	basins	$15,700
Riparian buffer: Critical zone buffer	100%	0.4	miles	$289,000
Riparian buffer: Deep-rooted vegetation buffer	100%	4.6	miles	
Riparian buffer: Multi-species buffer	100%	2.0	miles	
Riparian buffer: Stiff stem grass buffer	72%	0.0	miles	
Riparian buffer: Stream stabilization buffer	66%	0.2	miles	
Saturated buffers	50%	19.2	miles	$6,320,000

8. EVALUATION AND MONITORING

Refer to the Middle Cedar Watershed Management Plan (MCWMP) for detailed recommendations for monitoring in the watershed. The Iowa Soybean Association (ISA), in cooperation with the City of Cedar Rapids, currently conducts snapshot water quality monitoring on Prairie Creek downstream of the City of Keystone. This monitoring provides vital information that can be used to detect trends in water quality and help prioritize conservation effort. The ISA monitoring should be continued into the future as a minimum level of water quality monitoring.

Potential expansion of water quality monitoring in the Headwaters Prairie Creek Subwatershed could include the following:

- Increase the number of samples that are taken throughout the year, targeting a wide range of flow conditions.
- Measure stream flow using either a continuous flow logger or develop a rating curve to be used with stream stage measurements.
- Conduct *E. coli* / bacteria monitoring per Iowa water quality assessment guidelines.
- Add total phosphorus to the monitored parameters or develop a relationship between dissolved reactive phosphorus and total phosphorus to be used as a reference point.

Refer to the MCWMP for further details on recommended methodologies for evaluating progress being made in achieving the goals developed in this HUC-12 Subwatershed Plan.

9. EDUCATION AND OUTREACH

Iowa State University Extension and Outreach developed a detailed education and outreach plan that is located in the appendices section of the Middle Cedar Watershed Management Plan. This plan is a useful tool that outlines ways to perform targeted outreach to producers and landowners that engages them in the planning and implementation process.

The Iowa Department of Natural Resources and the U.S. Environmental Protection Agency also have some general guidelines for public outreach that can be helpful:

- Involving stakeholders builds trust and support for the process and outcome.
- Successful watershed groups actively recruit members from diverse backgrounds and perspectives to take advantage of their unique skills and ideas.
- Forming a technical advisory team is helpful to provide further watershed-related data and analysis. They are usually comprised of subject matter experts, such as fisheries biologists, regional watershed Basin Coordinators, and Natural Resources Conservation Service staff.
- Coming together and assessing the watershed as a community provides the most current knowledge of water quality problems, generates an understanding how resources are valued, and garners support for the project.
- Pose simple questions to begin: Where are we now and where do we want to go? How do we get there? How will we know that we've arrived?

There are many additional educational resources available from other states and agencies that can be found online, including:

- Iowa Stormwater Education Partnership
- "Welcome to your Watershed" Poster and Game (Maryland Department of Agriculture)
- Growing the Next Generation of Watershed Stewards (Missouri Watershed Education Network)
- "A Watershed Moment: The Delaware River Watershed" (short film)

10. REFERENCES

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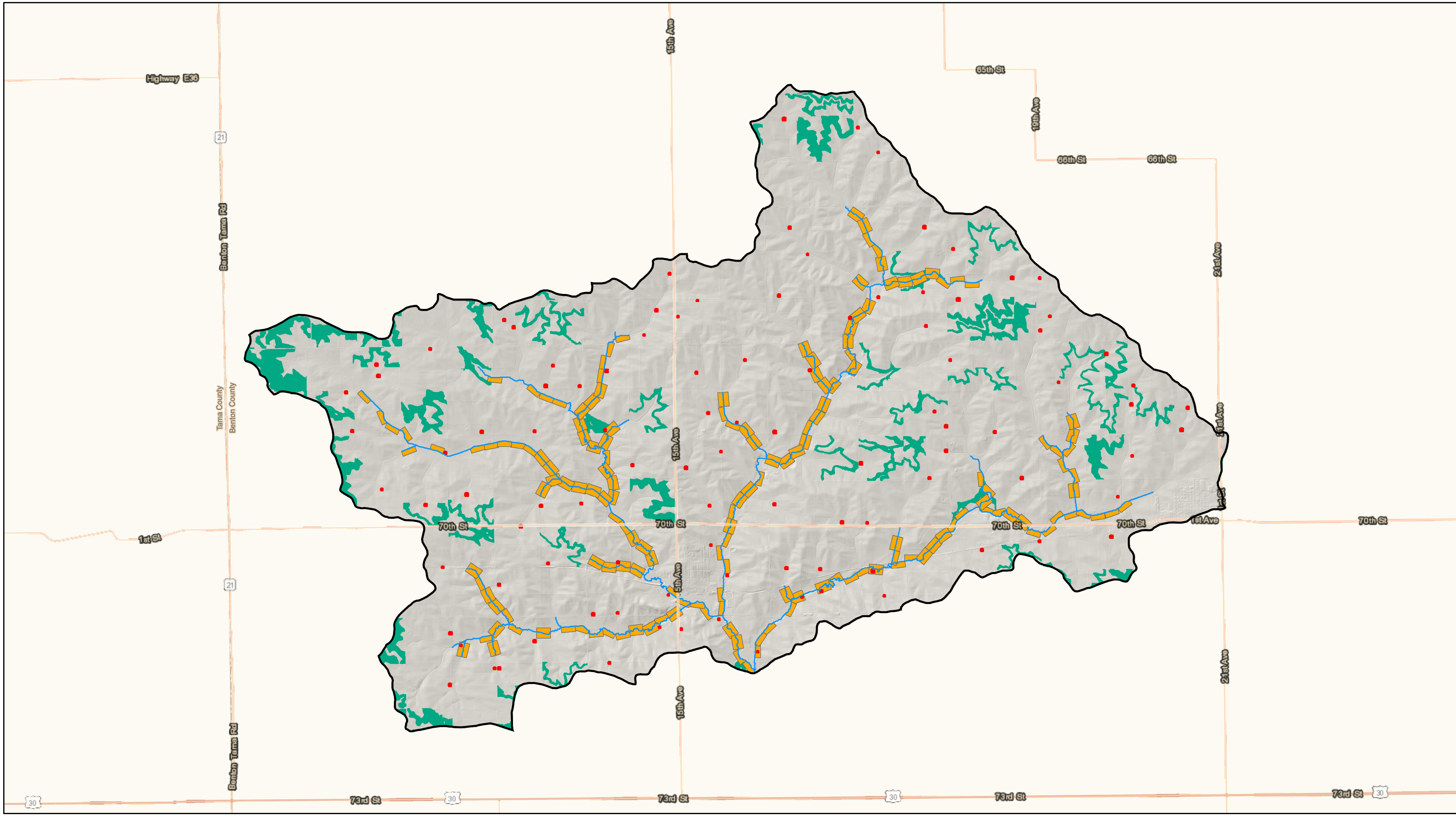
APPENDIX A. CONSERVATION PRACTICE PRIORTIZATION MAPS



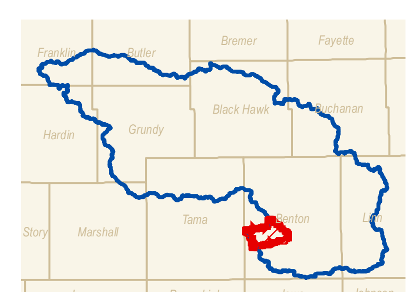
Headwaters Prairie Creek Subwatershed

Conservation Practice Prioritization

Map #1

Non-prioritized Conservation Practice Locations

- Denitrification Bioreactor
- Saturated Buffer
- Drainage Water Management



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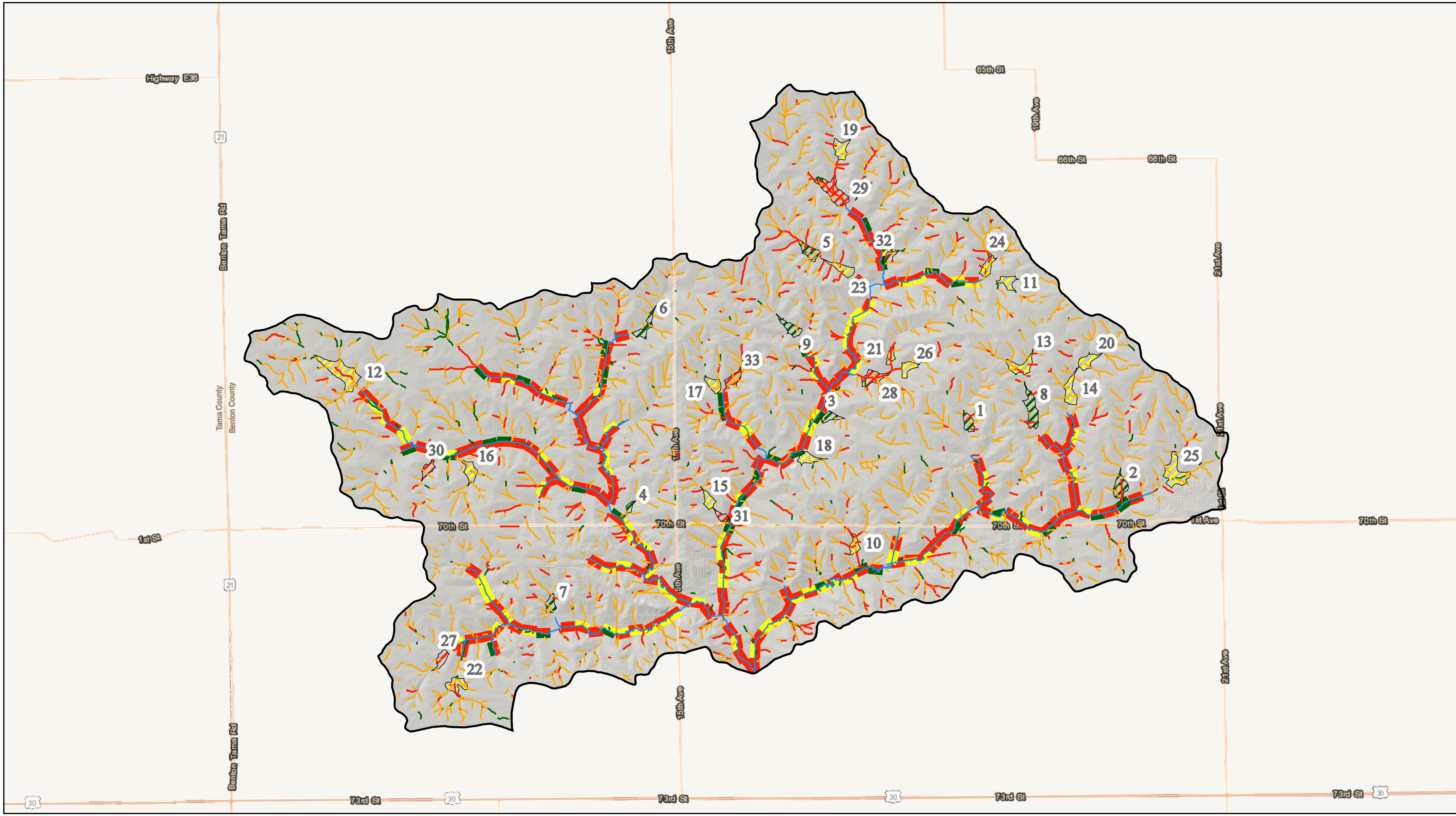
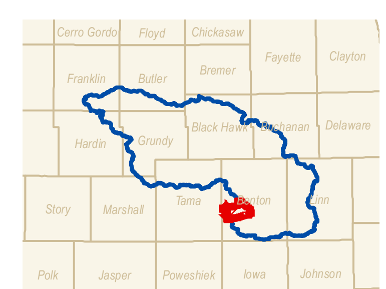


Prioritization of Conservation Practices

Saturated Buffer	Grass Waterway	Nutrient Treatment Wetland
High runoff risk	Low	Low CSR
Med runoff risk	Medium	Medium CSR
Low runoff risk	High	High CSR



Headwaters Prairie Creek Subwatershed

Conservation Practice Prioritization

Map #2

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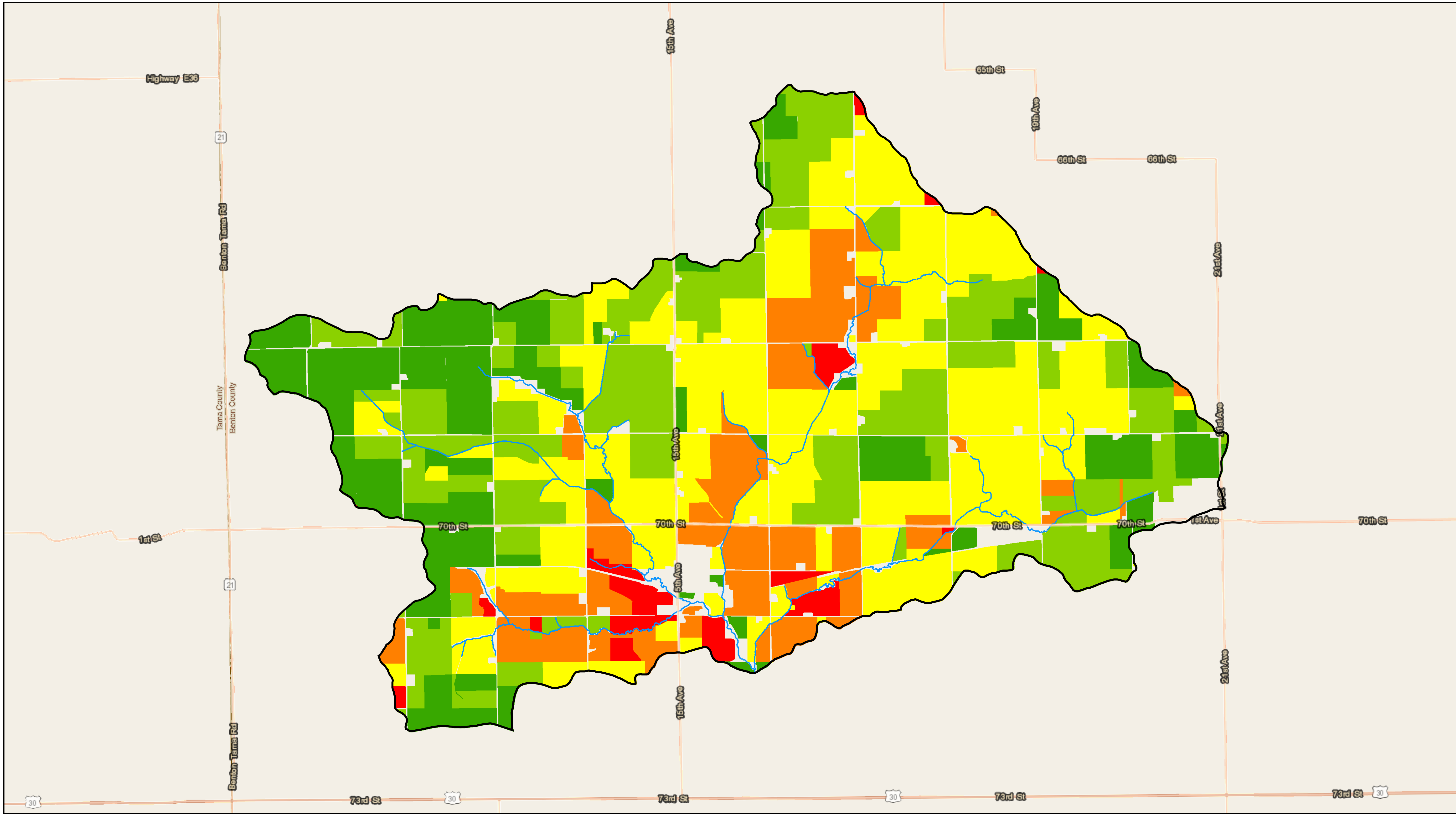

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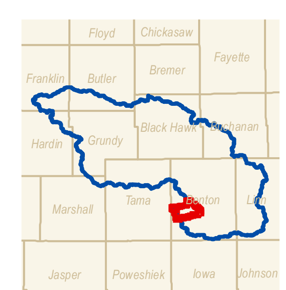
Prioritization of Conservation Practices: Contour Buffer Strips and Terraces

Slope Steepness
- Low
- Medium
- High



Headwaters Prairie Creek Subwatershed
Conservation Practice Prioritization
Map #3

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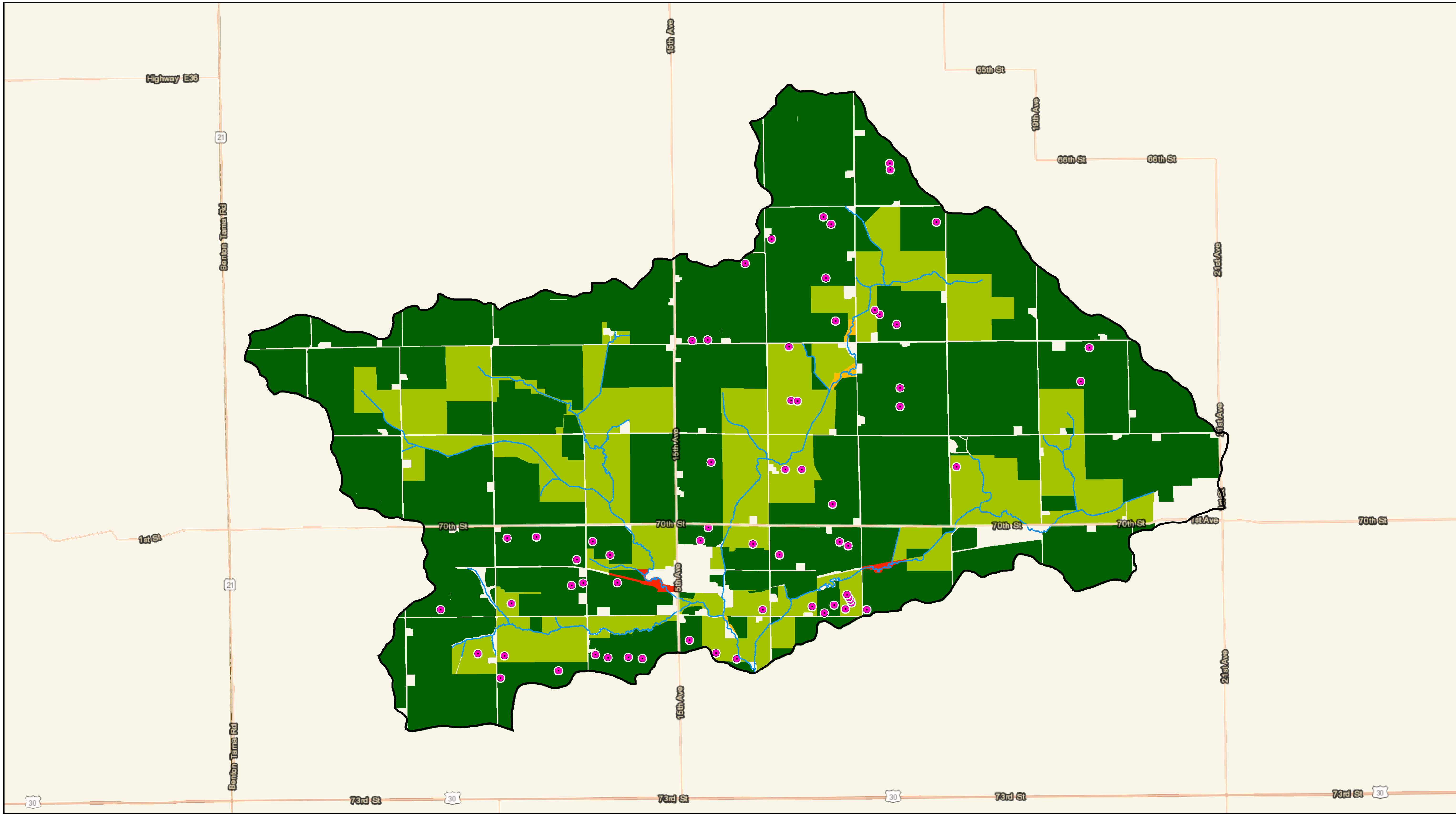

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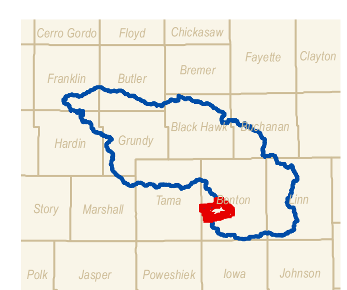
Prioritization of Conservation Practices:
Soil Health practices, no-till, perennial cover & WASCOBs

WASCOB

Run off Risk

- Low
- Medium
- High
- Critical



Headwaters Prairie Creek Subwatershed

Conservation Practice Prioritization
Map #4

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