Boone River Watershed Management Plan

Boone River WMA, Iowa

March 2022

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Boone River WMA

Watershed Management Plan

Prepared: March 2022

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Prepared for: Boone River WMA

Fiscal Agent: Wright County

Prepared by: JEO Consulting Group, Inc.

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This water quality management plan was prepared to guide the Boone River Watershed Management Authority (WMA) in developing and implementing future projects to improve water quality, habitat, and recreation; reduce flooding; and increase related education and partnership efforts across the watershed. The plan may also serve as a basis for seeking financial support for those projects. It has been written with guidance published in EPA's "Handbook for Developing Watershed Plans to Restore and Protect Our Waters," updated March 2008, including EPA's Nine-Elements of a Successful Watershed Plan. The planning process utilized a Community Based Approach and incorporated several Iowa Smart Planning Principles.

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DIGITAL COPY OF MATERIALS

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LIST OF ABBREVIATIONS AND ACRONYMNS

ACPF	Agricultural Conservation Planning Framework
ACS	American Community Survey
ACWA	Agriculture's Clean Water Alliance
APSIM	Agricultural Production Systems Simulator
ASL	Above Sea Level
BFE	Base Flood Elevation
BMIBI	Benthic Macroinvertebrate Index of Biotic Integrity
BMP	Best Management Practice
BRCRP	Boone River Comprehensive Restoration Plan
BRIC	Building Resilient Infrastructure and Communities
BRW	Boone River Watershed
BRWMA	Boone River Watershed Management Authority
CCB	County Conservation Board
CDBG	Community Development Block Grant
CFS	Cubic feet per second
CFU	Colony Forming Units
CIG	Conservation Innovation Grants
COS	Corn-Oats-Soybeans
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CSA	Critical Source Area
CSO	Corn-Soybeans-Oats
CSOA	Corn-Soybeans-Oats-Alfalfa
CSP	Conservation Stewardship Program
CSW	Corn-soybeans with a winter wheat cover crop
DC	District Conservationist
DD	Drainage District
DEP	Daily Erosion Project
DNR	Department of Natural Resources
DU	Ducks Unlimited
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
FEMA	Federal Emergency Management Agency
FIBI	Fish Index of Biotic Integrity
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
ft^3/s	Cubic feet per second
FWA	Flow Weighted Average
GFHI	General Fish Habitat Index
GHOST	Generic Hydrologic Overland-Subsurface flow Toolkit
GIS	Geographic Information System
GLO	General Land Office
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan

HSD	Hydrologic Soil Groups
HSEMD	Homeland Security & Emergency Management
HUC	Hydrologic Unit Code
HUD	US Department of Housing and Urban Development
IBI	Index of Biotic Integrity
IDALS	Iowa Department of Agriculture and Land Stewardship
IDNR	Iowa Department of Natural Resources
IDOT	Iowa Department of Transportation
IEDA	Iowa Economic Development Authority
IFC	Iowa Flood Center
IFIP	Iowa Financial Incentives Program
IFIS	Iowa Flood Information System
IHSEMD	Iowa Homeland Security Emergency Management Division
IIHR	University of Iowa IIHR-Hydroscience & Engineering
ILF	In-Lieu Fee
IR	Integrated Report
ISA	Iowa Soybean Association
ISU	Iowa State University
ISWEP	Iowa Stormwater Education Partnership
IWA	Iowa Watershed Approach
IWC	Iowa Water Center
IWQIS	Iowa Water Quality Information System
LICA	Land Improvement Contractors Association
LMI	Low to Moderate Income
LOST	Local Option Sales Tax
MCL	Maximum Contaminant Level
MDEQ	Michigan Department of Environmental Quality
Mg/L	Milligrams per liter
MRTN	Maximum Return to Corn
MS4	Municipal Separate Storm Sewer Systems
NCEI	National Centers for Environmental Information
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRE	Nutrient Reduction Exchange
NRS	Nutrient Reduction Strategy
NWTF	National Wild Turkey Federation
OWTS	Onsite Wastewater Treatment System
PALS	Post-Assisted Log Structures
PF	Pheasants Forever
PFS	Pay-for-Success
Ppm	parts per million
PPR	Prairie Pothole Region
PRC	Pollutant Reduction Calculator
RCPP	Regional Conservation Partnership Program
REAP	Resource Enhancement and Protection
RHA	Rapid Habitat Assessment

SGCN	Species of Greatest Conservation Need
SHP	Soil Health Partnership
SIPES	Social Indicator Planning and Evaluation System
SRF	State Revolving Fund
STRIPS	Science-based Trials of Rowcrops Integrated with Prairie Strips
SWAT	Soil & Water Assessment Tool
SWCD	Soil and Water Conservation District
T&E	Threatened and Endangered
TIF	Tax Increment Financing
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VTS	Vegetative Treatment System
WASCOB	Water and Sediment Control Basin
WBD	Watershed Boundary Dataset
WFPO	Watershed and Flood Prevention Operations
WMA	Watershed Management Authority
WMD	Wetland Management District
WPA	Waterfowl Production Areas
WQI	Water Quality Initiative
WWTF	Wastewater Treatment Facility

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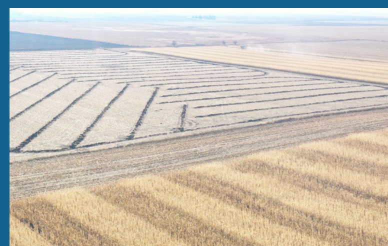
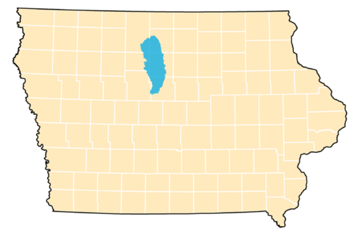
Boone River Watershed Management Plan

Executive Summary





A watershed management plan was prepared for the Boone River Watershed located in north central Iowa (shown in blue on map at right). This plan was sponsored by Boone River Watershed Management Authority (WMA), a voluntary coalition of local counties, cities, and soil and water conservation districts (SWCDs) within the watershed.

Approved in 2022, the plan identifies and prioritizes projects and activities to address water quality and flooding concerns across the watershed. Implementation of the plan is based on voluntary cooperation between WMA members, landowners, and other stakeholders. It will be updated every 5 years to maintain eligibility for funding assistance with implementation efforts.

Implementation of the plan relies on the voluntary adoption and use of Best Management Practices (BMPs), a broad set of conservation practices such as terraces, reduced tillage, grassed waterways, and others that help conserve soil and water resources. The plan helps to target BMPs to the most needed areas while also ensuring they can be adopted to fit the unique needs, lands, and budget of each farmer, landowner, and city.

The plan contains a long-term implementation strategy (20-years), short-term action plan (5-years), and an education plan.

VISION FOR THE WMA

The Boone River WMA will be a local voice in existing and new watershed efforts through community, county, state, federal, and private partnerships to improve water quality and increase flood resiliency across the watershed. This will be achieved through facilitation of education, outreach, and implementation of practices which are voluntary, compatible with agriculture, economically viable, environmentally sound, and that improve soil health, as well as enhance recreation and wildlife habitat.

Chapter 1 of the plan provides a brief overview of the plan and history of the watershed.

View the full plan at booneriver.org/boone-river-wma/

BOONE RIVER WATERSHED

DNR Iowa Department of Natural Resources

Funding provided by Iowa DNR Section 319 Watershed Improvement Program | Plan developed by JEO Consulting Group

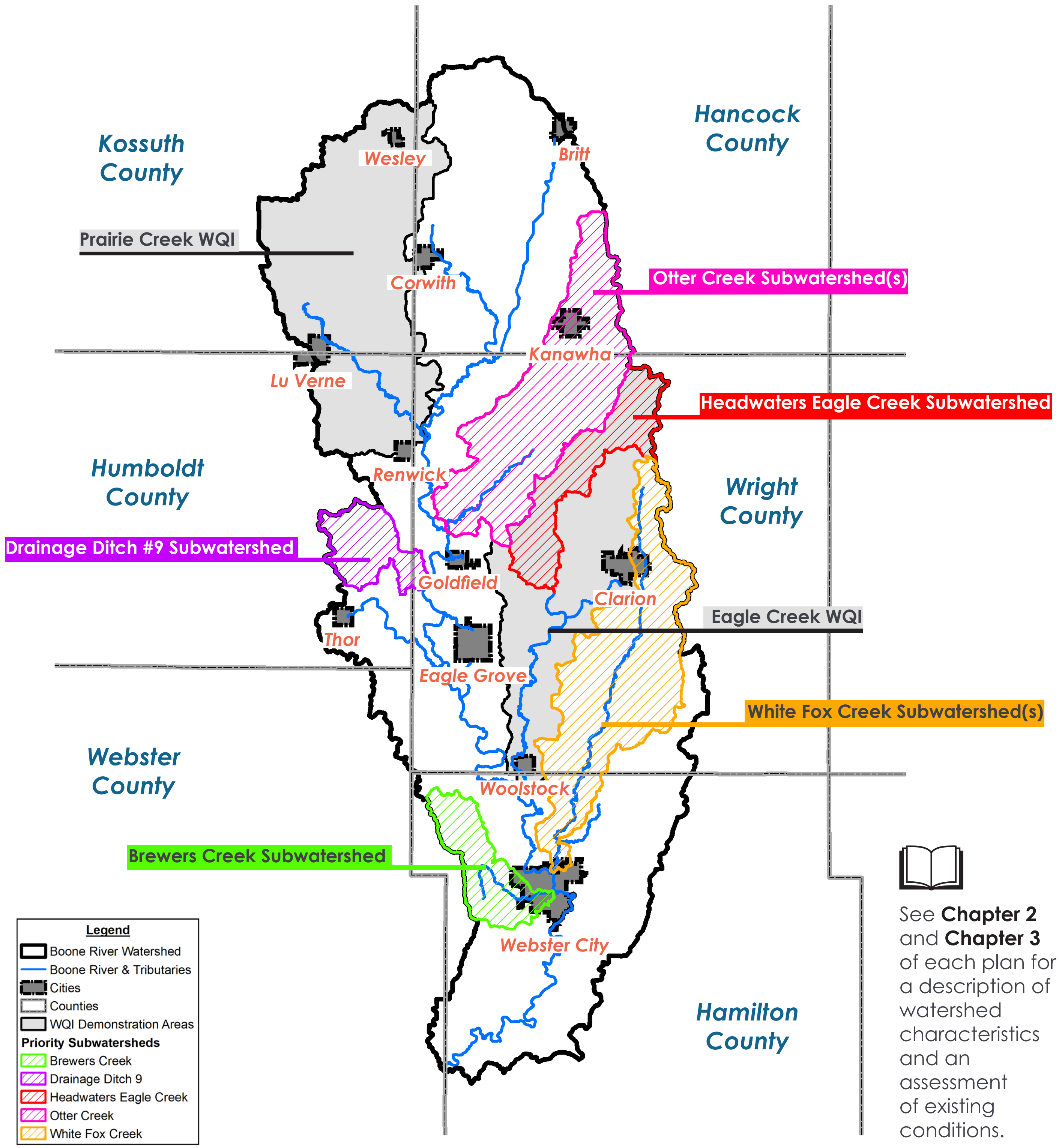
The Boone River Watershed faces multiple issues.

High nitrogen and phosphorus levels
caused by soil erosion and excess fertilizer runoff and leaching

High levels of bacteria
caused by waste from livestock, humans, and wildlife

Stream bank erosion
caused by stream channelization and higher runoff rates

Flooding
caused by changes to watershed hydrology and runoff patterns



See **Chapter 2** and **Chapter 3** of each plan for a description of watershed characteristics and an assessment of existing conditions.

More than a plan. A path forward.

The watershed plan includes goals and objectives that are SMART: Specific, Measurable, Attainable, Relevant, and Time-bound.

GOALS

1. Ensure water quality is adequate for all uses, both within the watershed and downstream, by meeting state water quality standards and goals.
2. Reduce flood risks and improve wildlife habitat within the watershed.
3. Build an aware and engaged community that works towards improving watershed management.

Goals and objectives are identified in **Chapter 4.** While **Chapter 5** outlines a long-term implementation strategy, **Chapter 6** provides a plan to involve and education stakeholders throughout the watershed, and **Chapter 7** is a short-term action plan to provide initial focus.

The action plan identifies priority activities that each city, county, and SWCD, along with the WMA should take over the next 5 years.

ACTION PLAN FRAMEWORK

EDUCATION
Outreach, education, or technical assistance aimed at various target audiences that helps to increase awareness of the WMA, the watershed plan, or assists in the increases adoption of BMPs.

PROJECTS & STUDIES
A standalone or specific effort meant to produce a product, tool, report, or achieve a tangible result.

PARTNERSHIPS & POLICY
Collaboration between WMA members or other partners and the resulting actions, guidelines, or protocols set forth to achieve a specific outcome.

MONITORING & PLAN EVALUATION
Efforts to collect, manage, and utilize data over time to track progress of meeting watershed plan goals.

Monitoring and assessing progress towards improved water quality and increased flood resiliency will be completed through long-term and short-term metrics.

Measurable Indicators of Desirable Change

INPUTS
- People
- Funding
- Public resources
- Private resources

HUMAN
- Partner organizations
- Partner agribusinesses
- Farmer knowledge and attitude
- Communities and management knowledge attitude

LAND
- Land use changes
- BMP adoption
- Flood resiliency indicators

WATER
- Edge of field monitoring
- Stream monitoring
- Modeled pollutant load reductions
- Flood loss avoidance study

Adopted from the Iowa Nutrient Reduction Strategy's (IDALS, 2017) logic model for measurable indicators of desirable change

EVERYONE HAS A ROLE TO PLAY

to improve water quality and mitigate flooding

WATERSHED MANAGEMENT AUTHORITY

- Act as the lead facilitator and coordinator for projects throughout the watershed
- Help identify and connect funding opportunities with local project sponsors
- Serve as a regional source for information
- Recruit additional members and build partnerships

CITY & COUNTY GOVERNMENTS

- Serve as local sponsors for implementing projects
- Leverage local funds against other grant programs
- Adopt policies that reduce runoff or protect floodplains
- Identify and implement urban storm water BMPs, like:
  - » Stormwater management
  - » Infiltration basins
  - » Dams and levees
  - » Channel improvements
  - » Bridge improvements
  - » Non-structural strategies (zoning, acquisitions, floodplain remapping, etc.)
  - » Join the Community Rating System program

LANDOWNERS & RESIDENTS

Voluntarily adopt BMPs, using cost-share opportunities, such as:

- Cover crops
- Drainage management
- Oxbow restoration
- Saturated buffers
- Buffer strips
- Perennial cover
- Farm ponds
- Floodplain restoration
- Bioreactors
- Wetlands
- Stream stabilization
- Prairie STRIPS

SOIL & WATER CONSERVATION DISTRICTS

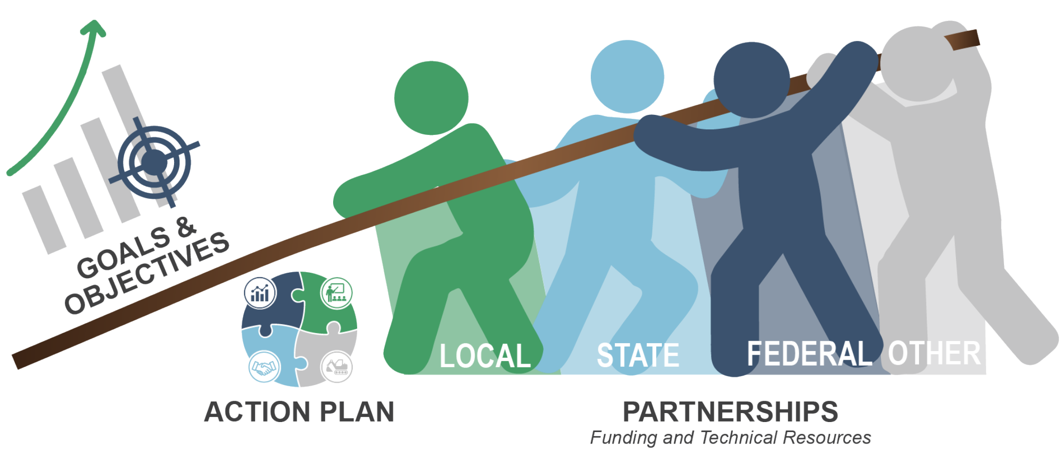
- Provide technical and financial support for BMPs

WE CAN DO MORE TOGETHER

Chapter 8 identifies funding and technical resources that can be used to help with plan implementation.

LEVERAGING THE POWER OF PARTNERSHIPS

Local project sponsors use the action plan to direct resources toward meeting goals and objectives. When a local champion can assemble partnerships to contribute towards a project, even more can be achieved.



GETTING STARTED

Within this plan are many ideas for improving the Boone River Watershed and ensuring the longevity of the Boone River Watershed Management Authority. This page is a place to start. The following first steps should be completed within the first year, after the plan is adopted.

1. Create **an implementation committee** to lead the actions outlined in this plan.
2. After plan adoption, **present the plan to each jurisdiction** involved (including both current and potential WMA members' jurisdictions). Presenting on a specific, short list of actions may yield the best outcomes.
3. **Hire a permanent watershed coordinator** to provide a catalyst for action items and give the WMA a more stable presence in the community. See Chapter 7 for more details.
4. **Host a funding workshop** for WMA Board Members or **have funding ideas as a standing WMA meeting agenda item** in order to develop a more stable funding base. Chapter 8 identifies possible entities or funding sources to invite and/or request funding information from. **Appendix E contains a funding roadmap** which outlines possible grants that could help with BMPs and education and outreach efforts, as well as ideas to develop local funds.
5. Work with WMA members to develop a strategy to **leverage funding from member entities** as available. See Chapter 8 for more details.
6. **Consider adjusting requirements for a quorum** at WMA board meetings**,** or **designate alternates from each member** to ensure work can still get done in the event of challenges with member attendance.
7. **Create an onboarding document** that would help new members get up to speed on the WMA, goals, and other updates.
8. Host a **board member retreat** to promote team building and give members a chance to connect with each other. One strategy for this is a float along the Boone River.
9. Host a **joint WMA board meeting with a public outreach event** to engage board members and the public, and to build the WMA presence across the community.
10. **Begin developing a BMP demonstration farm** for education, outreach, and research use at the local level. The existing County Farm owned by Wright County may be a potential location.

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CHAPTER 1. INTRODUCTION AND BACKGROUND

1.01 PLAN PURPOSE

The purpose of the Boone River Watershed Management Plan is to make recommendations that address water quality, flood mitigation and resilience, and other resource concerns identified by local stakeholders and project partners. While the primary focus of the plan is water quality, additional resource concerns that were identified include: shoreline and riparian areas, plant and animal communities, sediment, nutrients, stormwater, public access, flood resiliency, and hazard mitigation. The planning area for the watershed plan is based upon the Boone River HUC 8 (07100005).

The planning process followed the U.S. Environmental Protection Agency's (EPA) nine elements for watershed planning while incorporating Iowa smart planning principles, when applicable. This plan focuses on community-identified priorities and seeks to guide improvements over the next twenty years, with a focus on shorter term goals and actions. The implementation of this plan is based entirely on the voluntary actions of communities, landowners, and citizens of the Boone River Watershed.

The Boone River Watershed faces many challenges including degraded water quality, altered hydrology, loss of wildlife habitat, and decreased soil health. These issues were raised by the Watershed Management Authority (WMA) and are issues that local partners have been working to address for many years. Despite the dedication of partners and committed efforts to improving the watershed, little improvement in water quality and flooding have been realized. Conservation needs to occur at a much greater scale to have a measurable positive impact. This plan will help guide partners in their conservation efforts and give direction to the conservation steps that need to be taken to meet mutual watershed goals.

1.02 PLANNING AREA AND PARTNERS

As shown in Figure 1, the planning area follows the Boone River Watershed Hydrologic Unit Code (HUC) 8 boundaries. A hydrologic unit code (HUC) is a sequence of numbers or letters that identifies a specific watershed. HUC-8 refers to a subbasin of approximately 700 square miles (USGS and USDA, 2013). These boundaries are defined by the United States Geological Survey's (USGS) Watershed Boundary Dataset (WBD), and are based on topographic, hydrologic, and other relevant landscape characteristics without regard for administrative, political, or jurisdictional boundaries (USGS, 2018).

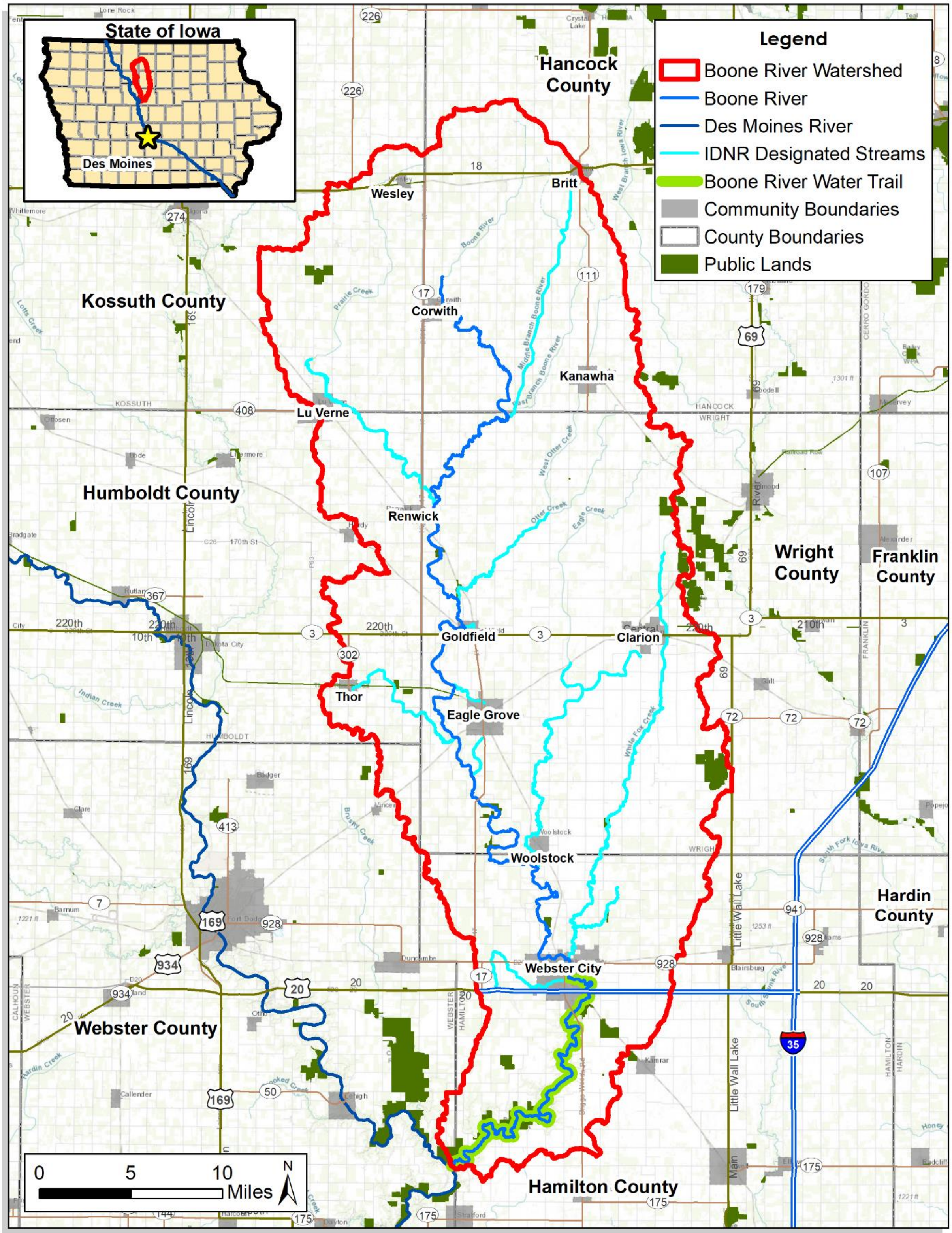


Figure 1: Boone River Watershed Planning Area

The Boone River Watershed encompasses approximately 581,350 acres and contains the 111-mile Boone River along with other tributary streams. Located entirely in the Des Moines Lobe landform, the watershed covers an area of poorly drained soils that corresponds to the southernmost extent of the last glacial advance in the Upper Midwest (Iowa, Michigan, Minnesota, North Dakota, South Dakota, and Wisconsin). The Boone River Watershed covers portions of six counties in Iowa, including Hamilton, Hancock, Humboldt, Kossuth, Webster, and Wright. Approximately 86% of land in the watershed is utilized for agricultural production, including corn and soybean production.

Notable tributaries within the Boone River Watershed are Prairie Creek, Otter Creek, Eagle Creek, White Fox Creek, and Buck Creek. Lyons Creek is notable due to recent watershed management efforts completed there, however; it is not a major tributary to the Boone River. The Boone River flows from the northern reaches of the watershed south to its confluence with the Des Moines River near Stratford, Iowa. The upper portion of the watershed's drainage system is composed of few wooded areas and small, shallow streams and drainage ditches. The lower stretch of the Boone River is heavily utilized for recreational activities such as fishing, canoeing, and kayaking. The southernmost 25 miles of the Boone River was designated by the Iowa Department of Natural Resources (IDNR) as a Protected Water Area in 1985 and is a designated water trail. This portion of the river is fast flowing and wide, moving through scenic hilly and forested areas. A summary of the Boone River Watershed's characteristics is provided in Table 1. Additional details on these summary characteristics are provided in Chapter 2.

Table 1: Plan Area Characteristics

Plan Area Component	Component Details
EPA Region	VII
HUC-8	Boone River Watershed (#07100005)
Counties	Portions of Hamilton, Hancock, Humboldt, Kossuth, Webster, and Wright Counties
Cities	Britt, Clarion, Corwith, Eagle Grove, Goldfield, Kanawha, Lu Verne, Renwick, Thor, Webster City, Wesley, Woolstock
Tribes	None
Estimated Population (2018)	31,014
Planning Area Boundary Size	581,350 acres
Major River Watershed	Des Moines River
Major Streams	Boone River, Prairie Creek, Otter Creek, Eagle Creek, White Fox Creek, and Buck Creek
Major Economic Activity	Agriculture
Major Crop(s)	Corn, Soybean
Major Livestock(s)	Cattle and Calves, Hogs, Chickens
Applicable TMDLs	No TMDLs existing within the watershed; however, the watershed does fall within the 2009 Des Moines River TMDL for Nitrates.
Water Quality Impairments	Portions of the Boone River are impaired due to *E. Coli* bacteria and low aquatic macroinvertebrate IBI scores. Several tributaries have been listed as impaired due to previously recorded fish kill events. The Boone River has also been identified as a major contributor of nitrate to the Des Moines River, which is impaired and has a TMDL for nitrate.
Other Pollutants of Concern	Nutrients (Nitrogen and Phosphorus) and Sediment
Lake Designated Uses (Number of applicable lakes)	A1 – Primary Contact Recreation (2 lakes) B(LW) – Lakes and Wetlands (all 5 lakes) HH – Human Health (all 5 lakes)
Stream Designated Uses (Number of applicable stream segments)	A1 – Primary Contact Recreation (6 stream segments) A2 – Secondary Contact Recreation (9 stream segments) A3 – Children's Contact Recreation (2 stream segments) B(WW-1) – Warm Water – Type 1 (3 stream segments) B (WW-2) – Warm Water – Type 2 (11 stream segments) HH – Human Health (3 stream segments)

Portions of the Boone River Watershed have been designated as critical habitat for a federally endangered fish, the Topeka shiner (*Notropis topeka*), by the U.S. Fish and Wildlife Service (USFWS). In order to prevent future degradation of the healthy ecosystems present, the Boone River has been identified by many as a priority for conservation of freshwater biological diversity. Good sand and riffle habitat, historically rich mussel communities, high aquatic Index of Biotic Integrity (IBI) scores, presence of sensitive aquatic invertebrates, high native fish diversity, and the presence of several threatened, endangered, and protected species of concern are some of the positive attributes of the Boone River.

For nearly two decades private, state, and federal funding has supported outreach and incentives to assist landowners with installing conservation practices that improve soil health, water quality, wildlife habitat, and farm resiliency. Partners such as The Nature Conservancy (TNC), USFWS, Iowa Soybean Association (ISA), Iowa State University (ISU), Iowa Department of Agriculture and Land Stewardship (IDALS), Natural Resources Conservation Services (NRCS), and others have been involved in conservation efforts in the Boone River watershed. These partners have been working with local producers and communities to accomplish conservation and agricultural goals. They have provided additional research, outreach, and funding to the watershed planning effort. Portions of the watershed were prioritized or targeted through the Mississippi River Basin Initiative, Iowa Nutrient Reduction Strategy (NRS), the Iowa Water Quality Initiative (WQI) to fund technical and financial assistance for conservation on private lands. Ongoing watershed efforts have continued throughout the planning process.

WATERSHED MANAGEMENT AUTHORITY

In 2010, Iowa lawmakers passed legislation authorizing the creation of Watershed Management Authorities (WMAs) as a mechanism for cities, counties, and Soil and Water Conservation Districts (SWCDs) to cooperatively engage in watershed planning and management. A WMA is formed through a Chapter 28E Agreement between two or more eligible political subdivisions within a specific HUC 8 watershed (IDNR, 2020b). WMAs are voluntary agreements between participating entities; additionally, formation of a WMA does not confer any special or new regulatory power to the WMA or the participating jurisdictions. There are multiple benefits to cooperating with other jurisdictions within a watershed including, but not limited to, the opportunities to:

- Conduct planning on a watershed scale, which has greater benefits for water quality improvement and flood risk reduction
- Foster multi-jurisdictional partnership and cooperation
- Leverage resources, such as funding and technical expertise
- Facilitate stakeholder involvement in watershed management

As of June 2019, there are 26 active WMAs in Iowa, including the Boone River WMA. With the assistance of the IDNR the Boone River WMA was officially established in spring 2019. Multiple cities, counties, and SWCDs are currently members of the WMA (Table 2). Efforts are ongoing to enlist the remaining relevant entities as official members.

Table 2: Boone WMA Membership Status of Eligible Entities

Entity	Member of Boone WMA?
Cities	
Webster City	No
Woolstock	No
Eagle Grove	No
Thor	No
Clarion	No
Goldfield	**Yes**
Renwick	No
Lu Verne	No
Kanawha	No
Wesley	No
Britt	No
Counties	
Kossuth	**Yes**
Hancock	**Yes**
Humboldt	**Yes**
Wright	**Yes**
Webster	No
Hamilton	**Yes**
Soil and Water Conservation Districts (SWCD)	
Kossuth	**Yes**
Hancock	**Yes**
Humboldt	**Yes**
Wright	**Yes**
Webster	**Yes**
Hamilton	**Yes**

Through the Boone River WMA, these parties can "cooperate with one another to successfully encourage, plan for, and implement watershed activities within the Boone River watershed" (State of Iowa, 2019). Iowa Code Section 466B.22 enables the Boone River WMA to:

1. Assess the flood risks in the watershed.
2. Assess and improve water quality in the watershed.
3. Assess options for reducing flood risk and improving water quality in the watershed
4. Monitor federal flood risk planning and activities
5. Educate residents of the watershed regarding flood risks and water quality.
6. Seek and allocate monies made available to the Authority for purposes of water quality and flood mitigation
7. Make and enter into contracts and agreements and execute all instruments necessary or incidental to the performance of the duties of the Authority. The Authority shall not have the power to acquire property by eminent domain. All interests in lands shall be held in the name of the Party wherein said lands are located.

The Boone River WMA has no taxing or eminent domain authority. This plan was developed for and under the direction of the Boone River WMA.

1.03 SUMMARY OF CURRENT CONDITION REPORTS

As an initial part of the planning process, a review of the existing conditions within the watershed was conducted to provide a greater understanding of the issues and opportunities present. This process also provided an opportunity to review the extensive amount of existing data, studies, and reports already completed within the watershed. This information will help the WMA prioritize areas to focus conservation efforts and quantify the estimated benefits. These existing conditions, along with previous monitoring data, will serve as baseline data to measure the success of this plan.

This section discusses the eight primary resource concerns initially identified by the WMA to be addressed during the planning process. Separate "current condition reports" for each one of the resources were completed and finalized in November 2020. Complete copies of these can be found in Appendix A. The following provides a summary of each.

SHORELINE & RIPARIAN AREAS

Extending along both sides of the Boone River and its tributaries, riparian areas provide wildlife habitat and are important for filtering sediment, chemicals, and bacteria from agricultural runoff. These areas, totaling 240 miles in combination, are home to many local plant and animal species. Currently, the Boone River is listed as impaired because of high concentrations of bacteria present in the water. This indicates that riparian areas are not as effective as they could be. Lake shorelines are located between riparian areas and the waterline and provide filtration services during runoff events. Within the Boone River Watershed, there is a total of 55,641 linear feet of shoreline; however, these shorelines have the potential to erode when wind and watercraft cause waves.

The following recommendations were identified to address riparian and lake shoreline resource concerns.

Riparian Area Management

- To the extent possible, support on-going efforts to protect riparian areas in the Eagle Creek, Eagle Grove, Lyons Creek, and Prairie Creek drainages.
- Evaluate riparian corridor health and function in priority subwatersheds.
- Evaluate opportunities to restore or enhance degraded riparian corridors and shorelines.
- Minimize impacts of future development on riparian areas and shorelines.
- Minimize impacts of agricultural activities on riparian areas.
- Minimize the impacts of recreational activities and new recreational facilities on riparian areas and shorelines.
- Assist in the development of conservation plans for landowners adjacent to streams.

<u>Lake Shorelines</u>

- Periodically evaluate lake shoreline conditions to identify areas exhibiting moderate to severe erosion.
- Work with the appropriate management authority to address lake shoreline erosion concerns.
- Include lake resources in future water quality assessments and watershed management plans.
- Evaluate impacts to lake shorelines on all future development projects.

PLANT AND ANIMAL COMMUNITIES

Despite only taking up roughly 1.6% of Iowa's total land mass, the Boone River is considered an area of significance due to its aquatic biodiversity. This river was identified in the Upper Mississippi River Basin Plan as an area with significant plant and animal life (BRWMA, 2019). The dynamic environment in the Boone River Watershed was developed through glacial activity in the landscape that includes the Des Moines Lobe (Prior, 1991). Out of the variety of plant communities in Iowa, prairies have suffered the most destruction (Reeder and Clymer, 2015). The Topeka shiner is a species of fish that is rapidly decreasing in population due to deterioration of its critical habitat.

The following recommendations were identified to address plant and animal resource concerns:

- Ensure the protection of the Topeka shiner and critical habitat through a variety of management actions.
- Expand the abundance and range of the Topeka shiner in the watershed.
- Support and promote conservation programs and practices throughout the watershed.
- Along with partners, continue to initiate targeted projects in priority subwatersheds that address water quality, soil health, habitat, wildlife, and public access.
- Support monitoring activities that help define the physical, chemical, and biological integrity of the Boone River and its tributaries.

SEDIMENT

Within the Boone River Watershed, there is less documentation of direct impacts of erosion and sedimentation on aquatic environments than there is of the impact of nutrients. Of the 240 miles of river, streams, and drainage ditches, there is limited information on erosion. However, three lakes in the watershed appear to have a potential for erosion concerns: Lake Cornelia, Briggs Woods Lake, and Big Wall Lake. When it comes to cropland, soil loss on farm fields from wind and rain erosion is also a concern. Overall, based on available watershed data, the primary sources of sediment entering the Boone River and its tributaries appear to be agricultural crops on highly erodible land, urban stormwater, and streambank erosion.

The following recommendations were identified to address sediment concerns:

- Utilize regulatory programs to control and monitor sediment loading from point source discharges, permitted facilities, and urban stormwater.
- Utilize non-regulatory programs to reduce sediment loading from agricultural and urban nonpoint sources in the watershed.
- Continue to support and promote funding programs and conservation practices throughout the watershed.
- Along with partners, continue to initiate targeted projects in priority subwatersheds that address water quality, soil health, habitat, wildlife, and public access.
- Support monitoring activities that help define the physical, chemical, and biological integrity of the Boone River and its tributaries.
- Conduct updated stream and soil erosion studies or modeling throughout the watershed to quantify current erosion rates, including from urban areas.

NUTRIENTS

Large amounts of nitrogen and phosphorus in bodies of water negatively impact the health of the surrounding environment, plant and animal species, and humans. Protecting the Boone River is imperative to the state's drinking water supply since it is a tributary of the Des Moines River which provides potable water to well over 500,000 people in Des Moines and its surrounding communities.

The following recommendations were identified to address nutrient concerns:

- Inform and engage landowners, recreational users, and the general public in the development of resource protection strategies.
- As applicable, utilize current regulatory programs to control and monitor nutrient loading from point source discharges, permitted facilities, spills and releases, construction sites, and urban stormwater.
- Utilize non-regulatory programs to reduce nutrient loading from agricultural and urban nonpoint sources in the watershed.
- Continue to support and promote conservation programs and practices throughout the watershed.
- Along with partners, continue to initiate targeted projects in priority subwatersheds that address water quality, soil health, habitat, wildlife, and public access.
- Support monitoring activities that help define the physical, chemical, and biological integrity of the Boone River and its tributaries.
- Develop a water quality model to help quantify existing nutrient loads and predict future loads under various land use scenarios.

STORMWATER

Stormwater management plays a critical role in protecting resources within the Boone River Watershed. Not only does stormwater runoff carry pollutants like trash, debris, petroleum, nutrients, bacteria, and sediment to various bodies of water, it also causes streambank erosion and flooding. Even though communities within the Boone River Watershed face many stormwater management problems, more information on the specific issues they face and strategies to prevent damages has yet to be acquired.

The following recommendations were identified to address stormwater concerns:

- Collect the necessary information to evaluate the impact of stormwater on local water resources and communities (i.e., drinking water and flooding).
- Inform and educate the public, contractors, consultants, and decision makers on stormwater concerns facing the watershed.
- Work with interested communities to develop a coordinated approach to implement cost-effective stormwater management measures.
- Monitor and quantify the effectiveness of individual stormwater control measures.
- Identify and evaluate the effectiveness of stormwater management efforts in the watershed.

PUBLIC ACCESS

Utilization of the Boone River for recreation and other public access activities provides numerous social benefits to residents both inside and outside of the watershed. The IDNR and counties within the watershed currently control the access policies for publicly owned natural areas outside municipal jurisdiction.

The following recommendations were identified to address public access concerns:

- Protection of downstream drinking water supplies
- Protection of critical habitat used by the Topeka Shiner
- Protection of recreational streams and lakes from bacteria loading
- Protection of shorelines, streambanks, and riparian areas from erosion and degradation
- Protection of private landowners adjacent or near public access areas
- Maintain long-term ecosystem health and biological diversity within the watershed
- Assure that public access is safe and supportive of any water quality and/or other policy goals

FLOOD RESILIENCY

Flood resiliency can be defined as the ability of entities, like individuals, communities, farmers, businesses, and government, coming together with their resources to prevent, mitigate, respond to, and recover from flood events. Flood Resiliency is based on four key components: spatial, structural, social, and risk (Tourbier, 2012). The spatial component includes the intensity of flooding; structural deals with damages during the flood event; social includes community partnerships for flood planning, response, and recovery; and risk addresses the ability of an area to prepare, respond, and recover from flooding events. Recognizing that flooding events will inevitably occur is important when considering flood resiliency, but much can be learned from past flooding events to prepare for future floods.

The following recommendations were identified to address flood resiliency concerns:

- Work with communities and stakeholder groups for holistic watershed management and planning
- Leverage the planning process to further refine and evaluate flood risk reduction strategies and projects
- Encourage the participation of multi-agency participation in watershed plan updates
- Create a strong network of stakeholders to facilitate the creation of partnerships to build social and financial resilience to flood events.
- Identify strengths and weaknesses in the current floodplain management, ordinances, infrastructure, and flood protection structures
- Identify and prioritize measures to build flood resilience within the Boone River Watershed
- Integrate the Boone River Watershed Plan with each local hazard mitigation plan

HAZARD MITIGATION

Within each county in the Boone River Watershed, there is an established Hazard Mitigation Plan (HMP). To be eligible for Hazard Mitigation Assistance (HMA) grants, a project must be included in a FEMA-approved and locally adopted hazard mitigation plan. Hazards are determined upon the State of Iowa HMP, the guidance of FEMA, and local planning teams. Generally, the most relevant hazards to watershed management include dam failure, flash flooding, levee failure, and river flooding.

There are already established goals and objectives utilized for guiding the development of HMPs within the watershed. The following recommendations were identified to address hazard mitigation concerns:

- Work with communities and stakeholder groups for holistic watershed management planning
- Leverage the hazard mitigation planning process to further refine and evaluate flood risk reduction strategies and projects

- Encourage the participation of multiple agencies in both hazard mitigation planning teams and watershed plan updates
- Integrate the Boone River Watershed Plan with each local hazard mitigation plan, to create greater funding eligibility for projects

1.04 EXISTING DATA AND PROJECTS

Watershed planning requires a careful balance of scientific, regulatory, social, and economic factors. As such, this plan was developed with input and guidance from a variety of organizations, programs, and resources. The following existing plans, projects, and data sources were heavily utilized to develop this watershed plan. However, the following is not an exhaustive list of information available or utilized. Additional discussion of these and other data sources can be found in the Current Condition Reports in Appendix A. Data that was specifically utilized in the plan to define watershed conditions and to inform implementation strategies is further detailed in Chapter 2 and Chapter 3.

WATER QUALITY MONITORING

The Boone River Watershed is blessed with a large dataset of water quality data that has been collected by many partners. The dataset is both long-term and covers multiple spatial scales. Chapter 3 of this plan provides additional analysis and information about existing water quality conditions. The following partners and sources of monitoring were available for the planning effort:

- Since 1999, IDNR has been monitoring water quality in the Boone River near Stratford.
- Similarly, since 2007, the ISA has collected water quality samples for Agriculture's Clean Water Alliance (ACWA) from the outlet of all 30 HUC-12 subwatersheds in the Boone River Watershed. The results of this work can be used to examine the long-term benefits that wide-spread adoptions of conservation practices can have on the watershed.
- The U.S. Geological Survey (USGS) and University of Iowa IIHR-Hydroscience & Engineering (IIHR) have been monitoring stream flows and nitrates in the Boone River near Webster City and Goldfield with two real time nitrate sensors since 2012.

The *Boone River Watershed Stream Nitrate Report* (Jones, Schilling, and Gilles, 2018) was completed by IIHR in 2018. The report is an analysis and summary of water quality monitoring conducted by ISA.

CONSERVATION PLANNING

TNC developed the *Conservation Action Plan* (CAP) for the Boone River Watershed (Blann, 2008) in 2008. This built upon a baseline ecological assessment taken in 2005 by TNC, the *Boone River Ecological Assessment* (Neugarten and Braun, 2005). The CAP focuses on wildlife and conservation issues and opportunities in the watershed. The CAP outlines strategic action alternatives and recommendation of actions to pursue to ensure a sustainable future of the Boone River Watershed.

In May of 2008, the *Boone River Watershed Rapid Watershed Assessment* was completed by the NRCS. It provided initial estimates of where conservation investments would best address the resource priorities of stakeholders, landowners, conservation districts, and other community organizations within the watershed.

DES MOINES RIVER TOTAL MAXIMUM DAILY LOAD FOR NITRATE

In 2009, IDNR published the *Des Moines River Water Quality Improvement Plan* (Schilling and Wolter, 2009). Surface water from the Des Moines River is used as drinking water by the City of Des Moines and surrounding communities. This plan was developed to calculate the allowable Total Maximum Daily Load (TMDL) of nitrate, coming from both point and nonpoint sources, for impaired segments of the Des Moines River. This work included the development of a Soil and Water Assessment Tool (SWAT) model, which was used to evaluate streamflow and pollutant loading patterns from contributing watersheds, including the Boone River Watershed.

IOWA NUTRIENT REDUCTION STRATEGY

The Iowa NRS is a science and technology-based framework to assess and reduce nutrients–particularly nitrogen and phosphorus–delivered to Iowa waters and ultimately the Gulf of Mexico (IDALS and others, 2017c). It is part of a larger nutrient reduction strategy set forth by the Mississippi River/Gulf of Mexico Watershed Nutrient Force established in 1997 and seeks to reduce the size, severity, and duration of hypoxia in the Gulf of Mexico (ISU, 2018c). Iowa is one of 12 states along the Mississippi River that was tasked with developing and implementing a state-level nutrient reduction strategy.

Initiated in 2013, the NRS was developed by the Iowa Department of Agriculture and Land Stewardship, the IDNR, and ISU. The strategy is designed to reduce nutrients in surface water from both point and nonpoint sources in a scientific, reasonable, and cost-effective manner (ISU, 2018c). It was the first effort in Iowa to utilize an integrated approach involving both point sources and nonpoint sources. Nonpoint source load reductions goals for nitrogen and phosphorus were established at 41% and 29%, respectively.

For more information, visit http://www.nutrientstrategy.iastate.edu.

The NRS identified the Boone River Watershed as a high priority area for implementing best management practices to reduce nitrogen and phosphorous loads. As such, the NRS was particularly relevant in the assessment of existing conditions within the watershed and helped to guide the implementation strategies for improving water quality in the Boone River Watershed.

BOONE RIVER WATERSHED NUTRIENT MANAGEMENT INITIATIVE

The Boone River Watershed Nutrient Management Initiative began in 2013 and is led by IDALS. The initiative focuses on education, demonstration, implementation, retention, and evaluation of practices identified in the NRS. Both the Prairie Creek Watershed and the Eagle Creek Watershed, subwatersheds of the Boone River Watershed, are included in this project. The goal of the initiative is to promote relationships between farmers, landowners, agribusinesses, and conservation agencies so conservation practices can be integrated and established throughout the subwatersheds. Conservation practices include bioreactors, cover crops, nutrient management, practice monitoring and evaluation, and strip tillage.

EXISTING SUBWATERSHED PLANS

Previous subwatershed plans in the region have focused on sustaining and improving water quality and agricultural productivity. The plans also addressed protecting and improving resources including soil health, wildlife habitat, and hydrologic function within the subwatersheds. The subwatersheds of the Boone River Watershed that already have watershed management plans are Eagle Creek, Eagle Grove, Prairie Creek, and Lyons Creek. The locations of these subwatersheds can be seen in Figure *2*.

Lyons Creek

This plan was created in 2012 to identify a feasible approach to balancing the quality of life and agriculture in the Lyons Creek watershed. The plan's vision statement covers themes of productivity and prosperity and is focused on water quality, hydraulic function of the watershed, and the enhancement of biodiversity. The plan's water quality goals were based on the nitrate reductions identified in the 2009 Des Moines River TMDL.

The Lyons Creek Watershed Management Plan was developed by ISA and funded by IDNR's Section 319 program. Implementation efforts were funded through 2015.

Eagle Creek

This plan was developed in 2017 by the ISA to assist with water quality improvement efforts funded through the Iowa WQI. The watershed plan focuses on providing direction for improvements of water and land while also pointing to how agricultural performance and the quality of life could be improved within the watershed. Watershed planning process recommendations by the IDNR and input from public and private stakeholders also helped in creating the plan.

Long-term goals of the plan address the vision of all stakeholders. These goals focus on increasing farmer and urban stakeholder involvement, increasing agricultural productivity/profitability, improving soil health, and improving/maintaining biodiversity and habitat. The goals also call for a reduction in soil erosion, a reduction of in-stream nonpoint source nutrient loading, and a reduction in flood risk. Water quality goals were based on the nitrogen and phosphorus reduction goals identified in the NRS. The successful implementation of the plan is contingent upon stakeholders such as landowners, farmers, residents, and non-governmental organizations, as well as local, state, and federal units of government.

Prairie Creek

This plan was also developed in 2017 by the ISA to assist with water quality improvement efforts funded through the Iowa WQI. This watershed plan focuses on providing a roadmap for water and land improvements while also pointing to how agricultural performance and the quality of life could be improved within the Prairie Creek watershed. Watershed planning process recommendations by the IDNR and input from public and private stakeholders also helped in creating the plan.

The vision of all stakeholders is addressed in the plan’s goals. These goals address increasing awareness and implementation of practices throughout the watershed, increasing agricultural profitability/sustainability, increasing soil organic matter, and improving wildlife habitat. Goals within the plan also focus on reducing in-stream nonpoint source nitrogen and phosphorus loading, reducing wind and water-induced soil erosion, and reducing flood risk. Water quality goals were based on the nitrogen and phosphorus reduction goals identified in the NRS. The successful implementation of the plan is contingent upon stakeholders such as landowners, farmers, residents, and non-governmental organizations, as well as local, state, and federal units of government.

Eagle Grove

The ISA developed this plan in 2018 to outline a phased approach for water and land improvement within the Eagle Grove Watershed. Input from both public and private stakeholders as well as recommendations from the IDNR also assisted in developing the plan.

Long-term goals of the plan address the vision of all stakeholders. These goals focus on identifying cost-effective solutions for watershed problems. Goals also address supporting the productivity and profitability of agriculture, creating conditions for healthy soil and water, and minimizing downstream impacts. Water quality goals were based on the nitrogen and phosphorus reduction goals identified in the NRS. The plan also highlights a goal of working with urban and rural stakeholders to implement conservation practices throughout the Eagle Grove Watershed. The participation of the following stakeholders is imperative for the successful implementation of the plan: landowners, farmers, residents, non-governmental organizations, as well as local, state, and federal units of government.

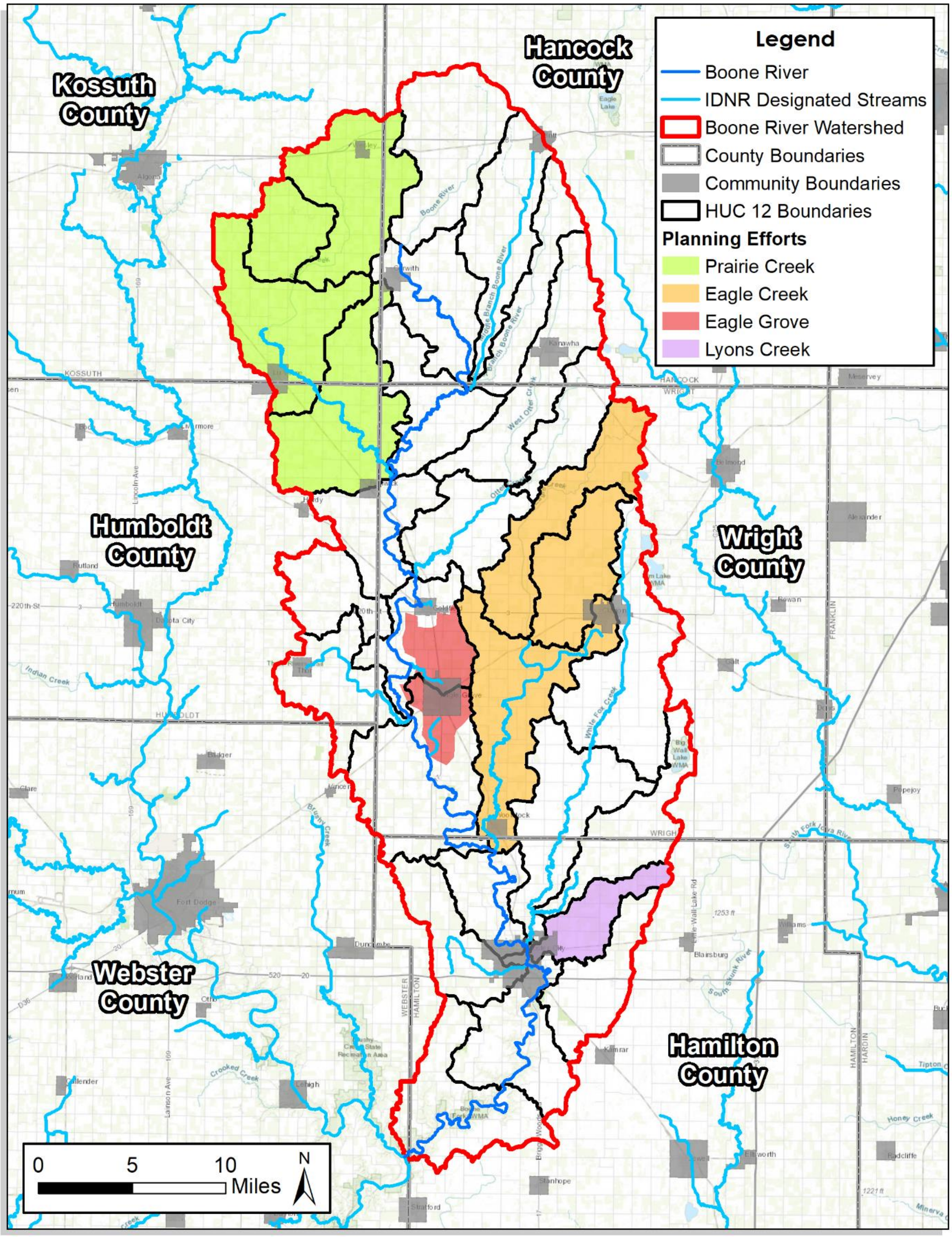


Figure 2: Subwatersheds with Watershed Management Plans

AQUATIC HABITAT PROJECTS AND STUDIES

The Boone River Watershed has been the focus of multiple agencies and partners, with the goal of monitoring and improving fish and wildlife habitat. Some of the notable efforts include the following:

- The water falls within the Iowa Wetland Management District (WMD). The Iowa WMD consists of scattered tracts of habitat (both wetland and upland grassland) known as Waterfowl Production Areas (WPAs). Currently, there are 75 WPAs in 18 counties in north-central Iowa totaling just over of 25,000 acres primarily managed by the IDNR. Even though district acquisition has only occurred in 18 counties to date, a larger 35-county boundary is approved. Additional discussion and maps of the Iowa WMD are provided in Chapter 2.
- The U.S. Fish and Wildlife Service has designated 836 miles of streams in Iowa, Minnesota, and Nebraska as critical habitat for the Topeka shiner (USFWS, 2004). Within the Boone River Watershed, Drainage Ditch 3 and Eagle Creek subwatersheds (approximately 14 miles of streams) have been designated as critical habitat. Critical habitat designates areas that contain habitat essential for the conservation of a listed species. A critical habitat designation does not set up a preserve or refuge and has no specific regulatory impact on landowners' actions on their land that do not involve federal agency funds, authorization or permits (USFWS, 2018).
- To date, The Nature Conservancy and Iowa Soybean Association has completed 32 oxbow restoration projects within the watershed. Oxbows improve riparian area functions including creating fish and wildlife habit, capturing nutrients and sediments, and providing floodwater storage. Studies have shown that “restored oxbows frequently harbor significant populations of Topeka shiners in Iowa and southwest Minnesota, and the collective evidence to date suggests that restoring oxbows in this region will be an important strategy for recovery of this endangered species” (Simpson and others, 2019).
- In 2015 a recent IDNR freshwater mussel survey found a significant increase in mussel populations in the Boone River over previous surveys, including three species of mussel that are on Iowa’s threatened species list. 14 sites were sampled as part of the state-wide mussel survey, including those that had been surveyed previously. A total of 16 live species of mussels were found, and several sites had more than 10 species at each site. This population increase would seem to indicate that conservation activities that have been ongoing in the Boone River Watershed are having a positive impact on freshwater mussel populations and the river itself (Kurth, 2018).

LOCAL HAZARD MITIGATION PLANS

The Federal Emergency Management Agency (FEMA) provides financial assistance for a variety of hazard mitigation projects, including flood risk mitigation, through its Hazard Mitigation Assistance (HMA) grant programs. However, to be eligible for HMA funds, a project must be included in a FEMA-approved and locally adopted hazard mitigation plan.

All six counties within the watershed planning area within the Boone River Water have local hazard mitigation plans. The plans and date of each plan's adoption, if applicable, are listed below:

- Kossuth County Iowa HMP (2018)
- Wright County Iowa HMP (2019)
- Hancock County Multi-Jurisdictional HMP (2019)
- Hamilton County Iowa Multi-Jurisdictional HMP (2019)
- Humboldt County Iowa HMP (2018)
- Webster County Iowa HMP (draft)

The Boone River Watershed Management Plan is not intended to supersede or replace existing local hazard mitigation plans.

This plan augments the existing hazard mitigation plans with a focus on flooding risks. Therefore, the identification of hazard mitigation alternatives to address flooding risks were identified and are provided in Chapter 5 of this plan. These actions or projects should be incorporated into existing hazard mitigation plans within the watershed to become eligible for HMA funding. Additional information is also provided in Appendix A within the *Hazard Mitigation Current Conditions Report*.

DES MOINES RIVER UPSTREAM MITIGATION STUDY

This study was completed in April 2020 by the Iowa Flood Center (IFC). The study looked at flooding and mitigation opportunities within the Des Moines River Watershed. Comparisons are made between current and proposed best management practices (BMPs), and past flood events, like the floods of 1993 and 2008, are studied and used to develop future flood mitigation strategies.

1.05 PLANNING PROCESS AND REQUIREMENTS

IOWA SMART PLANNING PRINCIPLES

The planning process has incorporated Iowa Smart Planning Principles, as described in the Iowa Smart Planning Act, found in Iowa Code Chapter 18B. The Smart Planning Act identifies ten principles which must be considered and may be applied when local governments and state agencies deliberate all appropriate planning, zoning, development, and resource management decisions. Additionally, the act outlines 13 elements that may be included in a city or county comprehensive plan. While this watershed plan is not equivalent to a city or county comprehensive plans, it may inform the development of these local documents.

This plan has incorporated the following (to varying degrees) the following Iowa Smart Planning Principles:

- Collaboration
- Natural Resources and Agricultural Production
- Sustainable Design
- Hazard Mitigation

NINE-ELEMENTS OF WATERSHED PLANNING

This WQMP addresses the EPA's Nine-Elements, as defined in their Handbook for Developing Watershed Plans to Restore and Protect our Waters (EPA, 2008). Throughout this plan, items that directly address one of the nine-elements are marked with a nine-element graphic like what is displayed to the left. The EPA requires that watershed projects receiving Section 319 funds be supported by either a watershed plan that addresses the Nine-Elements or an equivalent plan. Table 3 also provides an index for the location(s) of each element.

Table 3: Location of EPA's Nine Elements within the Plan

Element	Page Number(s)
Pollution/impairment source identification	77, 87, 93, 94, 110
Estimate of pollutant loading reduction needs	77, 138, 192
Nonpoint source management practices needed	150, 127, 157, 145, 171
Public information, education, and participation	20, 195
Schedule for implementing management practices	181, 211
Milestones to track progress in implementing the plan	181, 211
Criteria to evaluate effectiveness of management practices	185
Monitoring to evaluate the impact of implementing management practices	140
Technical and financial resource needs	179, 217

COMMUNITY-BASED PLANNING PROCESS

Community-based planning is a participatory process that uses local knowledge to influence and guide an action plan. This type of planning process is central to the development of an effective and implementable watershed management plan, which often transcends typical political boundaries. The success of a plan like this is dependent on the commitment and voluntary involvement of community members-–making it imperative that community members be engaged in the planning efforts.

Community-based planning techniques used in this plan included the involvement of a local stakeholder group and an open house style public meeting. The plan development also heavily relied upon participation and input from a technical advisory team (TAT). The TAT was made up of representatives from: IDNR, TNC, NRCS, USFWS, IDALS, IFC, ISU Extension, ISA, county conservation boards, and Iowa Homeland Security & Emergency Management Division.

STAKEHOLDER MEETINGS

An essential element of the community-based planning process was the assembly of a technical advisory group and stakeholder group. These groups provided input during the planning process, helped to develop watershed goals and objectives, reviewed the draft watershed plan, and will be instrumental in the implementation of this plan. Members included representatives of WMA; IDNR; TNC; other project partners; non-profits; local, state, and federal government agencies; and local citizens, landowners, and producers. Sign-in sheets from the stakeholder meetings are provided in Appendix B. Stakeholder meetings were held in conjunction with the quarterly WMA meetings. A short summary of each is provided below. More information about the stakeholder meetings, including meeting minutes, can be found in Appendix B.

- **June 4, 2020 –** The first stakeholder meeting was held virtually. The meeting began with a project background presentation and a brief overview of the anticipated planning process. A draft vision statement was presented for initial input and consideration by stakeholders. A facilitated discussion was held with stakeholders to identify and discuss issues and needs regarding water quality and other resource concerns in the watershed.
- **August 20, 2020 –** This second stakeholder meeting was also held virtually. At this meeting stakeholders were updated on the planning process to date, which included the completion of the Current Condition Reports. An updated vision statement was presented for additional feedback. The stakeholders were split into four smaller breakout groups to discuss specific ideas on implementation strategies, priorities and BMPs.
- **November 19, 2020 –** The third stakeholder meeting was held virtually. At this meeting, the final vision statement was presented and adopted by the WMA. Draft goals and objectives were presented to stakeholders for review and discussion.
- **February 18, 2021 –** This fourth stakeholder meeting was held virtually. Presentations on the Des Moines River TMDL and the Iowa Nutrient Reduction Strategy were given, to help provide additional context to the planning effort. An update on the planning process to

date was provided, including a summary of the water trail meetings (discussed further below). Updated draft goals and objectives, and related water quality data, were presented and discussed. An online survey was sent out for stakeholders to provide feedback on the updated draft goals and objectives.

- **May 20, 2021 –** The fifth stakeholder meeting was held virtually. At this meeting the goals for the watershed plan were finalized and adopted. Initial overview and discussion began on BMP targets, priority areas, action items, and the education plan. The stakeholders were split into four smaller breakout groups to discuss specific ideas on action action items to include in the action plan.
- **August 19, 2021 –** This sixth stakeholder meeting was held both in-person and virtually. Unfortunately, a quorum of WMA members was not present so no decisions or adoption of materials could be made, however there was significant discussion on implementation priority areas, the draft action plan, and planning for the public open house meeting began.
- **December 16, 2021 –** The seventh and final stakeholder meeting (Figure 3 of the planning process was held both in-person and virtually. At this meeting a presentation was given over the full draft watershed plan and all related deliverables. Initial comments were taken, and the plan was also sent to all WMA members and stakeholders via email for review and comment. Final preparations for the public open house meeting were finalized.

Figure 3: Photograph of Stakeholder Meeting

WATER TRAIL MEETINGS

Conducted ancillary to the rest of the planning process, water trail meetings were held to engage land managers/public agencies, landowners, and river users along with other interested members of the public within the watershed. These meetings were held to gather input and gauge interest on the possibility of extending the Boone River Water Trail. Attendees learned what a water trail is, the standard planning process for water trail designation, and how water trails relate to overall watershed management. A facilitated discussion was held to learn about certain aspects of a new water trail that would need to be addressed, such as water features, known hazards, and any other concerns about recreational use of the river. The water trail meetings were held virtually on the following dates:

- February 9, 2021 – Land Managers/Public Agencies
- February 9, 2021 – Landowners
- February 10, 2021 – River Users/Interested Public

All three meetings led to meaningful discussions about expanding the Boone River Water Trail and allowed for many members of the community to voice their opinions. More information about the water trail meetings, as well as meeting minutes, can be found in Appendix B.

PUBLIC MEETINGS

The community-based planning process culminated in two open house style public meetings (Figure 4). The meetings were both held on December 2, 2022. The meetings were held at the same location with one held over the lunch hour and a second meeting held in the evening in an attempt to target different audiences. Nearly 20 people attended the two meetings.

The public meeting provided an opportunity for the broader community to learn about the project, provide input on the stakeholder-informed goals and objectives, hold one-on-one conversations with the project team, and review the draft watershed management plan. The public meetings also offered an opportunity to connect watershed residents and businesses with existing resources to implement best management practices.

Figure 4: Photograph from Open House Style Public Meeting

CHAPTER 2. WATERSHED INVENTORY

2.01 INTRODUCTION

This chapter identifies components of the Boone River Watershed (BRW) and provides an inventory of the watershed's characteristics. Information about watershed boundaries, demographics, physical environment, water resources, hydrology, protected areas, wildlife and habitat, and existing policy and regulations within the BRW is reported and explored in this chapter. More details about topics covered throughout this chapter can be found in the Current Condition Reports in Appendix A. Those reports encompass resource concerns for the BRW that the Watershed Management Authority (WMA) has identified, which include the following: Shorelines and Riparian Areas, Plant and Animal Communities, Sediment, Nutrients, Stormwater, Public Access, Flood Resiliency, and Hazard Mitigation. Information contained in the Current Condition Reports facilitated the identification of resource and implementation priorities used in the development of the Boone River Watershed Management Plan. Additionally, any existing data gaps have been identified within the reports for future consideration.

2.02 WATERSHED BOUNDARIES

The Boone River Watershed spans approximately 581,350 acres in the northern portion of Iowa, as can be seen in Figure 5. Watershed boundaries are defined by the United States Geological Survey's (USGS) Watershed Boundary Dataset (WBD) (USGS, 2018). The WBD consists of multi-level watershed boundaries, each of which is assigned a hierarchical hydrologic unit code (HUC). The BRW boundaries are defined at the HUC 8 level (#10240002), while smaller subwatersheds discussed throughout the plan are defined at the HUC 12 level. The most up to date WBD for Iowa was downloaded from the Natural Resources Conservation Service (NRCS) Geospatial Data Gateway to accurately identify the BRW boundaries.

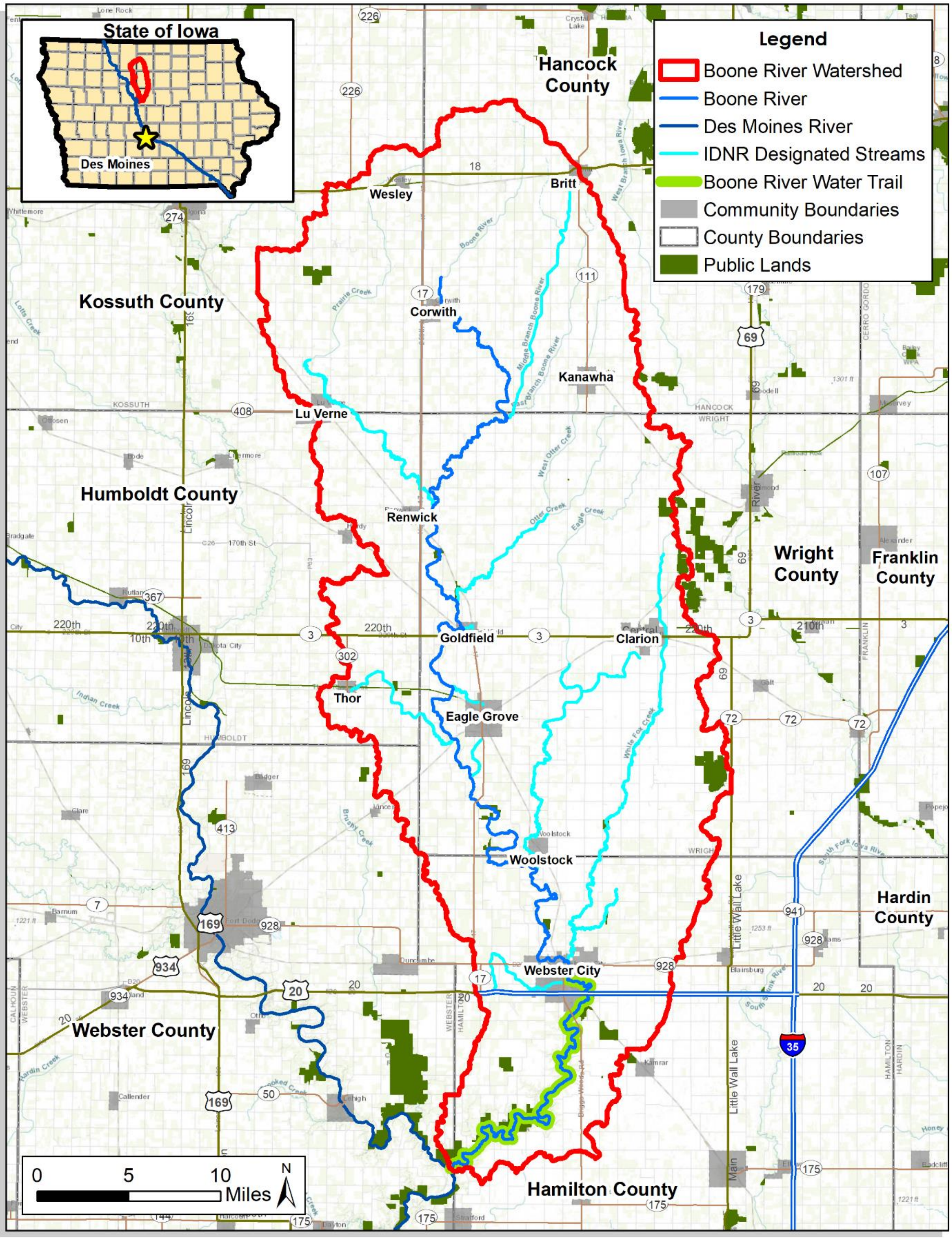


Figure 5: Watershed Location Map

2.03 DEMOGRAPHIC SUMMARY

POPULATION

The BRW encompasses portions of six counties: Kossuth, Hancock, Humboldt, Wright, Webster, and Hamilton County. The BRW has 12 incorporated communities, with none of those having populations greater than 8,000 (Table 4). Because the BRW does not fall along political boundaries, only estimates are available for demographic data. To provide the best estimate of demographics within the BRW, data was compiled from the US Census Bureau's American Community Survey (ACS) Topological Integrated Geographic Encoding and Referencing (TIGER) files at the block group level. The total population of the BRW is approximately 31,014 with the majority (61%) residing in communities (refer to Table 5 and Figure 6).

Table 4: Population of Communities

Community	Population
Britt	1,915
Clarion	2,772
Corwith	213
Eagle Grove	3,437
Goldfield	555
Kanawha	826
Lu Verne	298
Renwick	286
Thor	203
Webster City	7,779
Wesley	389
Woolstock	171

Source: ACS 2018 5-Year Estimates

Table 5: Population Type Distribution

Population Type	Population	Percentage
Communities	18,844	61%
Unincorporated areas	12,170	39%
Total	**31,014**	**100%**

Source: ACS 2018 5-Year Estimates

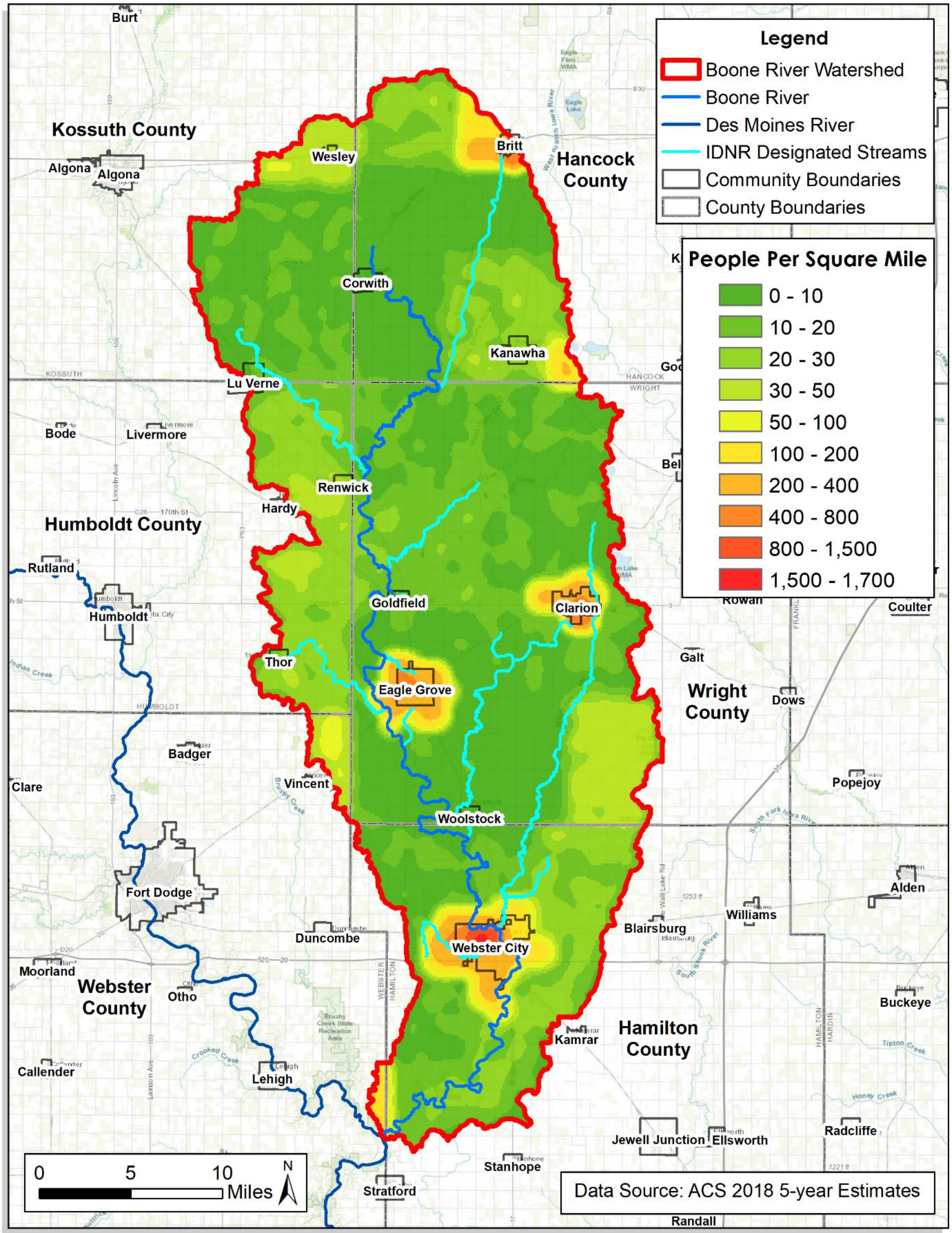


Figure 6: Population Density

AGRICULTURAL

Agricultural activities dominate the land use and economy of the watershed. Understanding agricultural activities is important to understanding the potential for certain types of pollutant sources throughout the watershed. Each agricultural activity may contribute differently to types, concentrations, and locations of pollutants.

The United States Department of Agriculture (USDA) Census of Agriculture (Ag Census) provides the most robust statistically valid data for this subject and is published every five years. Select data from the two most recently available years at the time of this writing (2012 and 2017) was analyzed to understand both existing conditions and recent trends within the watershed (USDA, 2012, 2019). To estimate values within the watershed boundaries, a percent area was applied to the county-wide data (Table 6). The primary crops grown in the BRW area include corn and soybeans; and cattle and hogs are the primary livestock produced.

Table 6: Changes in Agricultural Activities from 2012 to 2017

Item	2012	2017	Percentage Change
Land			
Number Farms	1,316	1,250	-5%
Land in Farms (acres)	573,512	565,086	-1%
Average Size of Farms (acres)	429	441	+3%
Livestock (Number)			
Cattle and Calves	15,670	13,244	-15%
Beef Cows	D	D	N/A
Dairy Cows	D	D	N/A
Equine	N/A	N/A	N/A
Sheep and Lambs	1,268	2,363	+46%
Goats	N/A	N/A	N/A
Hogs and Pigs	753,967	883,498	+15%
Broilers and other Meat Chickens	D	D	N/A
Chickens - Layers	D	D	N/A
Crops (acres)			
Corn for grain	320,915	297,050	-7%
Corn for silage	1,391	D	N/A
Soybeans	197,009	210,529	+6%
Forage	3,214	4,229	+24%

Source: USDA, 2012; USDA 2019

D – This data is withheld by USDA to avoid disclosing data for individual operations

ABSENTEE LANDOWNERSHIP

Absentee landowners are defined as those who own agricultural property, but do not live or operate on the land. This generally includes a diverse cross section of people including retired farmers and ranchers; those who have inherited or received land through gifts, marriage, divorce, or other means; and those who purchase land for investment or recreational purposes. Often a renter or another party is responsible for farming or maintaining agricultural activities on their land. Contacting absentee landowners or successfully encouraging them to participate in conservation practices can be challenging as these landowners are often distant from the specific conservation needs of the land. Understanding the level of absenteeism in the BRW is important to successfully develop outreach programs or target conservation programs.

Information from the most recent Ag Census records were utilized to estimate levels of absenteeism within the BRW area (USDA, 2019). This analysis showed the entirety of the area has greater than 40% absenteeism (Figure 7).

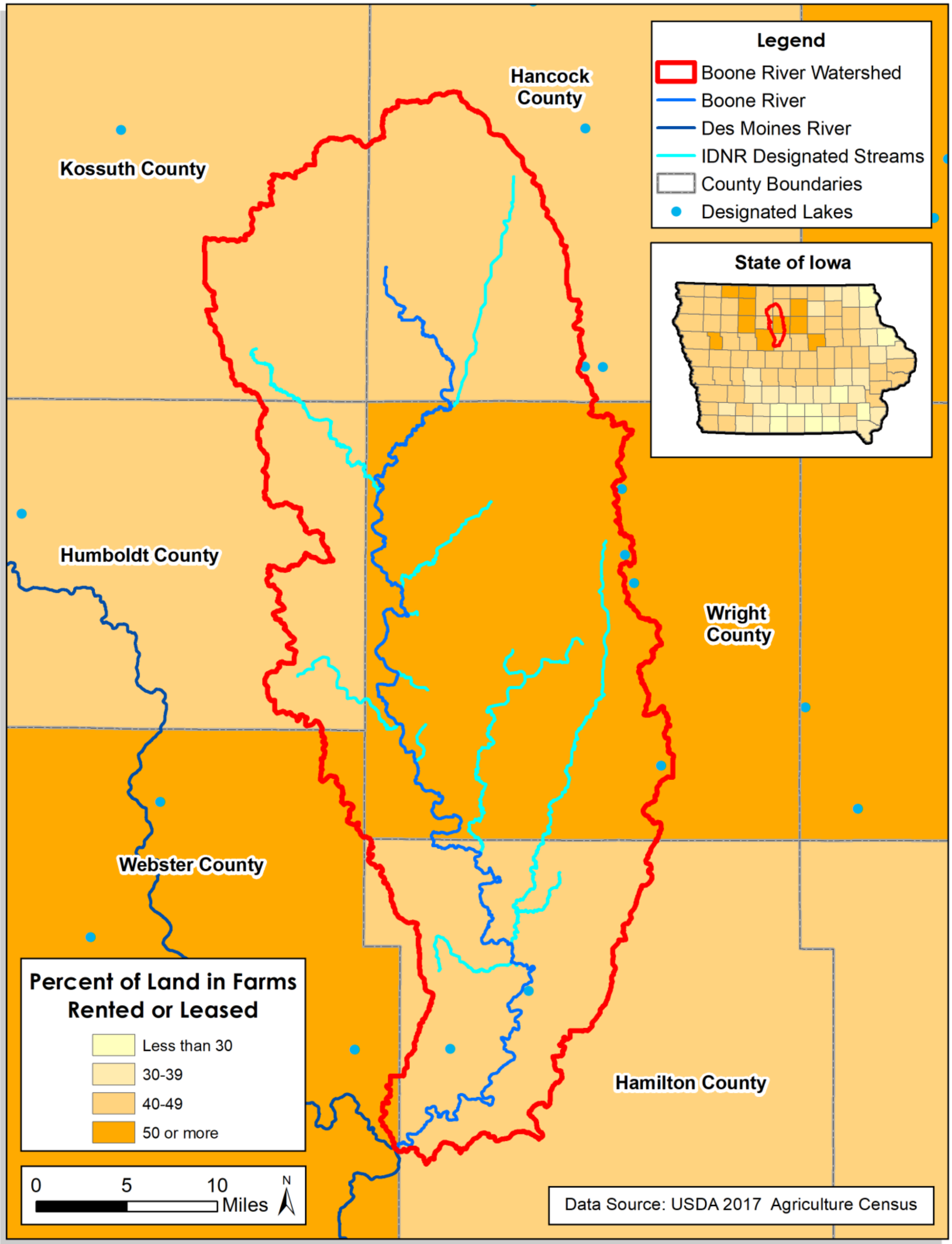


Figure 7: Percentage of Land in Farms Rented or Leased by County

2.04 PHYSICAL ENVIRONMENT

CLIMATE

The climate of the BRW is considered “Humid Continental” on the Köppen-Geiger Climate Classification System (Kottek and others, 2006). This climate is characterized by large seasonal temperature differences with hot, humid summers and cold winters. Precipitation is distributed throughout the year. The National Centers for Environmental Information (NCEI) maintains precipitation records from numerous stations within the BRW. Monthly precipitation averages range from a high of 5.7 inches in June to a low of 0.6 inches in January. Average high temperatures range from 84°F during the summer months to 24°F during winter months; average low temperatures range from 62°F during the summer months to 6°F during winter months. Average monthly temperature and precipitation variations are illustrated in Figure 8. Annual precipitation varies slightly across the BRW, though all locations within the watershed can be expected to receive, on average, between 33 and 36 inches of precipitation per year. Average annual precipitation across the BRW is shown in Figure 9.

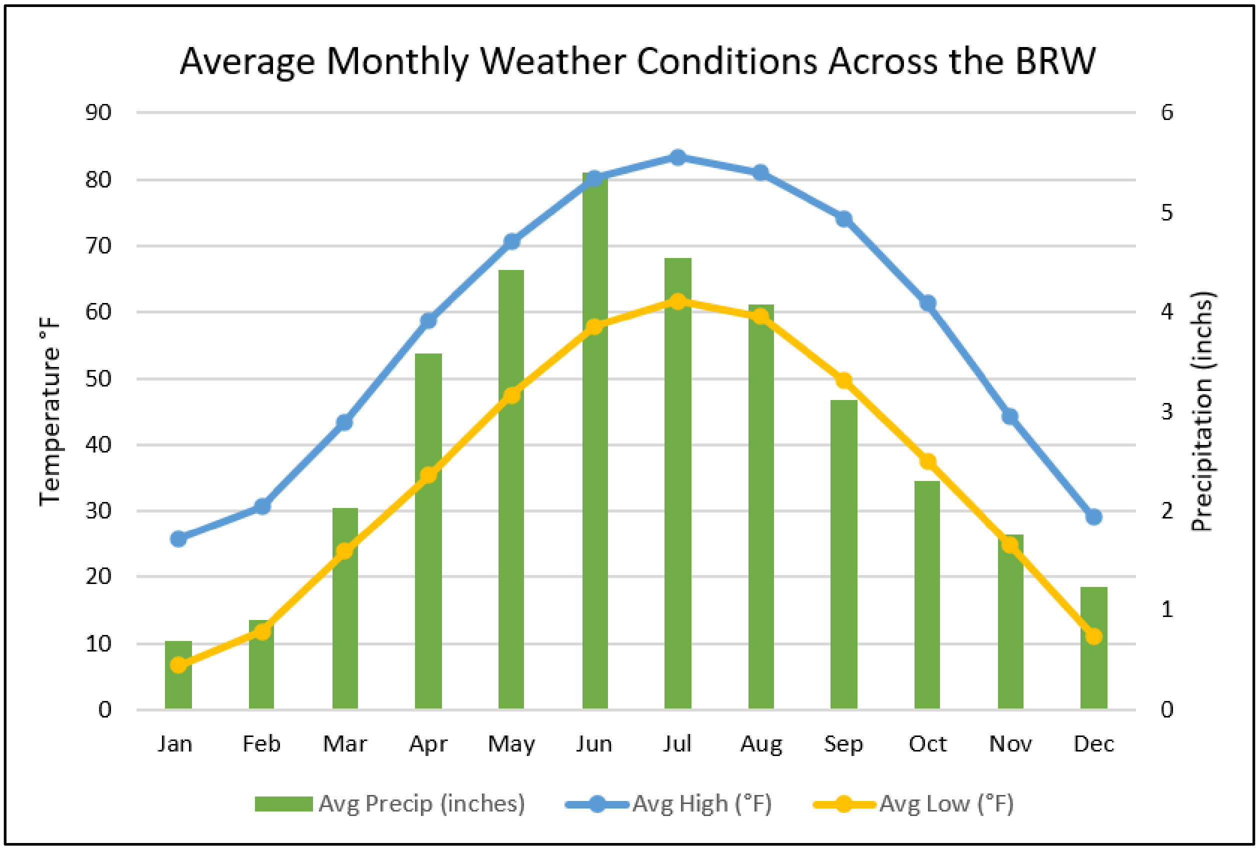


Figure 8: Average Monthly Temperature and Precipitation using data from Britt, Clarion, Kanawha, and Webster City, IA (1981-2010)

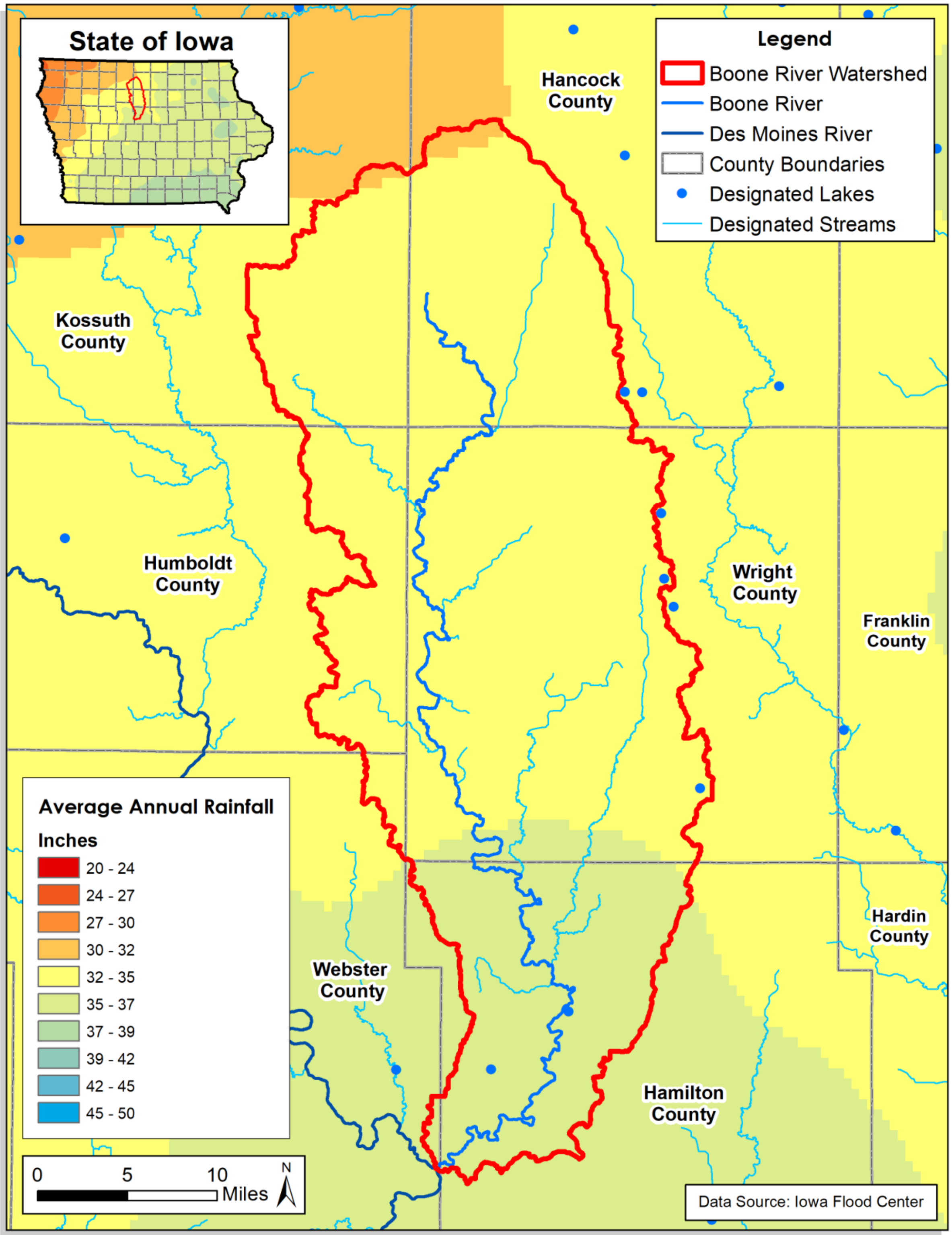


Figure 9: Average Annual Precipitation Map

LANDFORMS AND GEOLOGY

Iowa has a unique and diverse landscape that is the culmination of geologic processes occurring over millennia. To help understand these differences, Iowa has been subdivided into ten distinct landform regions (Prior, 1991). In each region a unique geologic history has shaped the landscape and natural resources. Each unique landform influences the distribution of plant and animal communities and helps determine an area's vulnerability to water quality or flooding problems. The entirety of the Boone River Watershed is located within the "Des Moines Lobe" landform region (Figure 10).

The Des Moines Lobe was the last area in Iowa with glaciers, making it geologically one of the youngest and flattest regions in the state. In general, the land is level to gently rolling with some areas of the moraines having the most relief. The morainal ridges and hummocky knob and kettle topography contrast with the flat plains of ground moraines, former glacial lakes, and outwash deposits. A distinguishing characteristic from other areas in Iowa is the lack of loess over the glacial drift. The stream network is poorly developed and widely spaced. What major rivers do exist have carved valleys that are relatively deep and steep-sided. Almost all of the natural lakes of Iowa are found in the northern part of this region. Most of the region has been converted from wet prairie to agricultural use through substantial surface water drainage. Only a small fraction of the wetlands remains, and many natural lakes have been drained as a result of agricultural drainage projects (IDNR, 2021b).

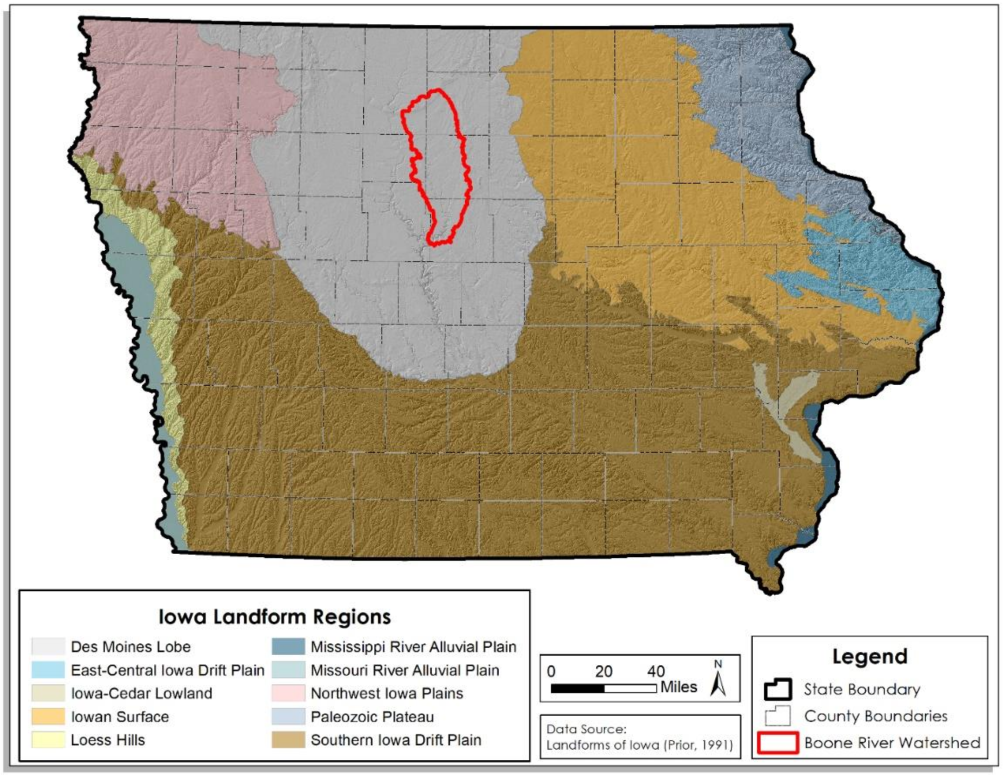


Figure 10: Landforms Within and Near the Watershed

The geology of the Des Moines Lobe has been clearly described in *Landforms of Iowa* (Prior, 1991) and summarized below:

> *The geology of this region is composed primarily of drift, or materials left behind by glaciers. However, due to their age these glacial drift deposits are less eroded than those in other areas of Iowa, such as the Southern Iowa Drift Plan. Following the glacial ice retreat, an inefficient drainage network was established in the Des Moines Lobe region of Iowa. Because of this post-glacial landscape, natural lakes, ponds, sloughs, and bogs formed in the hilly area. In fact, nearly all the naturally occurring lakes in Iowa are located in the Des Moines Lobe. River routes in this area were caused by glacier meltwater floods and overflowing channels from rapid ice melt across the landscape (Figure 11).*
>
> *As the Des Moines Lobe evolved, morainal ridges became prominent across the interior portion of the Lobe, stretching to the east and west. The ridges, standing up to 120 feet in height, formed along the central axis of the glacier, the most mobile portion of the glacier characterized by consistent freezing and thawing of ice.*

Other irregular landforms and deposits are also found throughout the area such as kames, eskers, and kettles. Water-transported deposits of sand and gravel that gathered in large crevices formed isolated hills called kames. Eskers are ridges that came from alluvial build-up in river channels that flowed beneath glacial ice. They are identified by their narrow form and winding topography. Kettles are characterized as being the opposite of kames and eskers and are bowl-shaped depressions found sporadically throughout the region. They developed when large, isolated glacial blocks were buried by small amounts of soil and rubble and slowly melted into the ground.

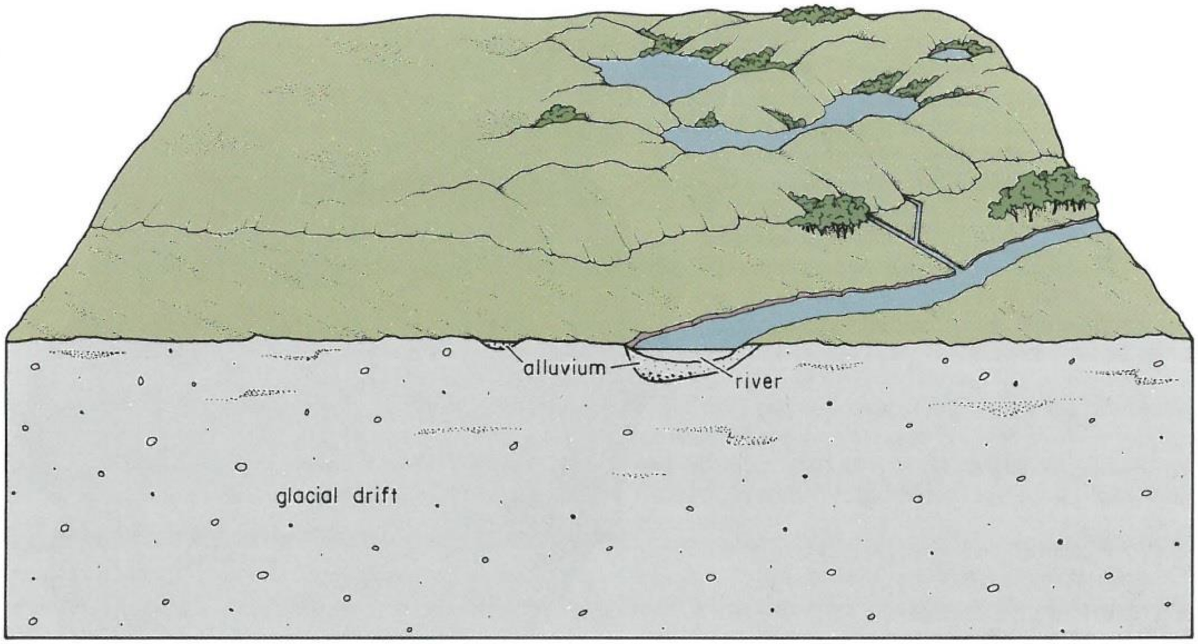


Figure 11: Typical Geologic and Terrain Cross Section of the Des Moines Lobe

Source: Prior, 1991

TOPOGRAPHY

Topography and slope describe the shape and relief of a landscape. Topography is a measurement of elevation, while slope is the percentage change in that elevation over a certain distance. These characteristics are important drivers in drainage and land use patterns within the watershed. Steep slopes lead to higher runoff rates and volumes, which can in turn produce more frequent and more severe flash flooding. High velocity runoff and low infiltration rates severely increase the risks for soil erosion and pollutant runoff.

The topography of the BRW reflects its geologic past. While the BRW is generally considered a flat landscape, there are areas of diverse topography and varying slopes, especially in Hamilton County along the Boone River (Figure 12). Elevation tends to increase from the southwest to the north, as one travels up the watershed. Elevations range from a low of 909.7 feet above sea level (ASL) in Webster County, to a high of 1,312.2 feet (ASL) in Hancock County. Slopes across the BRW tend to be very flat (0-2%); however, the downstream areas, in general, are dominated by very steep slopes (greater than 10%), especially in Webster and Hamilton County next to the Boone River and as it meets up with the Des Moines River. Other pockets throughout the watershed have moderately steep slopes and are seen sporadically throughout all 6 counties.

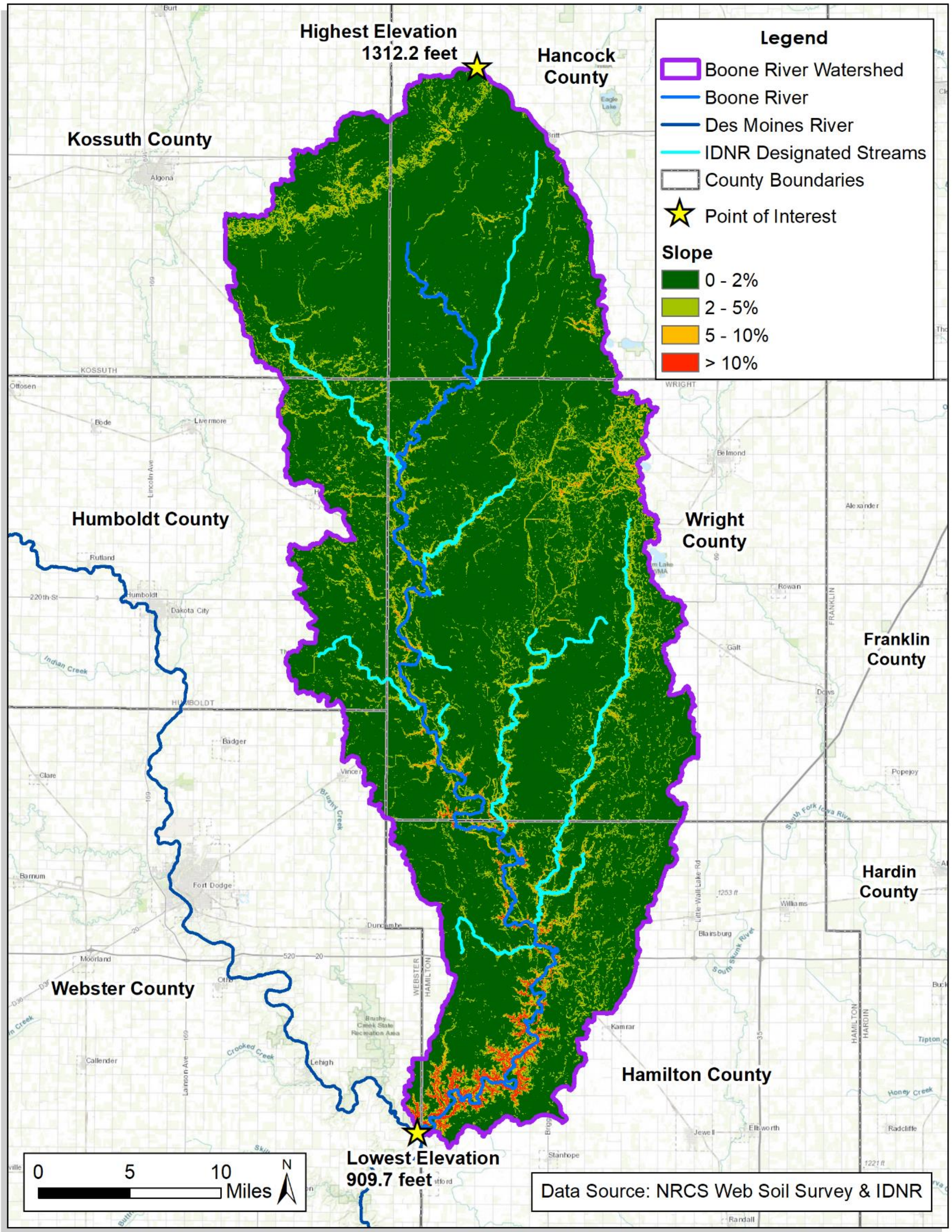


Figure 12: Topographic Relief Map

2.05 SOILS

Soil characteristics such as texture and infiltration rate directly influence the amount of runoff from the landscape and the potential for erosion. NRCS-USDA soils data was downloaded from the NRCS Web Soil Survey and analyzed specific to the BRW with the results provided in the following sections. Please note that information on soil erosion is provided in Chapter 3.

TEXTURE

Soil texture is given in the standard terms used by the USDA. These terms are defined according to the percentages of sand, silt, and clay in a soil sample that is less than 2mm in diameter. If the content of particles coarser than sand (greater than 2mm in diameter) is greater than 15%, an appropriate modifier is added. The clear majority of soils (more than 97%) found in the BRW are comprised of some sort of loam soil (Table 7). The distribution of these soil textures is generally consistent across the watershed, except for the southeast portion of the watershed in Hamilton and Wright counties. The soils in these areas are higher in silt content rather than sand. Figure 13 displays the soils based upon texture throughout the watershed.

Table 7: Percentages of Soil Surface Texture Classes in the Watershed

Soil Surface Texture	Percentage
Clay Loam	65%
Silty Clay Loam	16%
Loam	16%
Various	3%
Total	100%

Source: USDA, 2018

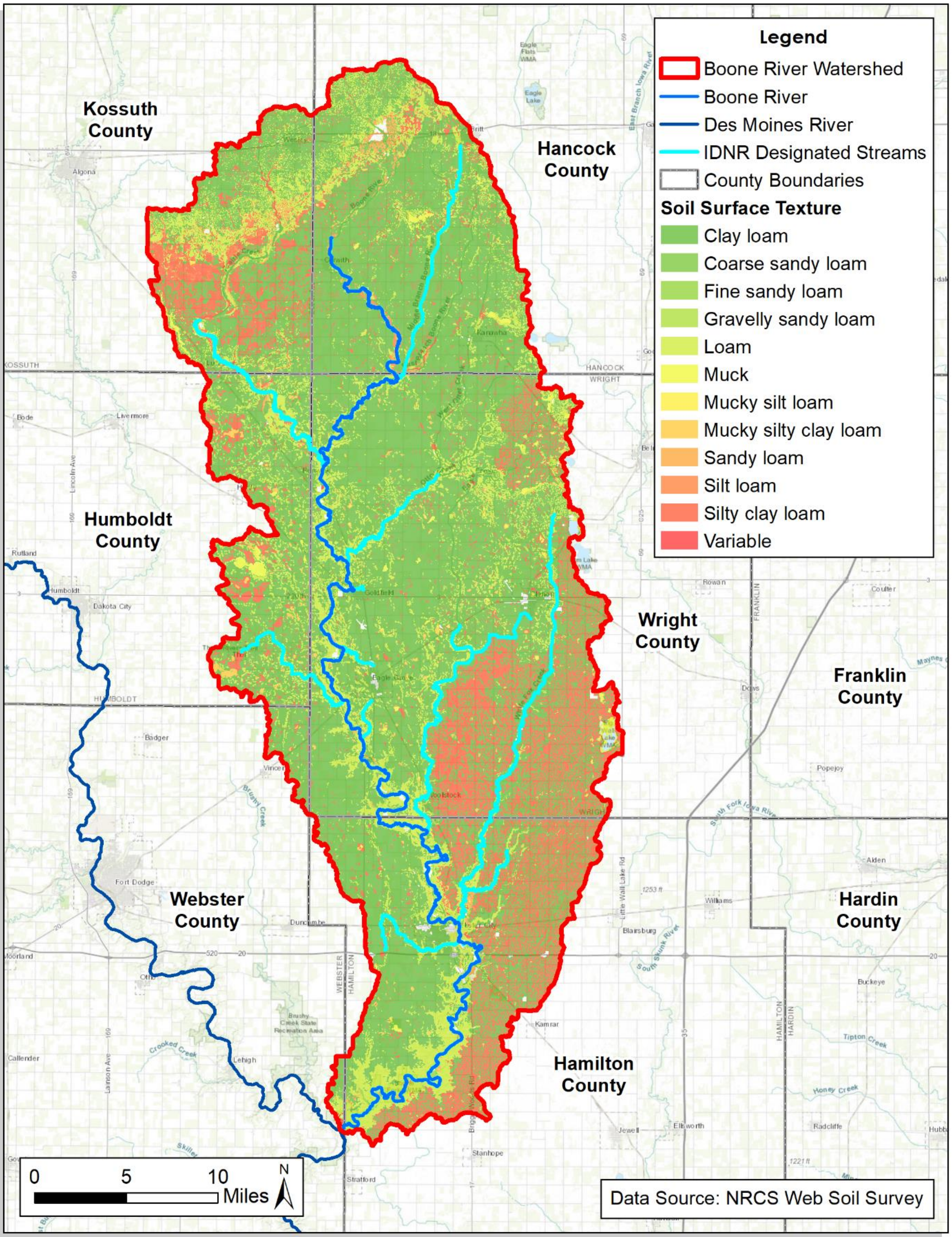


Figure 13: Soil Texture Map

INFILTRATION

The NRCS classification system divides soils into four major hydrologic soil groups (HSG): A, B, C, and D; and three dual classes: A/D, B/D, and C/D. Table 8 provides a description of the role soils plays in runoff generation. Soils within each hydrologic group have comparable runoff potential under similar storm and vegetative conditions. The soils in the watershed consist mostly of (more than 93%) C or C/D soil groups, which contribute to higher runoff rates. Figure 14 illustrates the geographic distribution of HSG types. The HSGs are consistent with the soil textures describe above.

Table 8: Breakdown of Hydrologic Soils Groups

Soil Group	Description	Percentage in the Watershed
A	Soils in this group have low runoff potential when thoroughly wet. Group A soils typically have less than 10% clay and more than 90% sand or gravel and have gravel or sand textures. Water is transmitted freely through the soil.	1.27%
A/D*	Dual Group, See description below table*	1.27%
B	Soils in this group have moderate infiltration and transmission rate when thoroughly wetted. Group B soils consist chiefly of moderately well- to well-drained soils with moderately fine to moderately course textures. Water movement through these soils is moderately rapid.	5.24%
B/D	Dual Group, See description below table*	3.00%
C	Soils in this group have moderately high runoff potential when thoroughly wet. Group C soils typically have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Water transmission through the soil is somewhat restricted.	12.61%
C/D	Dual Group, See description below table*	77.60%
D	Soils in this group have high runoff potential when thoroughly wet. Group D soils typically have clayey textures. Soils with a depth to a water impermeable layer less than 20 inches, and all soils with a water table within 24 inches of the surface are placed in this group. Water movement through the soil is restricted or very restricted.	0.04%

** Soils are assigned to dual groups if the depth to a permanent water table is the sole criteria for assigning a soil to hydrologic group D. If these soils can be adequately drained, then they are assigned to dual groups. The first letter applies to the drained condition and the second to the undrained condition. Source: USDA, 2020b*

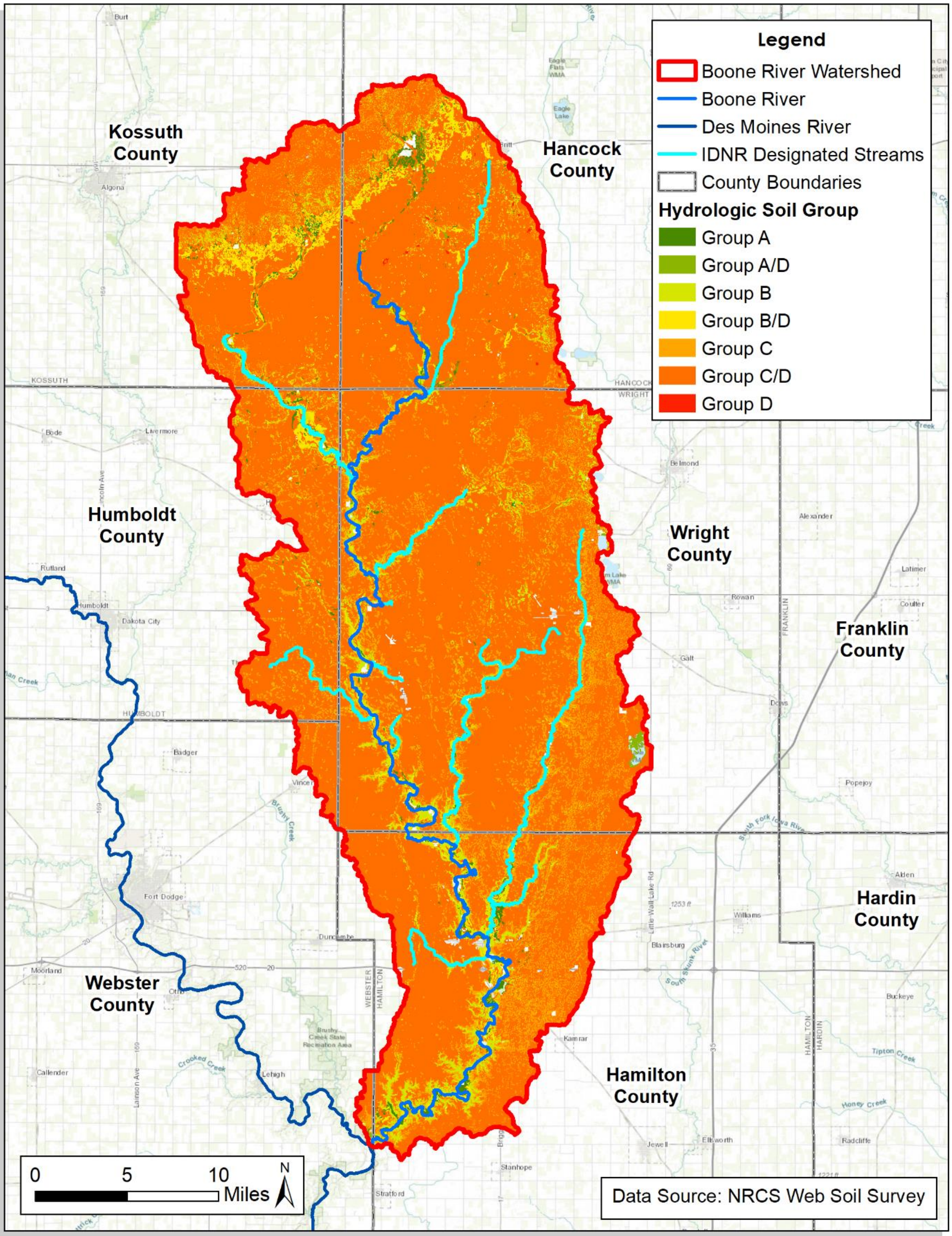


Figure 14: Hydrologic Soil Group Map

SOIL ORGANIC MATTER

Soil organic matter (SOM) is measured as a percentage by weight of soil material that is smaller than 2 mm across. Historically, soils in the Great Plains had high levels of SOM due to the deep roots of prairie grasses. However, intensive agricultural cultivation and erosion has led to reductions in SOM in some areas. SOM has implications for many aspects of soil health, and increased SOM can mean better protection against erosion, reduced leaching of contaminants due to an increase in cation exchange capacity, and better water holding capacity.

SOM is greatly impacted by management strategies. Cover crops, conservation tillage, and application of organic matter-rich amendments such as compost, manure, or biochar can all result in increased SOM. The soils in the watershed have relatively high SOM in most areas (Table 9). Low SOM is mostly seen in areas along the Boone River and tributaries where slopes are higher and erosion is more likely to occur (Figure 15).

Table 9: Soil Organic Matter Within the Watershed

Soil Organic Matter (% by weight)	Percentage of Watershed
< 2%	1.18%
2 – 3%	7.94%
3 – 5%	17.8%
5 – 15%	72.4%
>15%	0.67%

Source: NRCS, 2020

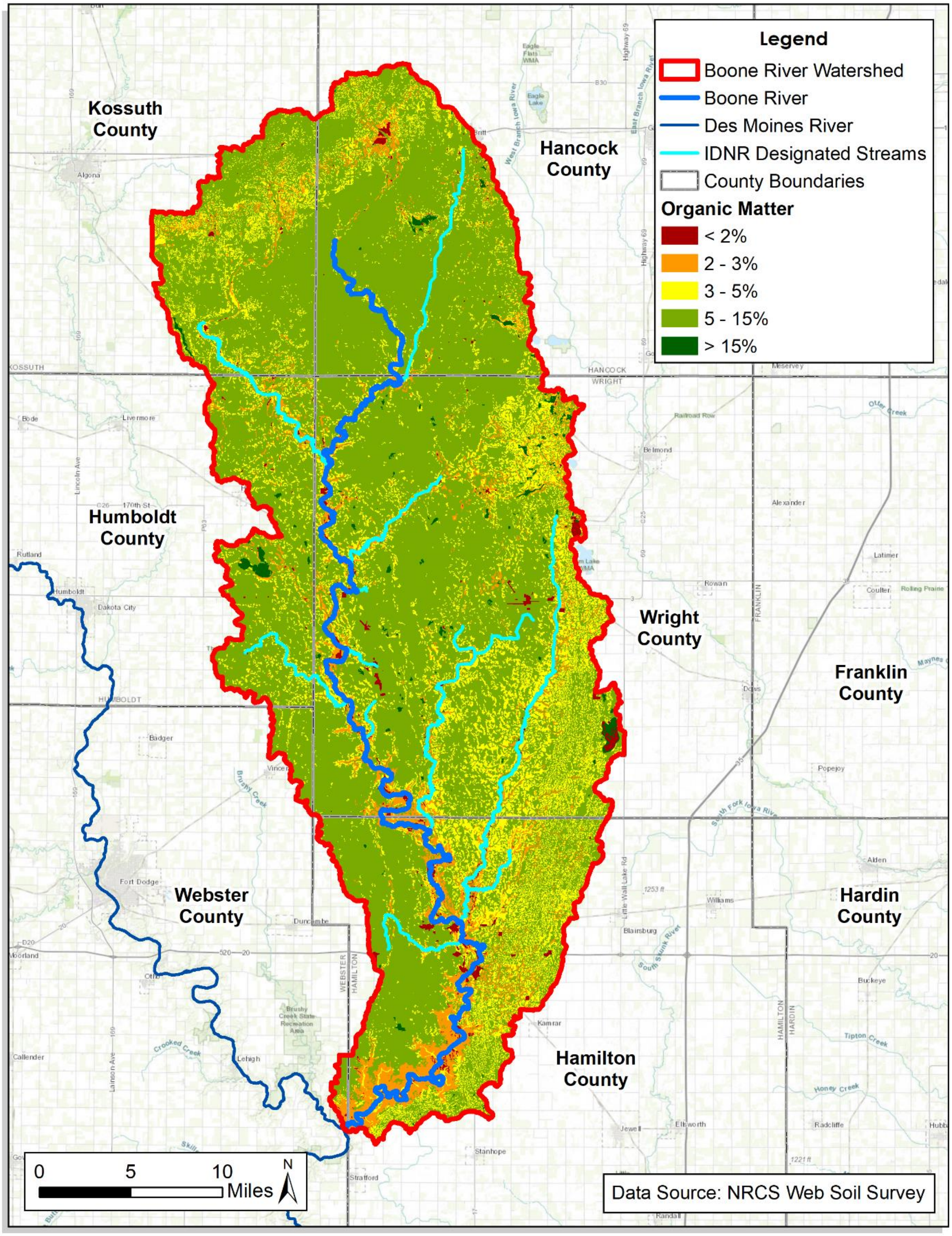


Figure 15: Soil Organic Matter Map

2.06 LAND USE

‘Land use’ and ‘land cover’ are two separate terms, yet they are often used interchangeably. Land use describes how people utilize the land (i.e., urban or agriculture), while land cover describes the physical material of the earth’s surface (i.e., type of vegetation). For the purposes of this plan ‘land use’ will be used as a common term for simplicity and because the term implies intentional management. Understanding land use is at the heart of watershed planning as the activities and uses of the land within a watershed are often key to identifying specific sources of pollutants. Understanding how land use affects watershed functions (such as hydrology) requires an understanding of both the historical and present-day land use conditions of the watershed. Streams and other biological communities evolved in the historic setting, and understanding those conditions, as well as the modern-day changes and subsequent impacts to them, is key to finding solutions to current problems.

HISTORICAL LAND USE

Surveys conducted by the General Land Office (GLO) and developed by Iowa State University (ISU) Geographic Map Server were used to develop a map of the historical land use in the BRW between 1832 and 1859, prior to major European settlement (ISU, 2018a). The vast majority of the watershed, like most of Iowa, was covered by prairie. Small areas of forest and wetlands could also be found across the watershed, as can be seen in Figure 16.

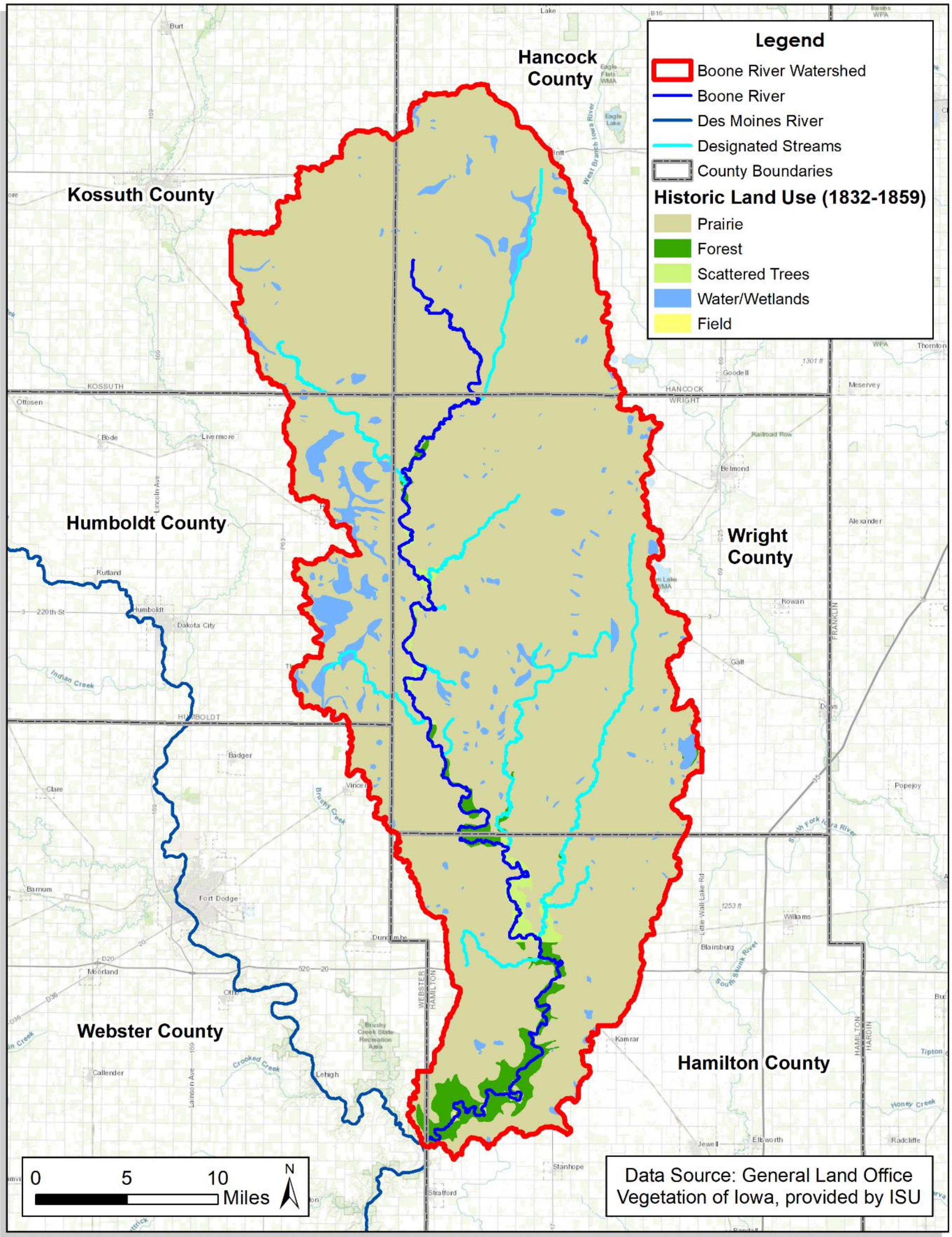


Figure 16: Historic Land Use Map (1832 – 1859)

PRESENT DAY LAND USE

As European settlement and agriculture came into Iowa, land use began to drastically change. Settlers transformed the prairie-forest-wetland mosaic into small farms, grain fields, and pastures. Changes in the 20th century were even more dramatic with the advent of improved farming technology and government incentive programs. Modern tiling machines allowed wet areas to be drained, farms increased in size and decreased in complexity, and agricultural chemical use became widespread. Across Iowa, between 1900 and 2014 row crop acres increased from 9.1 million acres to 23.4 million acres, and hay and small grain acres decreased from 6.8 million acres to 1.2 million acres. The average farm size increased from 100 acres to more than 340 acres. In many cases, larger farms and field sizes have eliminated fencerows, windbreaks, and waterways (Association of State Wetland Managers, 2015).

A century and a half of change to Iowa's landscape has resulted in a shift in the composition of plant communities and wildlife, as well as changes in runoff and water quality. Most of the state is now covered with row crops (primarily corn or soybeans), with the remainder primarily grassland and small areas of timber, wetlands, or other land uses. The approximate percentage of Iowa's native vegetation remaining includes 0.2% of Iowa's native prairies, 5% of wetlands, and 37% of its forests (Association of State Wetland Managers, 2015).

Present day land use in the watershed was determined by GIS analysis of the 2019 USDA-NASS's Cropland Data Layer (Table 10). As seen in Figure 17, agriculture now dominates the watershed with 86% used for cropland and 4% for pasture (a small amount of this is likely prairie). Small amounts of the watershed are covered with open water or wetlands (3%) and forested areas (2%) are most prominent in the downstream portion of the watershed.

Table 10: Existing Land use in the BRW

2017 Land Use	Percentage
Crop	86%
Developed (Urban)	5%
Pasture/Grass	4%
Open Water/Wetlands	3%
Forest	2%
Total	100%

Source: USDA-NASS Cropland Data Layer (2019)

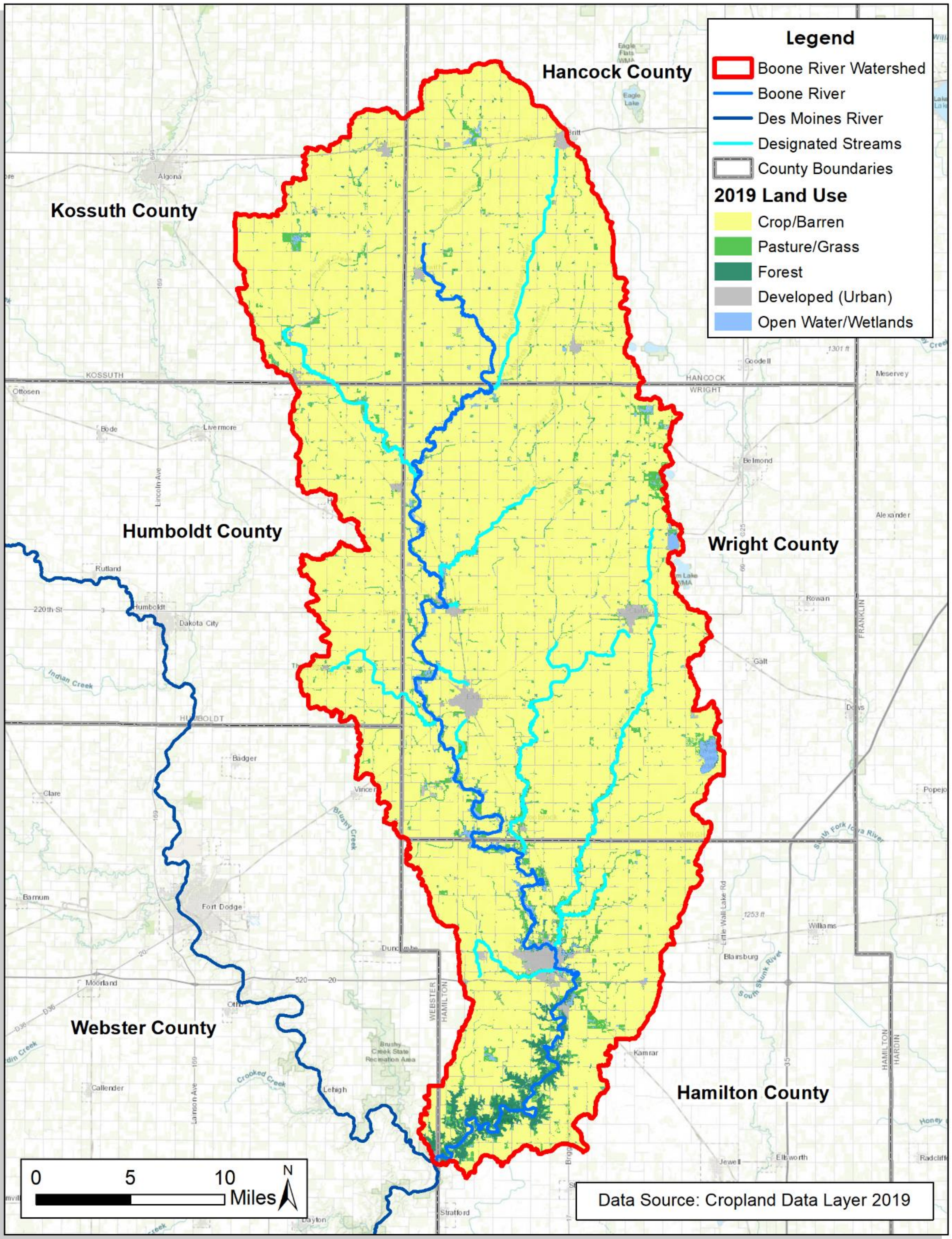


Figure 17: Present Day Land Use Map

2.07 WATER RESOURCES

STREAMS AND RIVERS

The IDNR maintains a GIS database of streams (and stream segments) that have been given designated uses for the purposes of administering the Clean Water Act. Designated uses vary but include swimming, fishing, human health, drinking water supply, and others. These designated use segments are perennially flowing streams or intermittent streams with perennial pools. Each of these designated streams or segments have been assigned an identification number for consistent identification purposes. While this plan focuses on these designated streams, much of the discussion or projects identified in this plan can also apply to or provide benefits to other streams, segments, or waterbodies in the BRW.

The Boone River is composed of several designated stream segments covering approximately 240 stream miles (Figure 18), five of which are drainage ditches. There are eight additional named tributaries contributing approximately 213 miles of the 240 stream miles to the Boone River Watershed: Buck Creek, Buttermilk Creek, Brewers Creek, Eagle Creek, Otter Creek, Prairie Creek, White Fox Creek, and Middle Branch Boone River (Table 11). Lyons Creek is not included in these statistics as it is not included in the IDNR designated stream database. The Boone River Watershed exhibits a dendritic drainage pattern, with many of the perennial tributaries flowing in a north-to-south direction.

Table 11: Designated Streams in the BRW

Stream Name	Stream Length (miles)	Stream Name	Stream Length (miles)
Boone River	99.63	White Fox Creek	31.93
Middle Branch Boone River	5.75	Drainage Ditch 2	5.20
Brewers Creek	5.26	Drainage Ditch 3	10.56
Buck Creek	5.27	Drainage Ditch 4	2.69
Buttermilk Creek	0.55	Drainage Ditch 94	2.64
Eagle Creek	29.81	Drainage Ditch 105	2.87
Otter Creek	9.85	Unnamed Creeks (3 segments)	2.73
Prairie Creek	18.69	--	--
Total Miles	**239.74**		

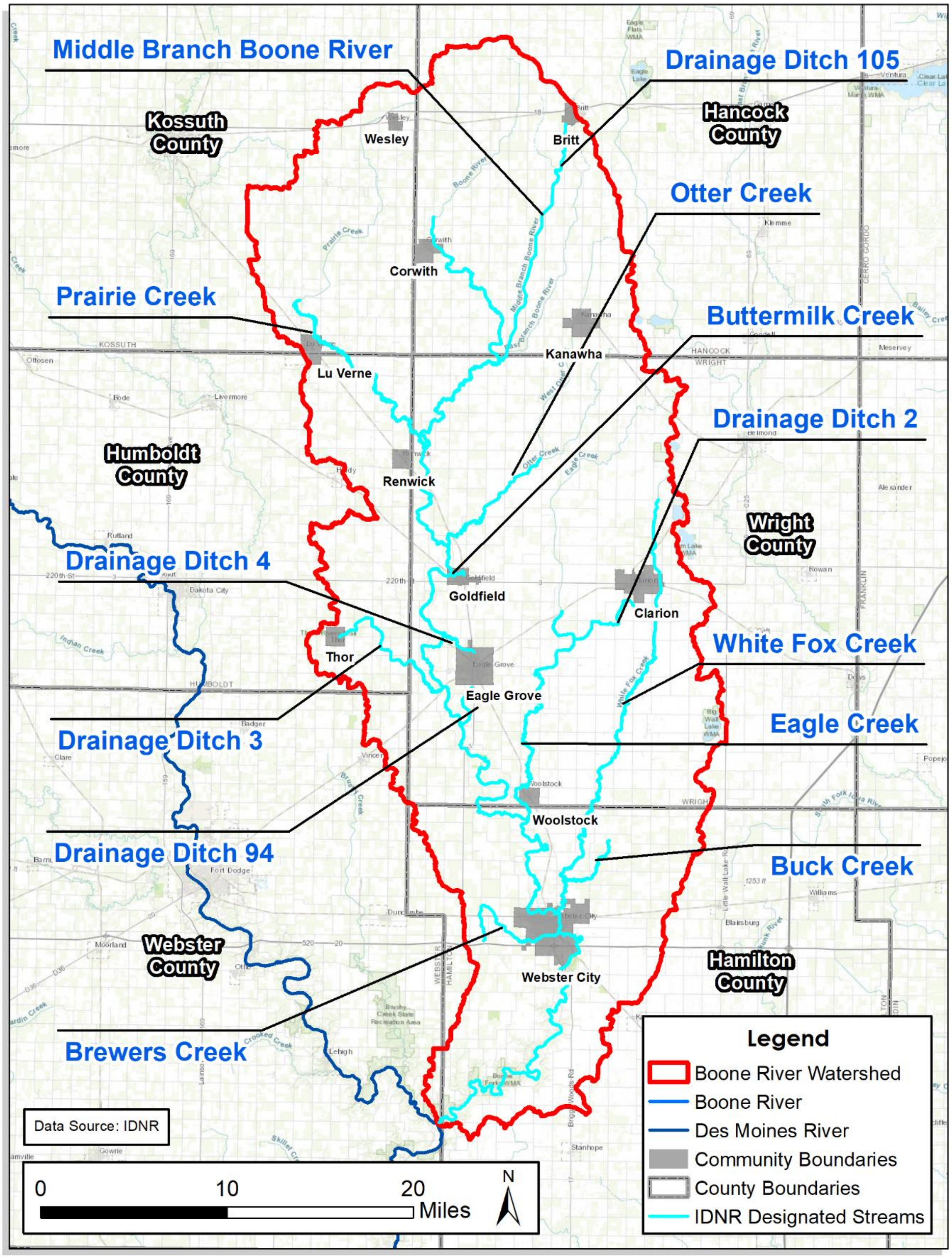


Figure 18: Map of Designated and Named Streams

LAKES AND RESERVOIRS

Similar to designated streams, IDNR also maintains a GIS database for lakes, each of which has a unique identification number (lake code). There are five designated lakes in the BRW (Table 12, Figure 19). Big Wall Lake is the largest, covering 935 surface acres of permanent pool and is located between the communities of Clarion and Woolstock on the southeast edge of the watershed. Other designated lakes in the watershed range from less than 1 acre to nearly 250 surface acres and include: Briggs Woods Lake, Lake Cornelia, Fishpond Park, and St. Benedict W.A., Pond. The many lakes in the BRW offer recreational activities and facilities for fishing, hiking, picnicking, and camping.

It should be noted that this plan focuses on water quality and flood resiliency as they relate to the streams in the watershed and thus further discussion on lakes will not be included. However, projects identified within the plan will likely provide benefits to many of these lakes or other waterbodies in the watershed. Additional discussion on lakes can be found in the *Shoreline and Riparian Areas Current Conditions Report* in Appendix A.

Table 12: Designated Lakes in the BRW

Lake Name	Surface Area (acres)
Big Wall Lake	935
Briggs Woods Lake	59
Lake Cornelia	243
Fishpond Park*	0.7
St. Benedict W.A., Pond	10
Total	**1,248**

Source: IDNR, 2018a

**Area identified via aerial imagery*

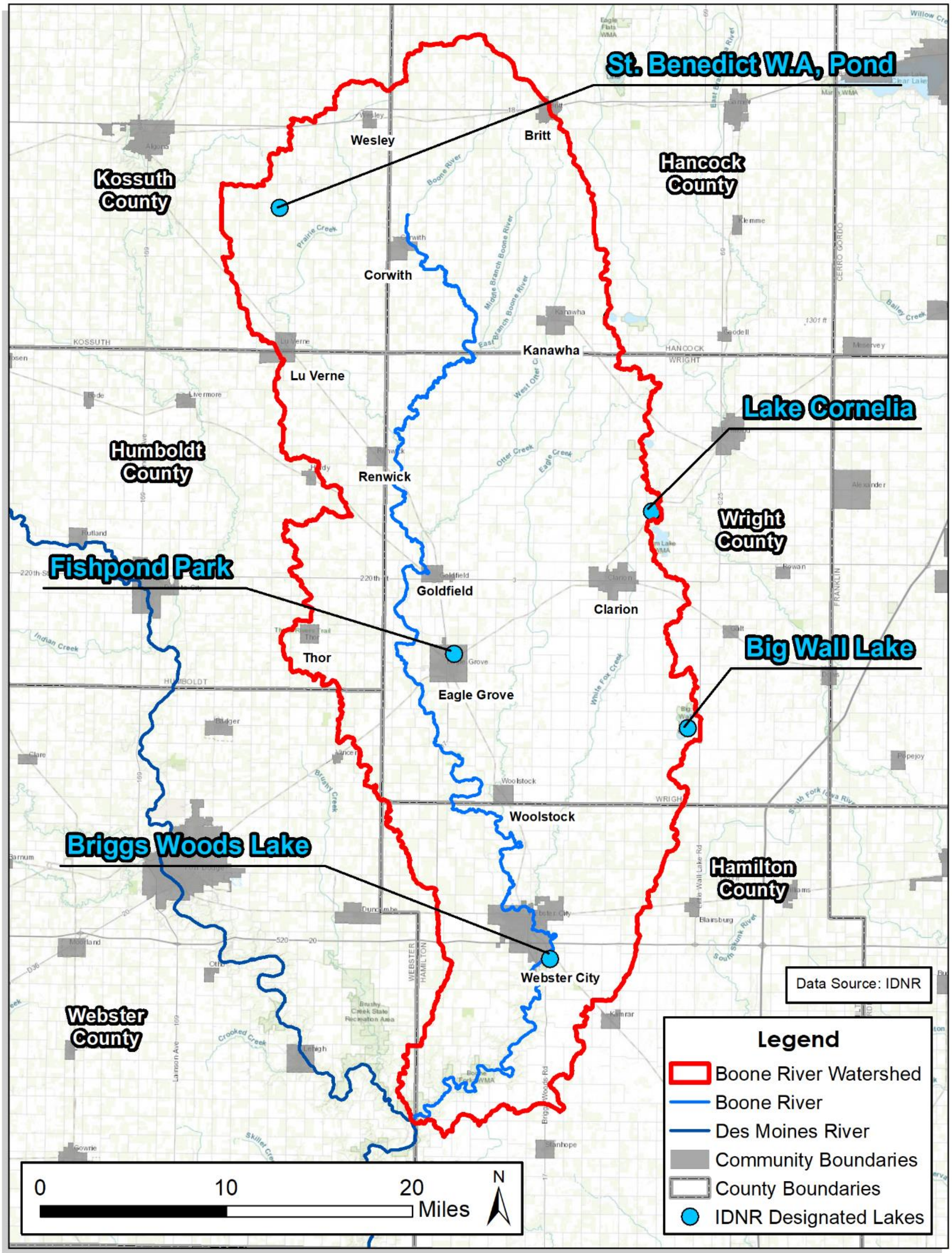


Figure 19: Map of Designated Lakes

WETLANDS

Overview

Wetlands are places where plants and animals live amid standing water or saturated soils. The term 'wetland' is often used interchangeably with other terms such as swamps, sloughs, potholes, marshes, bogs, fens, seeps, oxbows, shallow ponds, or wet meadows. In addition to being essential wildlife habitat, there are socio-economic values related to wetlands. In addition to the money generated from recreation (e.g., fishing, hunting, canoeing, and bird watching), wetlands are economically valuable in flood protection, regulating watershed hydrology, protecting water quality (through sediment trapping and nutrient removal), and erosion control.

Wetland basins once covered 4 to 6 million acres of Iowa. Those acres represented approximately 11% of Iowa's land surface based upon historical surveys and maps of the landscape prior to European settlement. Wetlands remain part of every watershed in Iowa, but 90-95% of the original wetlands were drained and are no longer fully functional (IDNR, 2016b). Historically, Iowa's wetlands were viewed as a hindrance to land development. In less than 150 years, these rich resources were drained, filled, or otherwise altered, drastically changing the face of Iowa's land.

Many types of wetlands exist in Iowa: prairie-pothole marshes (emergent wetlands), swamps (forested wetlands), sloughs, bogs (emergent wetlands), wet meadows (emergent wetlands), fens (emergent and scrub-shrub wetlands), and small ponds are examples of palustrine wetlands. The Lacustrine System includes large oxbows, natural lakes, and reservoirs. The Riverine System includes streams and rivers (Association of Wetland Managers, 2015).

Information on Iowa's wetlands, including those found in the Des Moines Lobe, are primarily documented in the following publications:

- IDNR's *2016 Wetland Program Plan for Iowa* (IDNR, 2016b)
- IDNR's *2010 Wetland Action Plan for Iowa*
- US Fish and Wildlife Service's (USFWS) *Iowa Wetland Management District Comprehensive Conservation Plan* (USFWS, 2014)

Additional information on Iowa's wetlands and the organizations that help to manage them can be found at the following websites:

- https://www.fws.gov/refuge/iowa_wmd/
- https://www.iowadnr.gov/environmental-protection/water-quality/water-monitoring/wetlands
- http://ppjv.org/

National Wetland Inventory

The USFWS has established the National Wetland Inventory (NWI) to provide biologists, managers, and others with a centralized inventory of wetlands in the United States. This was developed using remote sensing and aerial photography analysis, which is useful for a widescale inventory, however the NWI also has a tendency to miss smaller wetlands. Therefore, while useful, the NWI should not be considered a complete inventory of all wetlands and should not be used as substitute for on-the-ground surveys.

Analysis of NWI data indicates that there are approximately 6,000 acres of mapped wetlands in the watershed (Figure 20). These are all freshwater wetlands. The following is a breakdown of approximate acreages of NWI wetlands (by type) in the watershed:

- Emergent: 1,915 acres
- Forested/shrub: 866 acres
- Pond: 835 acres
- Lake: 893 acres
- Riverine: 1,500 acres

Many of the wetlands within the BRW are associated with the Prairie Pothole Region (PPR). The PPR is a naturally poorly drained region across North America (see Figure 20) containing thousands of shallow wetlands known as potholes, which are the result of glacier activity (as previously discussed in the landform section of this chapter). Iowa's Des Moines Lobe forms the southernmost extent of the PPR of central North America. There are also many riverine wetlands that are closely associated with the corridor of the Boone River and its tributaries. These mainly consist of those in the floodplain, along the river’s edge, and old oxbows or backwaters.

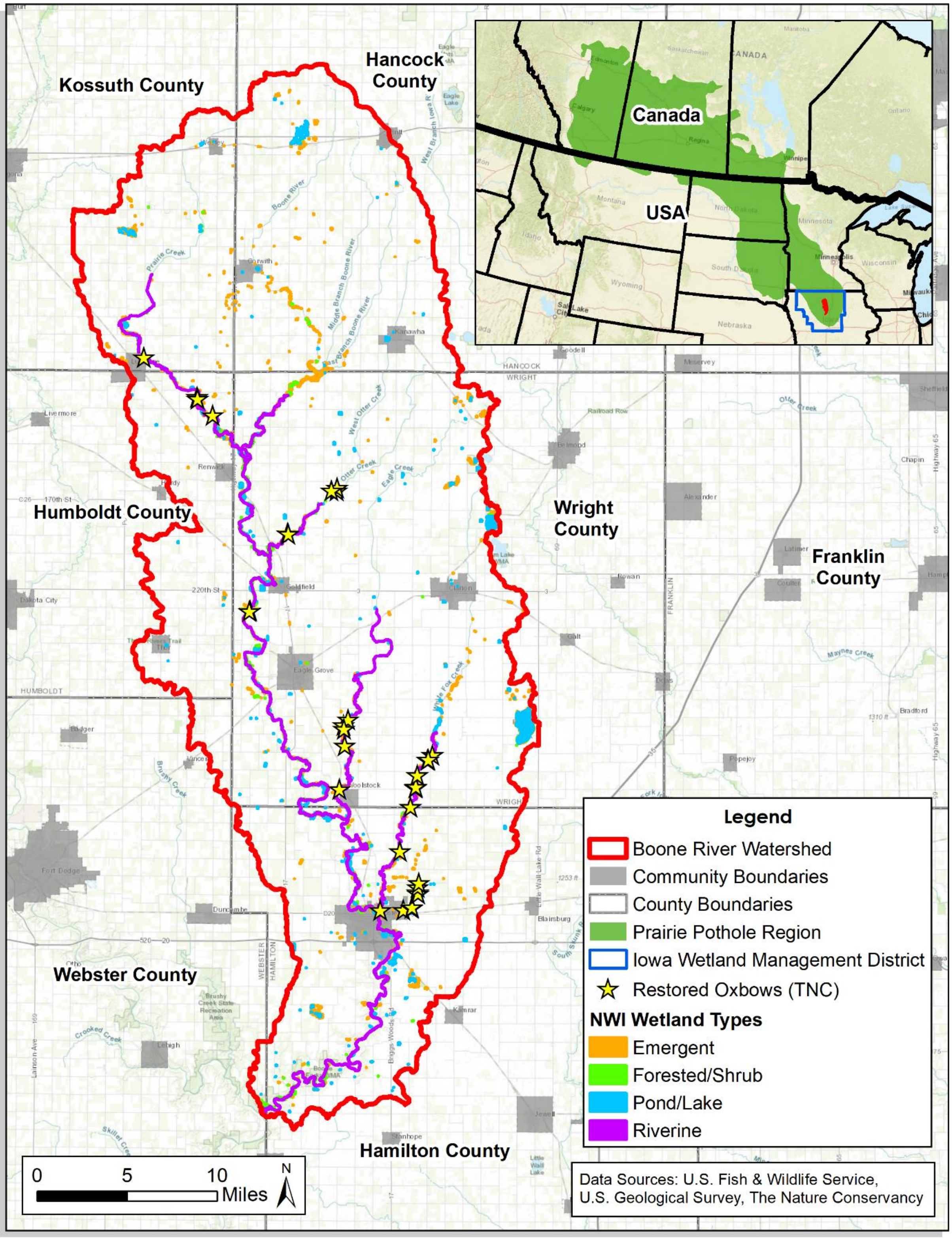


Figure 20: Wetlands Overview Map

Prairie Pothole Region

The BRW is located within the larger Prairie Pothole Region (PPR) (Figure 20). Prior to agricultural drainage, the PPR region contained abundant wetlands, many associated with "prairie potholes" or "kettles" evident from the General Land Office (GLO) surveyors' maps and notes. The numerous potholes and depressional areas throughout the area historically formed a unique hydrologic system. While subtle features on the ground, the linked depression systems stand out as dark web-like patterns when viewed from the air. Historically, these depressions provided an infiltrative hydrology, allowing surface water to be collected, stored, and gradually released to larger streams and underground aquifers (USFWS, 2014).

Today, the landscape looks much different, dominated by agriculture that consists primarily of corn and soybeans. This alteration has led to an imbalanced hydrological regime. In the upstream or headwater portion of small streams, water moves off the land much faster, allowing greater stream bank and bed erosion, creating increased transport and deposition of sediment, nutrients, and other pollutants, along with more severe flooding downstream. Draining of wetlands has lowered the water table, causing natural underground springs and small streams to stop flowing. Most of these hydrological changes have occurred within a human lifetime (USFWS, 2014).

Through drainage practices, the Des Moines Lobe has been left with 3% to 4% of its original wetland area, which was approximately 44% of the total land area of the Des Moines Lobe and 54% of the Boone River watershed pre-development (Arenas, 2020). Based on current land use estimates, that number has been reduced to approximately 3% of the watershed.

This area in Iowa falls within the Iowa Wetland Management District (WMD), as shown in Figure 20. The Iowa WMD consists of scattered tracts of habitat (both wetland and upland grassland) known as Waterfowl Production Areas (WPAs). Currently, there are 75 WPAs in 18 counties in north-central Iowa totaling just over of 25,000 acres primarily managed by the IDNR. Even though district acquisition has only occurred in 18 counties to date, a larger 35-county boundary is approved. This boundary follows the historic range of the PPR (USFWS, 2014).

The Iowa WMD, like many other WMDs, was established in 1962 by the USFWS to effectively manage the increasing number of WPAs being acquired with funds from the 1934 Migratory Bird Hunting Stamp Act (also known as the Duck Stamp Act). WMDs were established not only to manage all the WPAs in a multi-county area, but also to work closely with the private landowners, government and nongovernment organizations, businesses, and other federal agencies in their districts to improve wildlife habitat. Uniquely in Iowa, it was decided that while the USFWS would provide federal Duck Stamp funds for land acquisitions, the IDNR would supply the personnel necessary to restore and manage the WPAs (USFWS, 2014).

Management within the Iowa WMD is also coordinated with the Prairie Pothole Joint Venture (PPJV) which was created in 1987 under the North American Waterfowl Management Plan. The PPJV is one of nearly two dozen Joint Ventures dedicated to habitat conservation across North America. Joint Ventures provide a framework for partnerships between various organizations, to work cooperatively on conservation projects, from research and planning through implementation, evaluation, and monitoring.

The PPJV is a voluntary, self-directed partnership that functions as a network of partners at the local, regional, national and international levels. The partnership involves federal and state agencies, nongovernmental conservation groups, private landowners, scientists, universities, policy makers, resource managers, corporations interested in conservation, and others interested in prairie habitat conservation. Partners pool their resources and knowledge to accomplish more jointly than they could by working on their own.

Benefits of Wetland Restoration

The direct and indirect benefits of wetlands are numerous. Realizing the important roles wetlands play in Iowa's landscape, people are today restoring these diverse systems. The restoration process might be as simple as removing a drain tile or might be more complicated and costly.

Maintaining the ecological integrity of wetlands in an agriculturally dominated landscape such as the BRW is particularly challenging given that most wetlands are relatively small and isolated within the larger landscape. The source of many of these problems is the effluent of drainage tiles that dump into wetlands. The tile introduces a pathway for excess sediment, nutrients, and pesticides to enter the wetlands. The influence of consolidated water from drainage tile in wetlands can effectively interrupt the important and natural wet/dry cycle of PPR wetlands (USFWS, 2014).

The Nature Conservancy (TNC) assists with projects designed to protect land and water and are currently a partner on the Boone River Watershed Nutrient Management initiative. TNC and partners have developed an oxbow restoration program in the watershed. Oxbows improve riparian area functions including creating fish and wildlife habit, capturing nutrients and sediments, and providing floodwater storage. Additional information can be found at the following websites:

- https://booneriver.org/project-area/oxbow-restoration/
- https://www.fws.gov/midwest/partners/getinvolved.html

Many oxbows the Boone River Watershed are intact, but many are also degraded and in need of restoration. 32 oxbows have been successfully restored in the BRW (Figure 20); however, ample opportunities exist to continue these restorations. 416 potential oxbow restoration sites have been identified; however, it is unknow if all these need to be restored. It is recommended that a conservation professional be consulted when evaluating restoration needs of individual oxbows. It should be noted that funding is available to cover 100% of the cost of restoring oxbows in the Boone River Watershed.

The USFWS administers the "Partners for Fish and Wildlife Program". This program provides technical and financial assistance to landowners interested in restoring and enhancing wildlife habitat on their land. Projects are custom designed to meet landowners' needs. All private landowners interested in restoring wildlife habitat on their land are eligible to participate. Current partners in the BRW include farmers, ranchers, forest landowners, recreational landowners, corporations, local governments, and universities.

ARTIFICIAL DRAINAGE

The Des Moines Lobe, and in particular the Boone River Watershed, is one of the most agriculturally productive areas in the region. This has been made largely possible through artificial drainage of the landscape. Due to the relatively flat landscape of the watershed and lack of natural drainageways, nearly all of the watershed is subject to some form of man-made drainage through a combination of drainage district projects and field tiling. This artificial drainage has allowed countless acres of wetlands and other wet areas to be converted and used for agricultural production. The reclamation process is completed through the removal of surplus groundwater from surface soils to provide optimal conditions for row crop growth.

An overview of this artificial drainage system is important in understanding the overall hydrology of the watershed and how water quality is affected.

Drainage of permanent and seasonal surface water from the landscape in lakes, ponds, wetlands, and potholes generally involves channelization of existing rivers, installation of tile drainage, and construction of drainage ditches to connect depressional areas to natural streams. Shallow groundwater is drained from fields with the uniform placement of field tiles that connect to a main drain. Field tiles can be made from clay, concrete, cement, aluminum, iron, steel, or plastic (Garvin and others, 2017).

To assist landowners in draining their fields, drainage districts have been created through authority granted by the Iowa Legislature and Constitution. Drainage districts are governed by a board of trustees. Typically, the county board of supervisors (where the district is located) serves as those trustees. The basic purpose of the drainage district is to provide and maintain facilities for draining the excess water in a watershed area. Figure 21 illustrates the full extent of drainage districts across the watershed.

While a drainage district is responsible for larger drainage infrastructure, landowners are responsible for the installation and maintenance of tiling infrastructure on their property. These tile lines are generally buried 3-5 feet below ground level. The tile system is necessary to move excess water from fields to streams or drainage ditches, as illustrated in Figure 22.

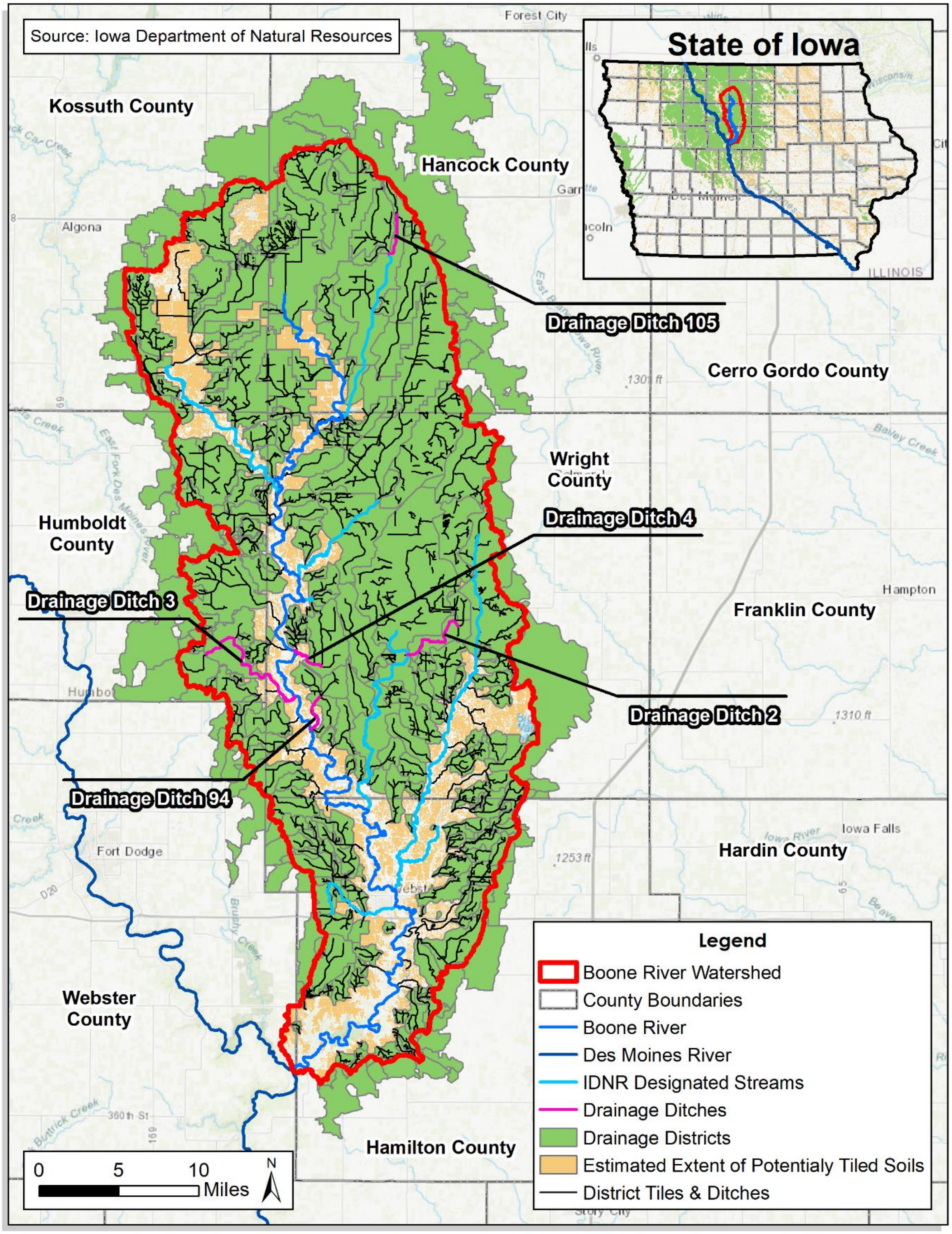
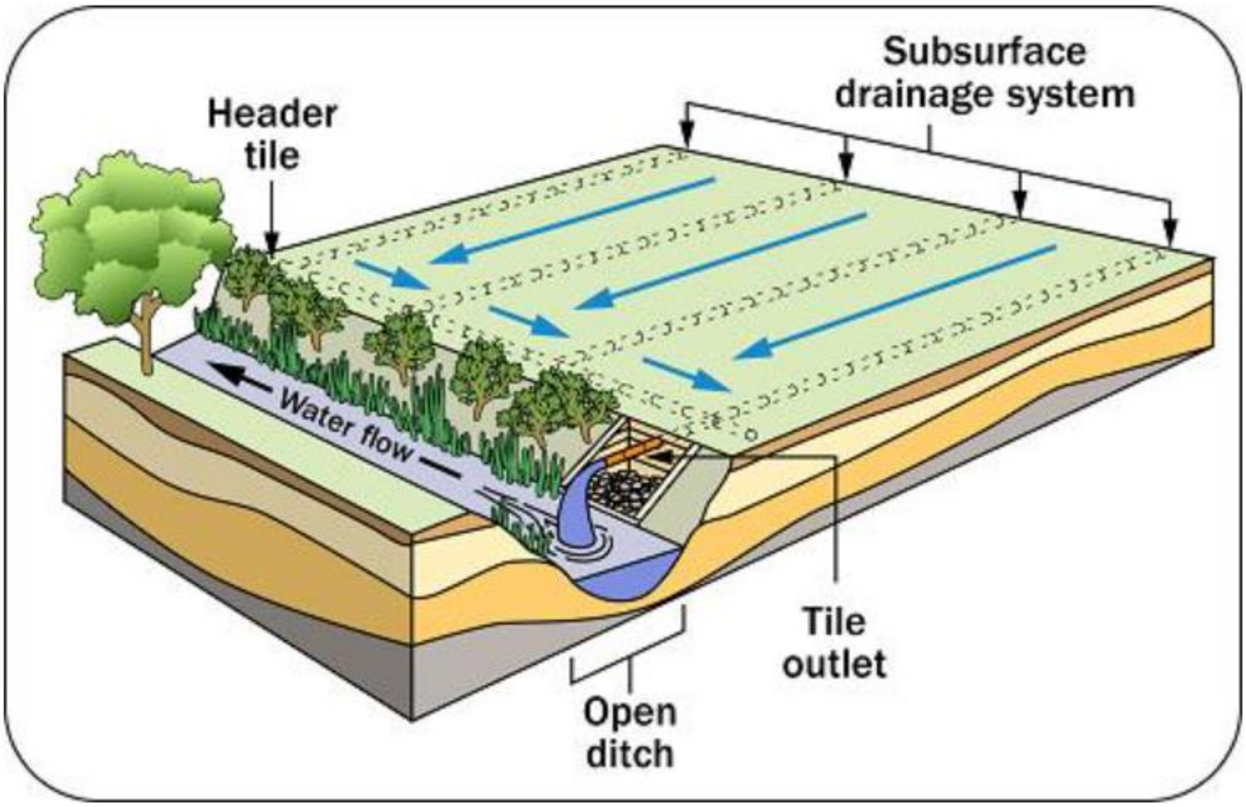


Figure 21: Map of Approximate Boundaries of Drainage Districts and Ditches

Some documentation of tiling installations, including private locations, is kept by county recorders or NRCS offices. However, the available knowledge of the full extents of both private tiling systems and county drainage district infrastructure and drainage areas is limited due primarily to dated record keeping. The information presented in this plan only provides the reader with a general understanding of this system. For project level planning involving drainage infrastructure and tile lines, landowners and county records should be consulted and corroborated with an on-the-ground assessment.



Source: Vander Veen, 2019

Figure 22: Conceptual Illustration of a Tile Drainage System

While there are many agricultural benefits to drainage, the effects on streamflow and water quality can be serious. Field tiling and drainage infrastructure lower water tables and quickly remove water from saturated soil. Water from field tiles flows into ditches and streams much more rapidly than would naturally occur. This influx of water has led to increased streamflows, resulting in increased stream erosion. Additionally, flushing water from fields faster increases the risk of nutrients (especially nitrogen) being caried away and harming downstream water quality. While tile drainage presents unique challenges to watershed management, there are many new and innovative practices that can be implemented to mitigate these effects. These will be explored more in Chapter 5, but include practices such as saturated buffers, drainage water management structures, and bioreactors.

2.08 HYDROLOGY

HYDROLOGIC CHARACTERISTICS

Characterizing the hydrologic regime of a watershed is an important step to understanding how land and water use practices influence flooding and water quality. This understanding is also critical to building appropriate hydrologic models of the watershed. *Figure 23* contains a conceptual hydrograph and cutaway which illustrates key hydrologic concepts. When the hydrologic system experiences changes, the stream system responds with changes in physical, chemical, and biological parameters. Physical changes may lead to increased flooding and reduced streambank stability which may, in turn, alter chemical and physical water quality parameters and ultimately degrade the biological ecosystem or human uses of the stream.

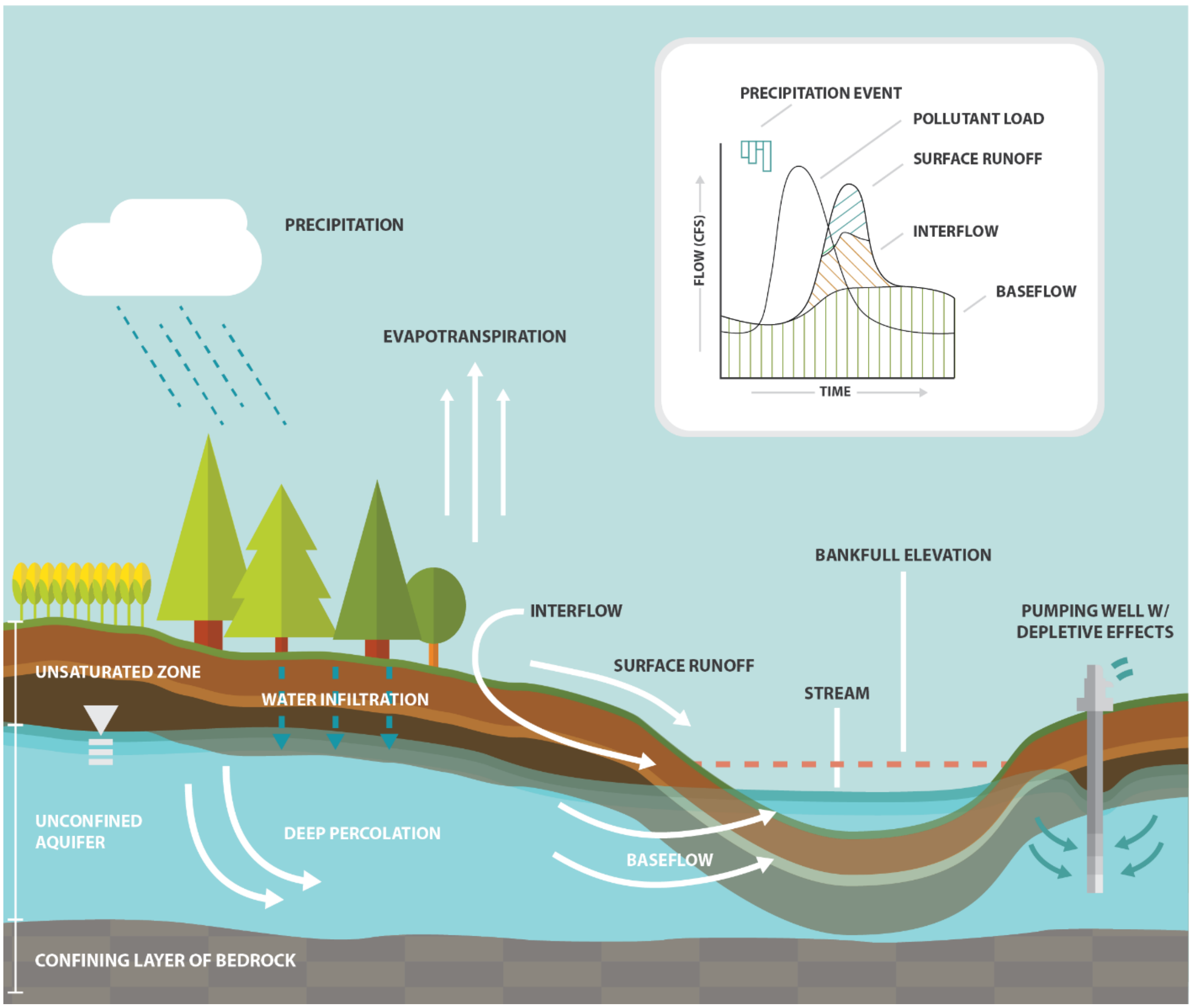
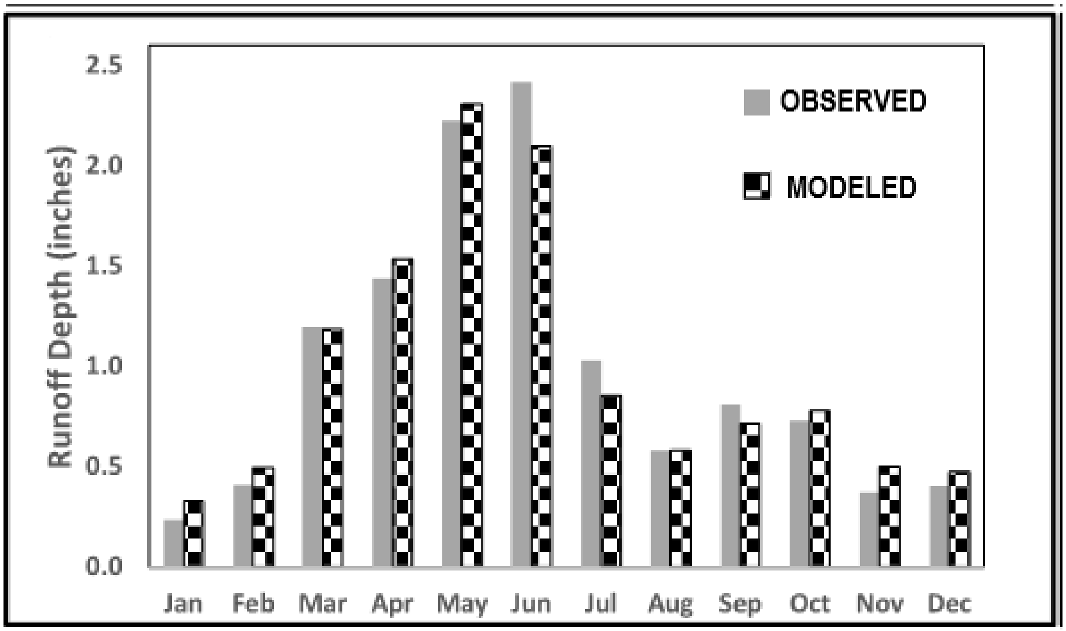


Figure 23: Conceptual Illustration of Key Water Cycle Parameters

Hydrologic processes are complex, involving many interactions that can be difficult to quantify. Additionally, impacts may be seen on both temporal and spatial scales. The location, extent, timing, and type of activities all play a role in alterations. Changes can be seen in the magnitude and timing of peak and low flows, or in year-to-year flow trends. Some activities (roads, seasonal irrigation withdrawals, etc.) cause short-lived alterations, while other activities (dams, urbanization, channelization, groundwater mining, etc.) can cause long-term changes in the hydrology of a watershed (EPA, 2003).

Through a separate study completed in April 2020, the IFC conducted the *Des Moines River Upstream Mitigation Study* (Arenas, 2020). Though the study is about the Des Moines River, key insights about the hydrology of the Boone River were able to be extracted.

Streamflow in the Boone River is driven by both precipitation and tile drainage. Changes in streamflow can be measured by "runoff depth", which is the total runoff volume (from both precipitation and tile drainage) divided by the drainage area. In the BRW runoff displays a marked seasonal cycle; the window between April and August shows the highest runoff depths, as illustrated in Figure 24, from the *Des Moines River Upstream Mitigation Study*. Both drainage districts and tiling play a major role in watershed hydrology and water quality, due to the widespread use of these facilities. In the *Des Moines River Upstream Mitigation Study,* modeling estimates for the Des Moines River Watershed (which includes the Boone River) show that for very dry years more than 80% streamflow comes from tiles. Conversely, during wet years the contribution of tile drainage to streamflow is lower than 30%. On average, tile drainage contributions to annual streamflow are slightly less than 40% (Arenas, 2020).



Source: Excerpt from the Des Moines River Upstream Mitigation Study (Arenas, 2020)

Figure 24: Observed and Simulated Average monthly Runoff Depth (2002 – 2018) for Boone River near Webster City

It is clear, through a review of the *Des Moines River Upstream Mitigation Study*, the BRW plays a significant role in the Des Moines River Basin. Several additional trends regarding the hydrology of the BRW were identified through a review of the study:

- A trend of increasing streamflow amounts and increased variability were observed. These were statistically significant for low and mean (average) daily flows. High flows exhibited a similar trend but was not statistically significant.
- These changes in long-term streamflow began around 1985, with another possible change occurring more recently between 2010 and 2018.
- Approximately 40% of the flow in the Boone River is a result of direct runoff from precipitation, while 60% is a result of baseflow. Tile flow is mixed into both flow sources.
- The BRW had the highest average annual streamflow volume compared to other watersheds in the Des Moines River Basin.

It is recommended that a focused hydrologic study be completed on the BRW. This study should be similar in scope to and could leverage the model that was already created for the *Des Moines River Upstream Mitigation Study.* This proposed study would be a powerful tool for better understanding and defining the complicated hydrologic system of the BRW.

STREAMFLOW

Streamflow regimes are composed of seasonally varying environmental flow components including high flows; base flows; and pulses and floods that can be characterized in terms of their magnitude, frequency, duration, timing (predictability), and rate of change (flashiness) of hydrologic conditions (Poff and others, 1997).

To understand a typical hydrologic cycle and streamflow regime within the watershed, a representative stream gage was identified to review streamflow record. The USGS stream gage located on the Boone River near Webster City (05481000) has a respectable period of record of 1940-present (only 1990 – present was available for download and analysis by JEO) and is downstream to much of the planning area. However, while representative of the area and long-term trends, it should be noted that all streams have unique responses to storm events due to variability in precipitation patterns and effects of terrain, soils, and land cover. This creates both local and regional flow patterns. Additionally, the hydrology of the BRW is affected significantly by artificial drainage.

A review of the discharge data for the Boone River demonstrates a few trends which provide a basic understanding of the dynamic hydrologic cycle of the planning area:

- Streamflow can vary considerably day-to-day, as precipitation is the most significant water supply to the planning area (Figure 25).
- A predictable seasonal pattern can be seen in streamflows. There is an increase in runoff in late winter and early spring caused by snowmelt, leading to increased streamflows.

There is also an increase in streamflows during the late spring and early summer storm season. Many years there are flood events in both the spring and fall rainy seasons.

- A long-term trend of increase in streamflows has been noted across the Midwest (Brown and Caldwell, 2012). This was also demonstrated by IFC in the *Des Moines River Upstream Mitigation,* which used the full period of record since 1940. However, through JEO's analysis of data since 1990, the trend at this site shows a gradual decrease in streamflows in the Boone River (Figure 26). This may be caused by a multitude of factors: decreased rainfall, increases in water usage upstream, drought, or others.
- There are long-term patterns of wet and dry periods, as seen in the running 5-year average (Figure 26). The highest daily average streamflow recorded was 19,623 cubic feet per second (CFS) in June 2008, and the lowest daily average was 3 CFS in September 2012. The long-term average flow is 884 CFS.
- Streamflows are seasonally predicable across the planning area, but less predictable during high flow and flood events due to natural and anthropogenic impacts which vary across subwatersheds.

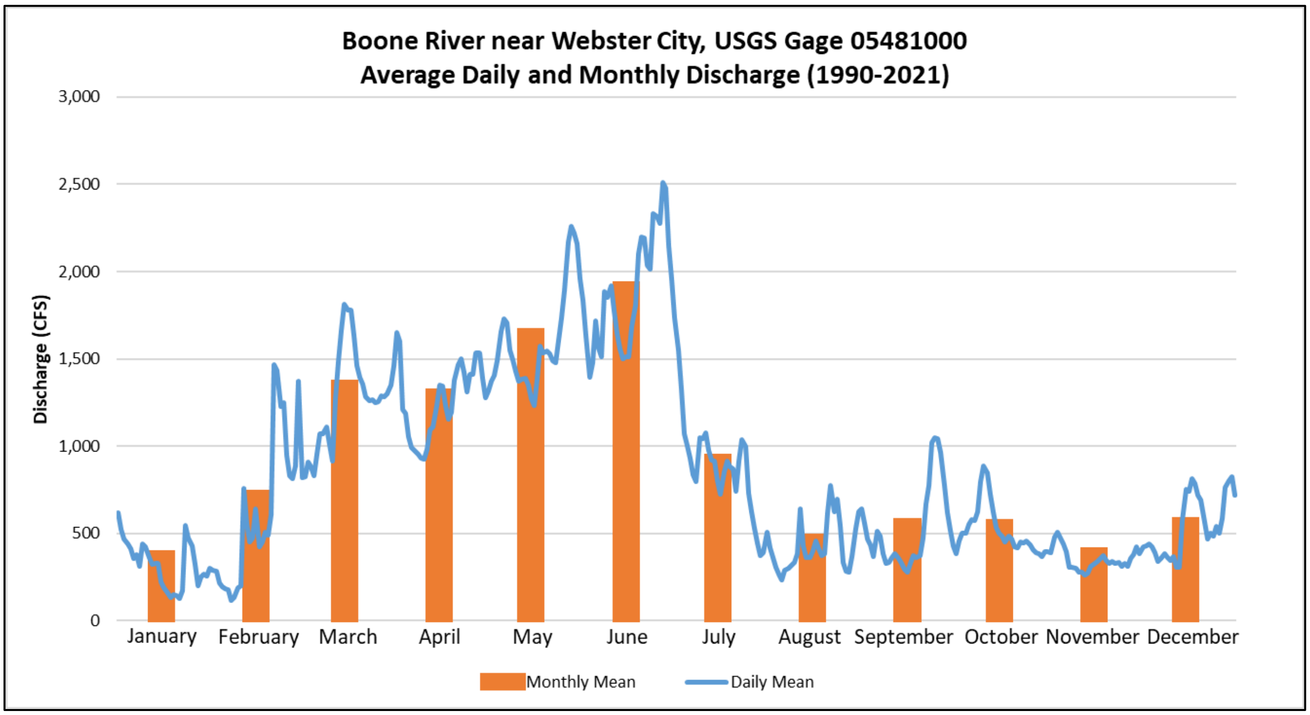


Figure 25: Streamflow Hydrograph of an Average Year for the Boone River

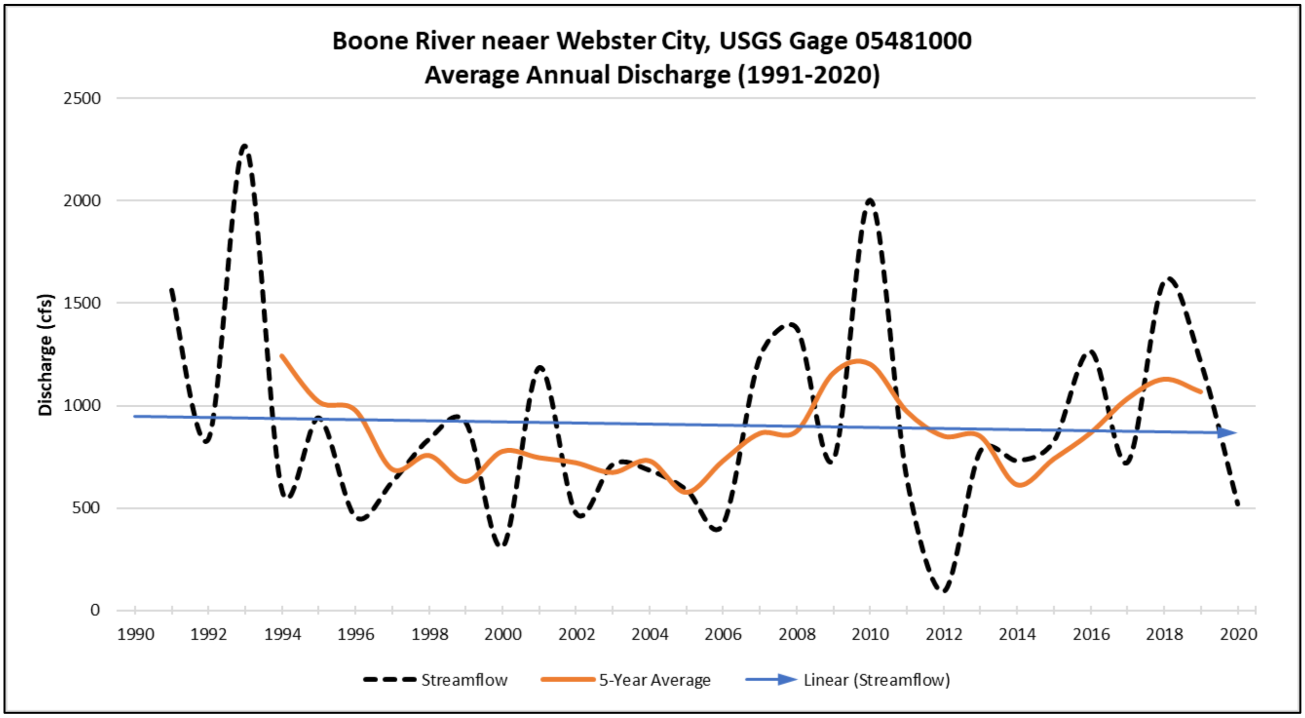


Figure 26: Long-Term Streamflow Hydrograph for the Boone River

Variations in streamflow levels, including high flow or flooding events, are an important part of the natural ecological function of streams. Many fish and aquatic organisms require habitat that cannot be maintained by minimum or even typical flows over the long term. A range of flows are necessary to scour and revitalize gravel beds, import wood and organic matter from the floodplain, and provide access to riparian wetlands. Additionally, these processes are important in the natural cycling or movement of nutrients and sediments (Poff and others, 1997).

Understanding these hydrological conditions is important to making management decisions regarding watershed planning, especially in regard to stream restoration and management practices. However, extremely high flows may be considered flooding, which may cause damage to infrastructure, homes, businesses and other property, and endanger human life. Balance is needed in the management of streams within the planning area.

The *Des Moines River Upstream Mitigation Study* Report provides a helpful summary of the overall nature of flooding within the planning area:

> *Floods are typically related to large amounts of precipitation or snow melt and saturated or frozen soil. In Iowa, historic records show that the great majority (>90%) of floods occur in the spring and summer; the month of June shows the highest number of flood events. Precipitation records show that heavy rains occurred in the fall as well; however, Iowa soils have a larger capacity to infiltrate water late in the year, and therefore fall floods are less common. In Iowa's flood history, the events of 1993 and 2008 are on an entirely different scale than the*

others. These two events stand out from the rest when looking at the extent of the area impacted, recovery costs, precipitation amounts, and streamflows recorded.

A review of data from the USGS stream gage (05481000) located on the Boone River near Webster City provides an indication as to the magnitude and frequency of flooding that occurs in the planning area. Gage height data, which indicates the depth of water in the stream channel, was reviewed against the National Weather Service's (NWS) designated "flood stage", which is set at 14 feet. Figure 27 shows that since 2007, the gage has recorded the river reaching the NWS flood stage 16 separate times during four events (2008, 2010, 2016, and 2018). The stream has been above its average level (3.38 feet) on numerous occasions where it may be considered a high flow event, but not a flooding event: 74 occurrences reached between 9 to 12 feet, and 21 occurrences reached between 12 to 14 feet.

Additional insights on flooding in the BRW were identified in the *Des Moines River Upstream Mitigation Study:*

- The Boone River had higher occurrences of smaller magnitude flooding events (5- and 10- year) than other locations in the Des Moines River Basin
- The BRW exhibits a seasonal flood pattern. Most flooding events occur during the moths of May and June, with a secondary peak in March and April, following snowmelt and spring rains.
- There is a marked decline in flood risk after July.

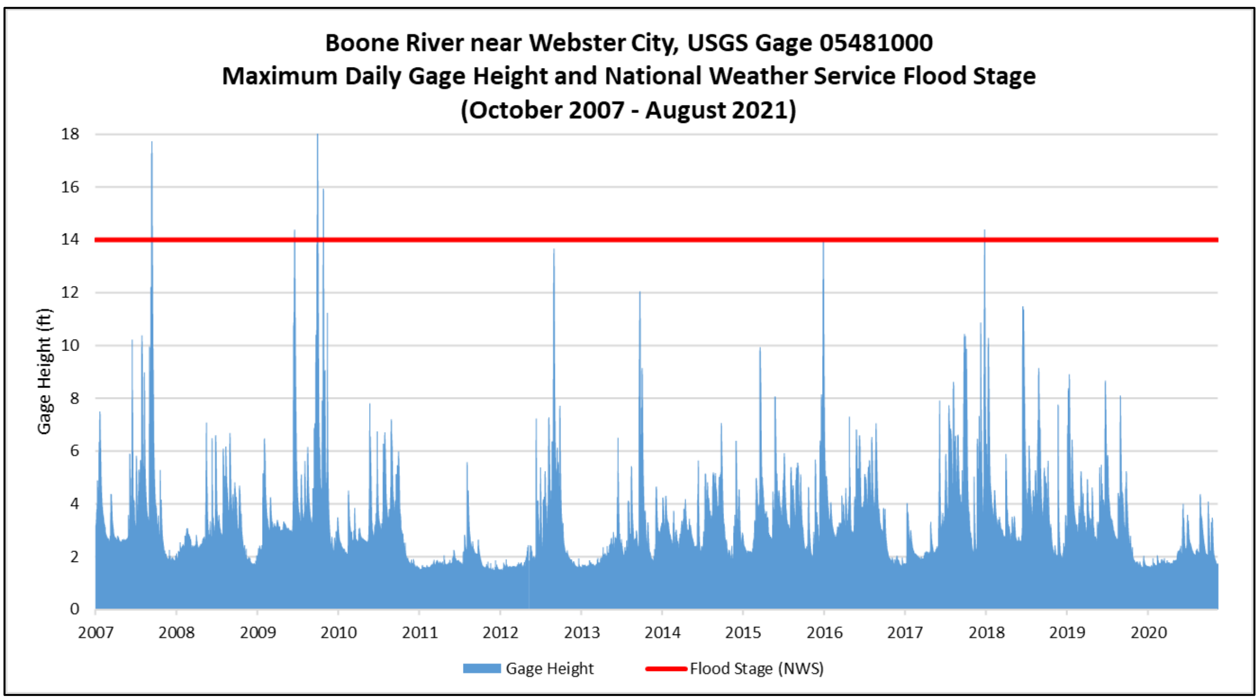


Figure 27: Maximum Daily Gage Height and Flood Stage Records for the Boone River

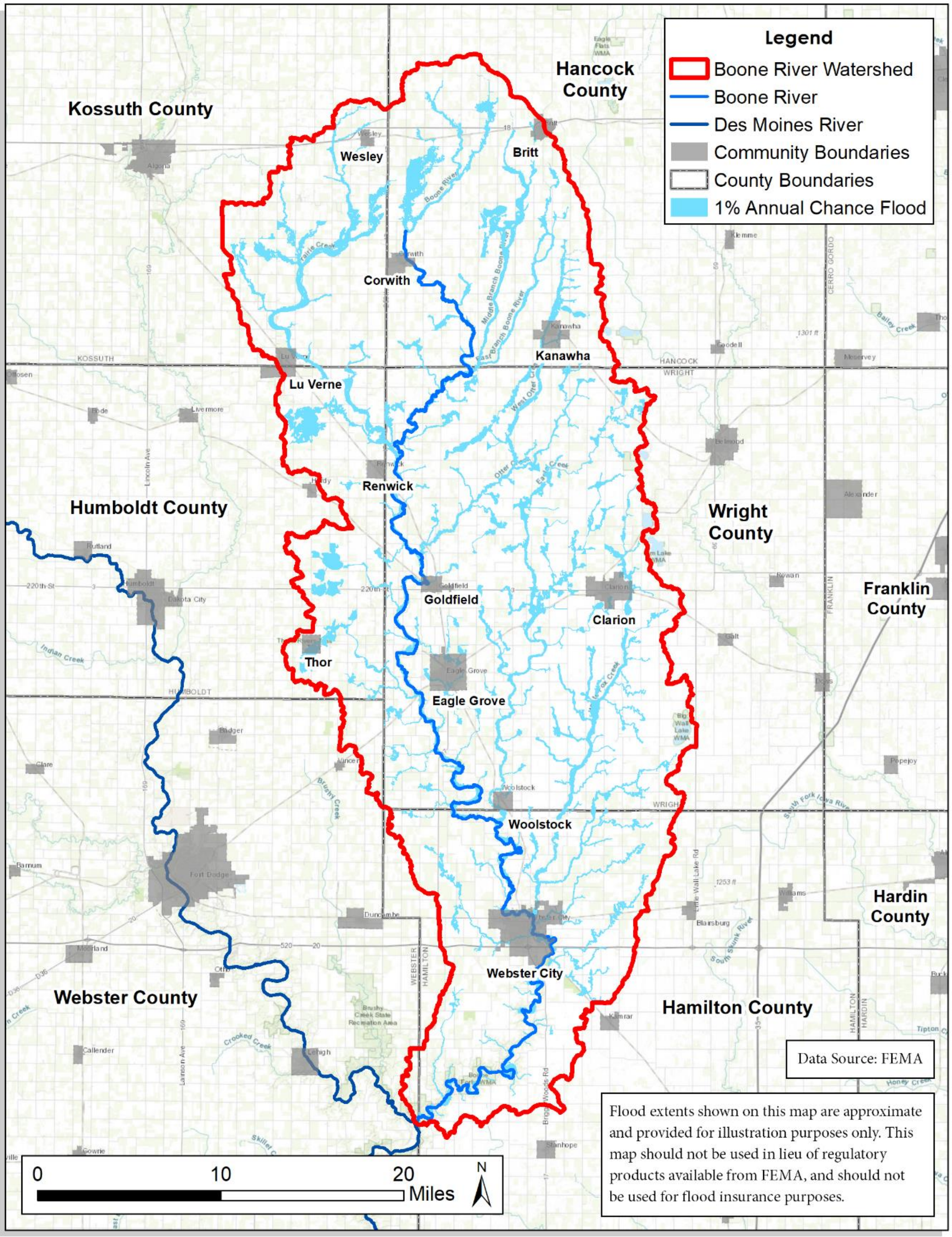
FLOODPLAINS

In general terms, floodplains are areas adjacent to creeks, streams, and rivers that include the channel and extend to the edges of a valley. These are the areas that both receive floodwaters when stream channels flow out of their banks and provide conveyance of waters during high flow events. Other floodplain functions include flood risk reduction, habitat conservation, water quality protection and groundwater recharge. The natural benefits of floodplains and flooding typically outweigh the risks, with the exception of urbanized and built-up areas. The Federal Emergency Management Agency (FEMA) has taken steps to define floodplains to both preserve their natural functions and to reduce flooding risks to human populations.

FEMA has delineated floodplains based upon the anticipated 1% annual chance of flood flows exceeding base flood elevations (BFE). These areas are commonly referred to as the “100-year floodplain” and are illustrated in Figure 28 for the BRW. In some areas, a regulatory “floodway” has also been established. Floodways are areas that must not be encroached upon to prevent the base flood elevation from increasing by more than one foot. While almost any area in the watershed is at some level of risk for flooding, regulatory floodplains and floodways have been mapped and formally acknowledged by FEMA.

Historically, cities have been developed along waterways for various reasons such as transportation and commerce. As a result, these population centers are at an increased risk of flooding. The same is true in the Boone River Watershed as many of its cities are located along the Boone River or its tributaries. The degree of flood risk for each community varies considerably based on topography, flooding timing and duration, watershed size, flood control structures, land use, or other factors.

No flood risk assessment was available to be included in this watershed planning effort; however, it is recommended that this be done in the future. A flood risk assessment is a key step towards creating both communities and a watershed that is flood resilient. A flood risk assessment is conducted to identify communities with the highest risk for flooding. This information can then be used to identify and prioritize potential mitigation alternatives. A watershed approach towards flood risk reduction allows local issues to be addressed, while also having positive effects on reducing flooding within the larger watershed. Additional discussion on this and other flood mitigation recommendations can be found in the *Flood Resiliency Current Conditions Report* (Appendix A); as well as Chapter 3 and Chapter 5.



Source: FEMA, 2018

Figure 28: Map of FEMA Delineated Floodplains

2.09 WILDLIFE, HABITAT, AND PUBLIC ACCESS

Iowans maintain a strong connection to wildlife, and many participate directly in wildlife-associated recreation. In 2013, a non-partisan survey of Iowa's voters found that 97% of respondents agree with the statement "We need to ensure that our children and grandchildren can enjoy Iowa's land, water, wildlife, and the natural beauty the same way we do" (Reeder and Clymer, 2015).

Including wildlife and habitat related information in this watershed plan is important. Land protection provides a range of benefits, including increased wildlife habitat, recreational opportunities for humans, and maintaining or restoring ecosystem functions such as water filtration, flood abatement, and carbon storage. (Reeder and Clymer, 2015). Where opportunities to enhance water quality or flood resilience, as identified in this plan, overlap with opportunities to conserve wildlife and habitat or expand recreational access, the likelihood of success is higher. Addressing multiple goals provides opportunities for project partnering and opens additional funding avenues for projects. The Boone River Watershed should look for these opportunities and work towards realizing them. More information about plant and animal communities and public access and recreation can be found in the Current Conditions reports in Appendix A.

A map of all public lands is shown in Figure 29. This includes areas that are owned or managed by various entities. Each may have different requirements for public access and allowed activities. The following websites provided interactive, online mappers where more details for each area can be viewed:

- https://www.fws.gov/refuges/find-a-wildlife-refuge/
- https://www.iowadnr.gov/Hunting/Places-to-Hunt-Shoot
- https://www.mycountyparks.com/

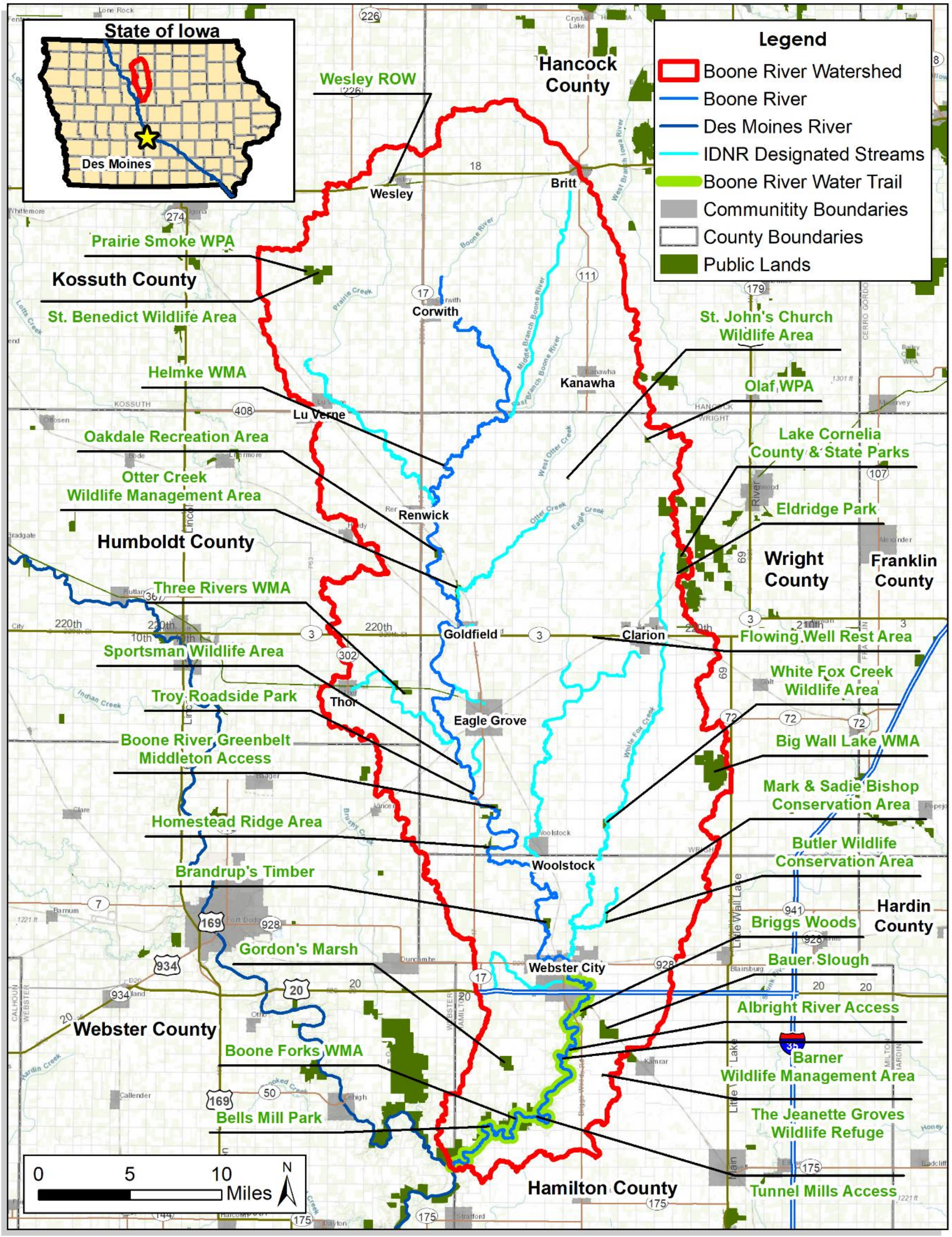


Figure 29: Public Lands within the Watershed

BOONE RIVER WATER TRAIL

The lower portion of the Boone River, from Webster City to the confluence with the Des Moines River, is considered a state water trail (Figure 30). Water trails are recreational corridors and routes on rivers and lakes that provide a unique experience for canoeists and kayakers, including access to riverside campgrounds and other amenities like shelters and restrooms in city, county, or state parks (IDNR, 2010). Iowa water trails are developed to produce “low or no impact on the stream and riparian, or stream-edge, ecosystems” (IDNR, 2010).

This same portion of the Boone River is also considered Protected Water Area (PWA). The Boone River was the first river to be designated a PWA. The PWA program was initiated in 1987 when the State legislature addressed the need for additional open space protection in Iowa. The basic purpose of the PWA program is to maintain, preserve and protect existing natural and scenic qualities of selected lakes, rivers and marshes and their adjacent land areas. Management of PWAs is done cooperatively between local and state agencies and private landowners. IDNR provides leadership and coordination for those property owners who are interested in assuring that their land next to the water resource will look much the same in the future as it does today (IDNR, 2021a).

Figure 30: Map of the Boone River Water Trail

IOWA WILDLIFE ACTION PLAN

IDNR updated its *Iowa Wildlife Action Plan* in 2015. This plan was written to guide the conservation of wildlife and natural places across the state and with the intent to outline the steps needed to conserve wildlife, before they are endangered, and habitat, before it become too costly to restore. The plan assesses the health of wildlife and habitat within the state, identifies the problems they face, and outlines the actions that are needed. The plan focuses on Species of Greatest Conservation Need (SGCN).

Habitat availability, quantity, and quality are primary factors influencing the viability of wildlife populations (Reeder and Clymer, 2015). While the plan lays out several conservation related visions, strategies, and actions, they are not specific to the BRW and are not specifically designed to be solely implemented by the IDNR. They are designed to provide a broad framework of actions that can be undertaken by all levels of government, private organizations, and private citizens. They will take a broad array of funding sources, skills, expertise, and partnerships to implement. The plan lays three general approaches that should be undertaken. The following one is where most opportunities exist for projects and partnerships within the BRW, particularly in the context of implementing this watershed management plan:

> *Habitat in rivers, streams, lakes, impoundments and wetlands can be improved only if soil erosion, siltation, and all the associated problems are reduced. Targeting areas to protect and restore habitats for terrestrial SGCN will help with this process but will not protect enough land by itself to help all aquatic systems. Vegetative cover must be returned to more of the landscape to hold soil in place. Existing soil-retention programs like terracing, buffer strips, and no-till agriculture need to be expanded and new approaches explored to make soil conservation more widely acceptable and financially attractive to the farming community (Reeder and Clymer, 2015, p. 130).*

The following goal was identified within the plan, and is particularly relevant to the BRW:

- *The amount of permanently protected wildlife habitat in Iowa will be doubled to 4% of the state's land area (p. 100).*

THREATENED AND ENDANGERED SPECIES

Identifying specific locations of Threatened and Endangered (T&E) species in the BRW was outside the scope of this planning effort. However, the ranges of both federal and state listed species overlap with the BRW. More information about T&E species and sampling efforts for freshwater mussels in the BRW can be found in the *Plant & Animal Communities Current Conditions Report*, found in Appendix A. It is recommended that project sponsors consult with the United States Fish and Wildlife Service (USFWS) and IDNR for specific project sites where threatened or endangered species' habitats may exist. The USFWS maintains a tool to help identify T&E species that may occur in a project area, which can be accessed online: https://ecos.fws.gov/ipac/

Designated critical habitat for the Topeka Shiner (*Notropis topeka (=tristis))* is found within the BRW. As can be seen in Figure 31, this area is located in Humboldt and Wright County, Iowa with small portions in Hamilton and Webster County. Table 13 identifies federal T&E species which can be found in the BRW. Although not explicitly addressed in Table 13, various species of mussels (including some that are on Iowa's threatened species list) have shown decline in the Boone River and have been monitored as recently as 2015. There are 94 state listed T&E species in Iowa, and a list of those can be found at the Iowa Natural Areas Inventory interactive website: https://programs.iowadnr.gov/naturalareasinventory/pages/Query.aspx.

Table 13: Federally Listed Threatened and Endangered Species in the BRW

Type	Common Name	Scientific Name	Status
Mammals	Northern Long-eared Bat	*Myotis septentrionalis*	Threatened
Fishes	Topeka Shiner	*Notropis topeka (=tristis)*	Endangered
Insects	Poweshiek Skipperling	*Oarisma poweshiek*	Endangered
Flowering Plants	Prairie Bush-clover	*Lespedeza leptostachya*	Threatened
	Western Prairie Fringed Orchid	*Platanthera praeclara*	Threatened

Source: USFWS, 2018

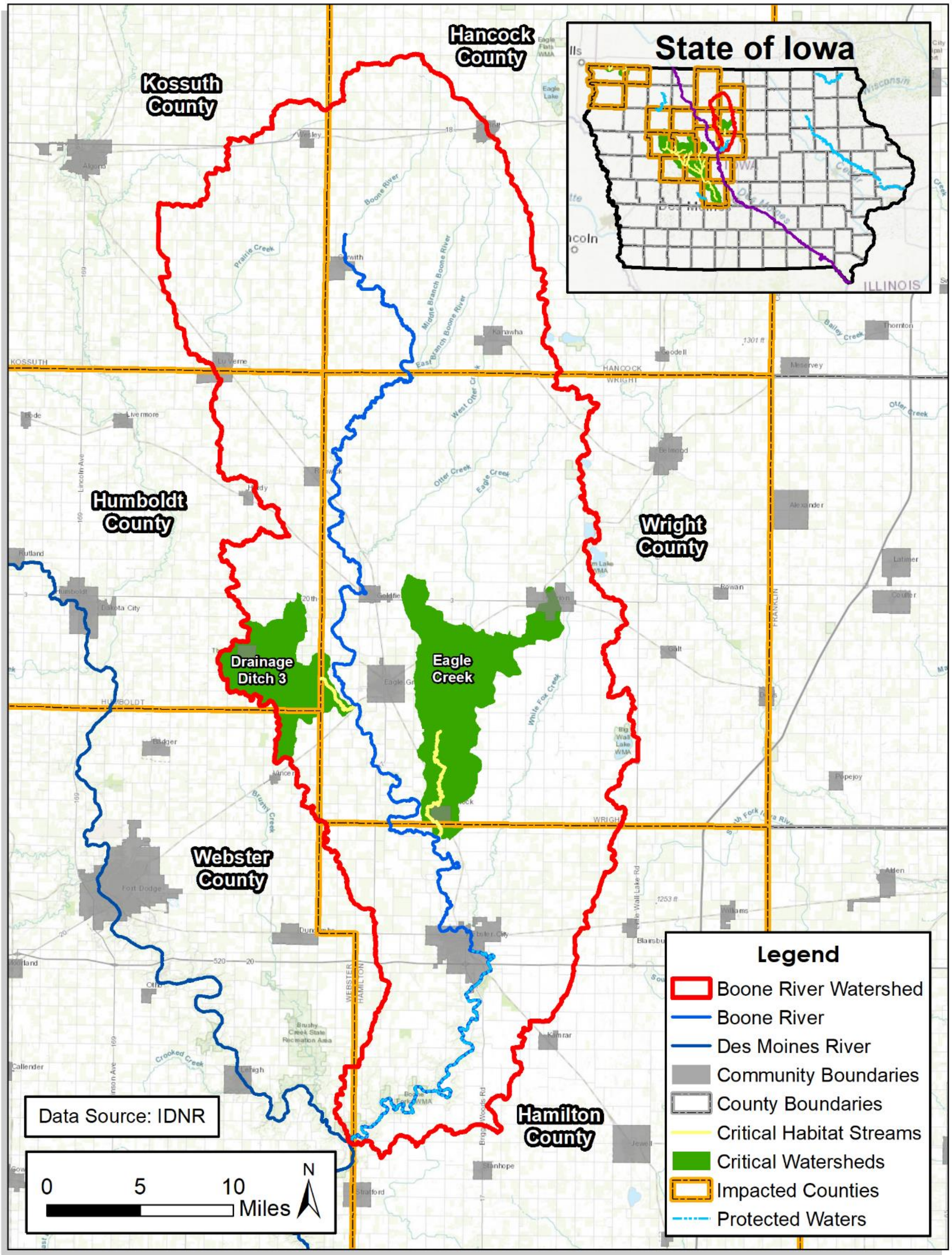


Figure 31: Map of Critical Habitat Areas for Topeka Shiner

AQUATIC INVASIVE SPECIES

Aquatic invasive species are non-native organisms introduced into rivers, streams, and lakes. They generally have few to no predators or any other natural controls on their population, such as disease or competition, allowing their numbers to grow unchecked. Once established, these species may cause irreparable harm, introduce disease, out-compete native species, change the physical characteristics of waters, damage equipment, clog water delivery systems, and negatively impact local and national economies.

While there is not a complete list of locations where invasive species are found, IDNR maintains information on potential invasive species in Iowa. Table 14 identifies aquatic invasive species which may be present within the BRW. Prevention is the strongest defense against invasive species. Posting signs or distributing educational information are some methods to prevent the introduction of these species into the watershed. However, if these or other invasive species are found to be in the watershed, future education efforts could be designed to target their reduction and/or elimination.

Table 14: Aquatic invasive species which may be present within the BRW

Type	Common Name	Scientific Name
Fish	Bighead Carp	*Hypophthalmichthys nobilis*
	Silver Carp	*Hypophthalmichthys molitrix*
	Black Carp	*Mylopharyngodon piceus*
	Round Goby	*Neogobius melanostomus*
	White Perch	*Morone americana*
	Ruffe	*Gymnocephalus cernuus*
	Rudd	*Scardinius erythrophthalmus*
Plants	Brittle Naiad	*Najas minor*
	Curlyleaf Pondweed	*Potamogeton crispus*
	Eurasian Watermilfoil	*Myriophyllum spicatum*
	Flowering Rush	*Butomus umbellatus*
	Purple Loosestrife	*Lythrum salicaria*
	Saltcedar	*Tamarix* spp.
Invertebrates	Fishhook Waterflea	*Cercopagis pengoi*
	New Zealand Mudsnail	*Potamopyrgus antipodarum*
	Quagga Mussel	*Dreissena rostriformis bugensis*
	Rusty Crayfish	*Orconectes rusticus*
	Spiny Water Flea	*Bythotrephes longimanus*
	Zebra Mussel	*Dreissena polymorpha*

Source: IDNR, 2020e

FISH PASSAGE

Throughout much of Iowa, including the Boone River Watershed, there are numerous man-made obstructions or obstacles on rivers and streams. These obstacles create barriers to fish passage and migration. Many aquatic species rely on the ability to move throughout a stream system to find habitat or opportunities to breed, raise young, feed, or escape adverse conditions. The primary obstacles present include low head dams and perched culverts. In 2014, IDNR completed a dam removal/modification project near Goldfield that is now a whitewater feature. Chapter 5 provides additional discussion on possible remaining low head dams in the watershed

Additional barriers to fish and aquatic life passage exist between the riparian areas, oxbows, and other habitat. These are primarily the result of removal of riparian vegetation, sedimentation, stream downcutting, and field leveling. Another common obstruction to fish passage is a perched culvert, which is one with an outlet elevated above the downstream water surface, allowing a freefall condition. This condition requires migrating fish to leap into the culvert from the downstream pool. This is rarely possible, especially for smaller minnow-type fish species, such as the endangered Topeka Shiner.

Surveys have been completed in Prairie Creek, Eagle Creek, Buck Creek, Lyons Creek, and Drainage Ditch 206 subwatersheds. Data from IDNR (K. Ament, written commun., 2020) and USFWS (J. Jarvey, oral commun., 2021) indicate there are numerous perched culverts throughout the watershed. Figure 32 is an example of perched culverts within the BRW. Additional information is provided in the *Shorelines and Riparian Areas Current Conditions Report* located in Appendix A, and the USFWS presentation, located in Appendix C.

Figure 32: Example of Perched Culverts within the Boone River Watershed (Jarvey, 2021)

2.10 EXISTING POLICY AND REGULATIONS

STATE WATER QUALITY STANDARDS

The IDNR manages water quality for all surface waters within Iowa through the implementation of the state's Water Quality Standards (WQS), which are found in Chapter 61 of the Iowa Administrative Code. These standards include numerical standards for many potential water quality pollutants based on the waterbody's assigned beneficial use. When multiple uses are assigned to the same waters, the most stringent criterion for the appropriate pollutant or season applies. This plan has been written to address nonpoint source pollutant loadings from bacteria (*E. coli*), nutrients (phosphorus and nitrogen), and sediment.

Iowa's WQS are in place to protect the quality of surface water for human consumption, wildlife, industry, recreation, and other productive, beneficial uses. Beneficial uses are also protected by permits issued in accordance with both the requirements of these standards and for the applicable level of treatment or control for point and nonpoint sources of pollution. It should be noted that these standards apply to all surface waters of the State, except as noted in Chapter 61, even if they are not specifically assigned a beneficial use in Chapter 61. WQS can be both in numerical and narrative formats.

While there are many WQS which apply to both streams and lakes, the only WQS utilized for the development of this plan is identified in Table 15. It should be noted that no numerical WQS exist for nutrients or sediment. Goals for nutrient reductions have been identified through the Iowa Nutrient Reduction Strategy (discussed below), but these are not regulatory WQS.

Table 15: Summary of Water Quality Standards Applicable to this Plan

Parameter	Beneficial Use or Category	Water Quality Standard
Streams		
E. coli Bacteria	Primary Contact Recreation* (Class A1)	Seasonal Geometric Mean: 126 organisms/100 ml Maximum Single Sample: 235 organisms/100 ml

*Standard only applies March 15 – November 15

Source: Iowa Administrative Code, 2019

OTHER WATER QUALITY BENCHMARKS

As previously stated, there are no numerical WQS in Iowa for nutrients or sediment. Therefore, several “benchmark” water quality criteria were identified (Table 16) in order to help the WMA assess water quality data. The following documents were utilized to provide these benchmarks:

- **Nutrients:** In 2001 EPA published recommendations for nutrient water quality criteria for rivers and streams across the country (EPA, 2000). These documents present EPA's nutrient criteria for Rivers and Streams in Ecoregions across the country. They contain EPA's recommendations to states and authorized tribes for establishing their water quality standards. These recommended criteria are not laws or regulations - they are guidance that states and tribes may use as a starting point for the criteria for their water quality standards. The BRW is located within Nutrient Ecoregion VI: Corn Belt and Northern Great Plains. The recommendation summarized a large dataset and established the median values of 0.7625 mg/L total phosphorus and 2.18 total nitrogen as the overall guidance values for the area. While this guidance has no regulatory significance in Iowa, it does serve as a useful benchmark to understand water quality conditions of streams.
- **Sediment:** Total Suspended Solids (TSS) is commonly used as a surrogate for sediment. A benchmark was identified through a methodology established by the Kansas Department of Health and Environment (KDHE). KDHE has analyzed a large dataset of TSS data and associated biological monitoring data. A strong threshold relationship exists at 50 mg/L median TSS, above which streams are unlikely to support a rich diversity of aquatic life (KDHE, 2020). While this guidance has no regulatory significance in Iowa, it does serve as a useful benchmark to understand water quality conditions of streams.

Table 16: Summary of Water Quality Benchmarks

Parameter	Water Quality Benchmark	Source
Total Nitrogen	2.18 mg/L	EPA, 2001
Total Phosphorus	0.7625 mg/L	EPA, 2001
Total Suspended Solids (TSS)	50 mg/L	KDHE, 2020

TOTAL MAXIMUM DAILY LOADS (TMDLS)

A Total Maximum Daily Load (TMDL) is developed by IDNR when a waterbody has been identified as "impaired" for one or more designated beneficial uses. TMDLs establish the maximum allowable daily load of a pollutant a specific waterbody can receive and still meet WQS. TMDLs are specific to the waterbody they are developed for, and thus can vary.

The following TMDLs were developed for water bodies within the BRW, however they were not utilized in the development of this plan. The focus of these TMDLs is on lakes, whereas the focus of this watershed plan is on water quality in streams. Additionally, the TMDLs were not developed for any of the pollutants of concern that this plan addresses.

- Lake Cornelia: TMDL for Algae and Turbidity (2006)
- Briggs Woods Lake: TMDL for Organic Enrichment/Low DO and Algae (2012)

There is also a TMDL that has been developed for the Des Moines River. This TMDL was approved in 2009 and addressed high levels of nitrate. The 2009 Des Moines River TMDL set a maximum daily nitrate reduction target of 34.4%. This reduction corresponds with meeting a target concentration of 9.5 mg/l nitrate. This target was established to meet the EPA maximum contaminant level (MCL) of 10 mg/l for drinking water and still allow for a for a margin of safety of 0.5 mg/l.

While this TMDL does not directly apply to the BRW, it is relevant as the Boone River is a major contributor to the Des Moines River. The TMDL offers a comprehensive understanding of pollutant sources and the contributions the BRW makes towards nitrate loads in the region; however, water quality data that has been more recently collected will be used in Chapter 3 to better summarize water quality conditions in the watershed. **Ultimately, this plan addresses the link between high nitrate loads from the Boone River contributing to the impaired Des Moines River. Additionally pollutant reduction goals (Chapter 4) meet the criteria set out in the TMDL.**

The *Lyons Creek Watershed Management Plan for Nitrate Reduction*, which is located within the BRW, was prepared in 2012 and developed its goals to be linked to the 34.4% nitrate reduction called for in the 2009 Des Moines River TMDL.

Additional information on each TMDL can be found on the IDNR website:

https://www.iowadnr.gov/environmental-protection/water-quality/watershed-improvement/water-improvement-plans

SAFE DRINKING WATER ACT

In 1974, the Safe Drinking Water Act directed the EPA to establish national drinking water standards – these are known as Maximum Contaminant Levels (MCLs). These standards set limits on the amounts of various substances allowed in public drinking water. The IDNR is the primary agency responsible for enforcing the federal drinking water regulations in Iowa. The most pervasive drinking water pollutant is nitrate-nitrogen (nitrate). Nitrates are known to cause a disease called methaemoglobinaemia (or “blue baby syndrome”) primarily within infants, but it may also impact pregnant women and health-compromised adults. High nitrate levels in drinking water are typically caused by nonpoint source pollution, and thus, they are of interest in this planning effort. The MCL for nitrate-nitrogen is 10 milligrams per liter (mg/L) or parts per million (ppm) in drinking water. As previously noted, this MCL was also the driver in establishing the 2009 Des Moines River TMDL.

NUTRIENT REDUCTION STRATEGY GOALS

The Iowa NRS has identified statewide goals for reducing nonpoint source pollution. Specifically, for nutrient reduction, the NRS has set statewide reduction targets from nonpoint pollution sources for nitrogen at 41% reduction and phosphorus at 29% reduction. These goals have also been adopted through other local watershed management plans across Iowa. In the BRW, these goals have been adopted in the following plans:

- Prairie Creek Watershed Plan
- Eagle Creek Watershed Plan
- Eagle Grove Watershed Plan

To provide additional context on other nutrient reduction goals across Iowa, Figure 33 has been created through a review of readily available watershed plans. While this graphic is not all inclusive, it does illustrate the general level of nutrient reduction efforts that others in Iowa are attempting to achieve. It should be noted that these goals are generally based on a reduction of pollutant loads and are not based on the actual concentrations of nutrients or sediment in the water.

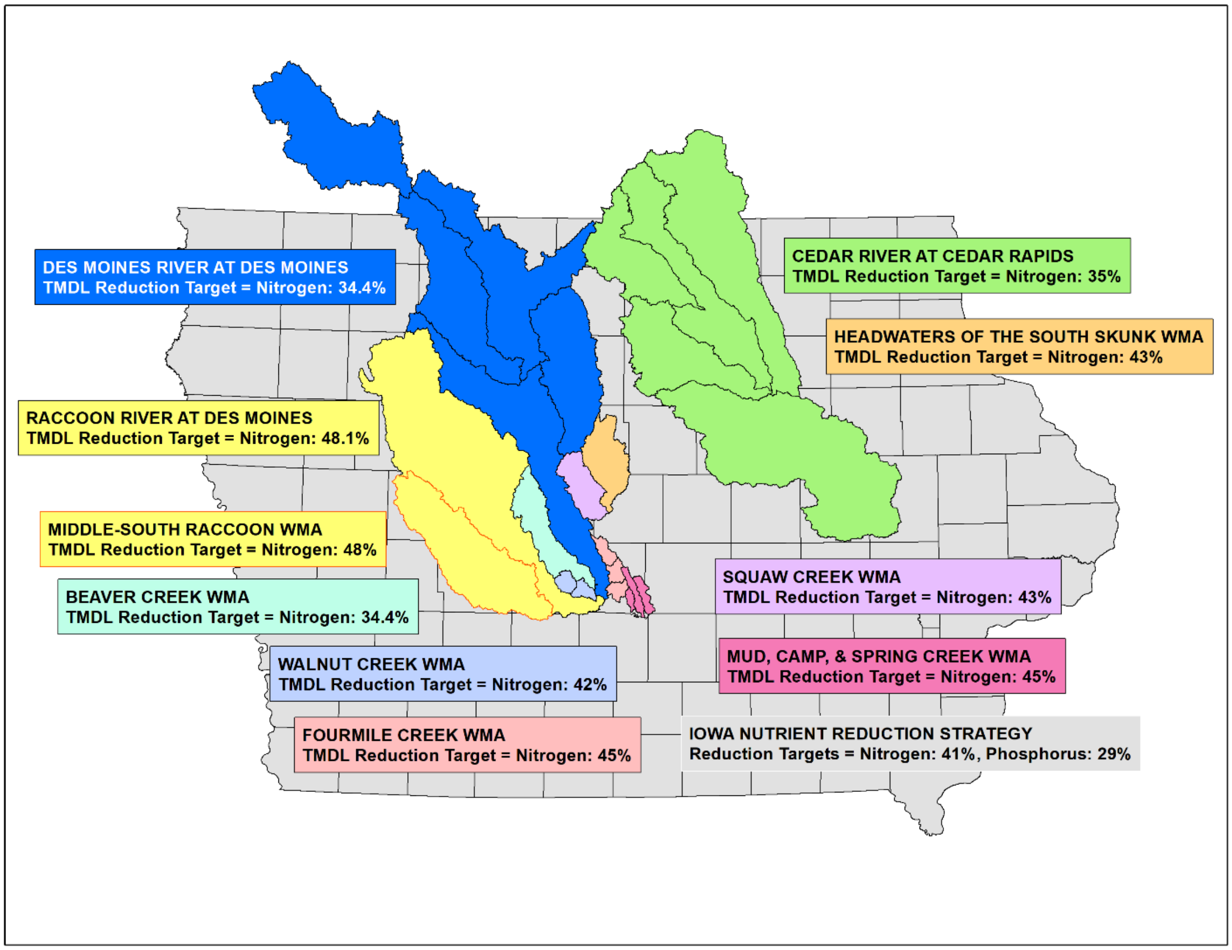


Figure 33: Nitrate Load Reduction Targets Across Iowa

FLOODPLAIN, STORMWATER MANAGEMENT, & PET WASTE ORDINANCES

Research was conducted to determine the presence of relevant floodplain, stormwater management, and pet waste management ordinances for cities in the BRW. The results of this effort were used to help identify project opportunities for water quality improvements or flood mitigation. These results can be seen in Table 17. Community websites were reviewed for online copies of floodplain, stormwater management, and pet waste ordinances. If a community did not have a website, or their ordinances were not available online, efforts were made to contact a community representative via email and through follow up phone calls.

Table 17: Summary of Select Ordinance Status for Cities

Community	Ordinance Type		
	Floodplain	Stormwater	Pet Waste
Britt	No	Yes	Yes
Clarion	Yes	Yes	Yes
Corwith	Yes	Yes	No
Eagle Grove	Yes	Yes	Yes
Goldfield*	-	Yes	Yes
Kanawha	Yes	Yes	No
Lu Verne*	-	-	Yes
Renwick*	-	-	-
Thor*	-	-	No
Webster City	Yes	Yes	Yes
Wesley	Yes	Yes	Yes
Woolstock*	No	-	-

** Denotes a community did not respond to or follow-up with contact efforts by JEO.*

Floodplain ordinances can limit or prohibit development in flood-prone areas to help reduce the number of homes and businesses at risk of flooding. In fact, limiting development of floodplains is one of the most effective ways to lower a community's flood risk and reduce future damages. If local rules and regulations limit or prohibit development in flood-prone areas, there will be fewer buildings at risk of damage when floodwaters rise. It is recommended that all communities adopt a floodplain management ordinance that meets or exceeds the minimum National Flood Insurance Program (NFIP) requirements.

The NFIP is a federal program managed by FEMA that offers flood insurance to households and businesses throughout the United States. The NFIP is a voluntary program in which participating communities adopt and enforce minimum floodplain management regulations that limit development in the FEMA-defined 1% annual chance floodplain. In exchange, the federal government makes flood insurance available to all residents in that community. Additional discussion on this and other flood mitigation recommendations can be found in the *Flood Resiliency Current Conditions Report* in Appendix A.

Stormwater occurs when precipitation falls to the ground and runs off the surface. In cities stormwater often makes its way to a stormwater system, typically consisting of pipes, ditches, culverts, outfalls, etc. before it is eventually discharged to streams. Stormwater does not pass through a wastewater treatment plant before being discharged to a stream. Stormwater discharge from communities has been recognized as contributing to water quality degradation, flooding, and stream erosion. Many cities in Iowa are required to have a permit for their Municipal Separate Storm Sewer Systems (MS4s) through the National Pollutant Discharge Elimination System (NPDES) administered by the IDNR. MS4 permits require cities who meet a specific population threshold to manage their stormwater. While no cities in the BRW meet this criterion, it is still recommended that they pass ordinances and develop projects which address stormwater management. Additional discussion on this and other stormwater related information can be found in the *Stormwater Current Conditions Report* in Appendix A.

Pet waste management ordinances address a pet owner's responsibility to clean up any solid waste left behind by their animal on public property, or the private property of another landowner. Pet waste can contribute bacteria, nutrients, and other contaminants to surface water during precipitation events. It is recommended that all communities adopt and enforce ordinances along with educational campaigns for pet waste clean-up.

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CHAPTER 3. CURRENT CONDITIONS

3.01 STREAM MONITORING NETWORK

The stream monitoring network in the Boone River Watershed is composed of multiple stream gages, sensors, and sampling sites. Multiple entities are responsible for maintaining sites, collecting data, and distributing this information to landowners, land managers, and the general public.

For the purposes of this plan, monitoring data has been summarized from select sites to better understand overall watershed and stream conditions, especially as they relate to sediment, nutrient, and *E. coli* water quality pollutants. Lake data has not been included in this scope. Some limited work has been conducted to analyze conditions for selected priority subwatersheds that are targeted for implementation efforts. It should be noted that the information presented here is not all inclusive and there may be other data sources and studies available which are not summarized here. The BRW has a rich level of water quality data and future efforts should be undertaken to further understand the spatial and temporal patterns across the watershed

The main data sources of the monitoring network used for this plan consists of the following data sources. Maps of these monitoring locations can be found in Figure 34 and Figure 35.

IOWA DNR AMBIENT STREAM MONITORING

- IDNR maintains a network of “fixed” stations to monitor ambient water quality data across Iowa. Currently, 60 stream sites are sampled year-round on a monthly basis. These sites have been monitored monthly since 1999.
- There is one (1) active monitoring site located on the Boone River: “Boone River near Stratford”, which has a period of record of 1999 - present. The monitoring station ID is 10400001. Data at this site can be accessed at the following link: https://programs.iowadnr.gov/aquia/Sites/10400001

AGRICULTURE’S CLEAN WATER ALLIANCE (ACWA) / IOWA SOYBEAN ASSOCIATION (ISA)

- A partnership of 13 agricultural retailers known as Agriculture's Clean Water Alliance (ACWA) has monitored water quality in the Raccoon River and Des Moines River watersheds since 1999.
- The ISA collects and analyzes water samples across this network.
- There are 30 active sites, located at or near HUC 12 outlets, which are monitored seasonally (April – August), with a period of record from 2007 – present.
- Additional information can be found here: https://www.acwa-rrws.org/water-monitoring/

US GEOLOGICAL SURVEY (USGS)

- The U.S. Geological Survey (USGS) manages 11 continuous water monitoring sensors in Iowa. These are primarily utilized for flow and discharge measurements, with some sites having water quality data.
- There are two (2) active monitoring sites located within the BRW:
  - Boone River near Webster City (period of record: 1940 – present)
    - Nitrate data was collected from 2012 – 2017, until a loss of funding
  - Boone River near Goldfield (period of record: 2009 – present)
    - No water quality data available at this site
- Additional information can be found here: https://waterdata.usgs.gov/ia/nwis/rt

UNIVERSITY OF IOWA IIHR – HYDROSCIENCE & ENGINEERING (IOWA FLOOD CENTER (IFC))

- The IFC manages a continuous water monitoring network of 60 high frequency, in-stream real-time monitoring sensors. Data from these sites can be found on the Iowa Water Quality Information System (IWQIS): https://iwqis.iowawis.org/
- IWQIS allows access to real-time water-quality data and information such as nitrate, pH, and dissolved oxygen concentrations, discharge rates, and temperature.
- There are 5 (five) monitoring sites located within the BRW
  - 2 are paired with USGS gages on the mainstem of the Boone River
    - Webster City (period of record: 2018-2020)
    - Goldfield (period of record: 2016 – 2020)
  - 3 are monitoring oxbows, 1 of which has been discontinued

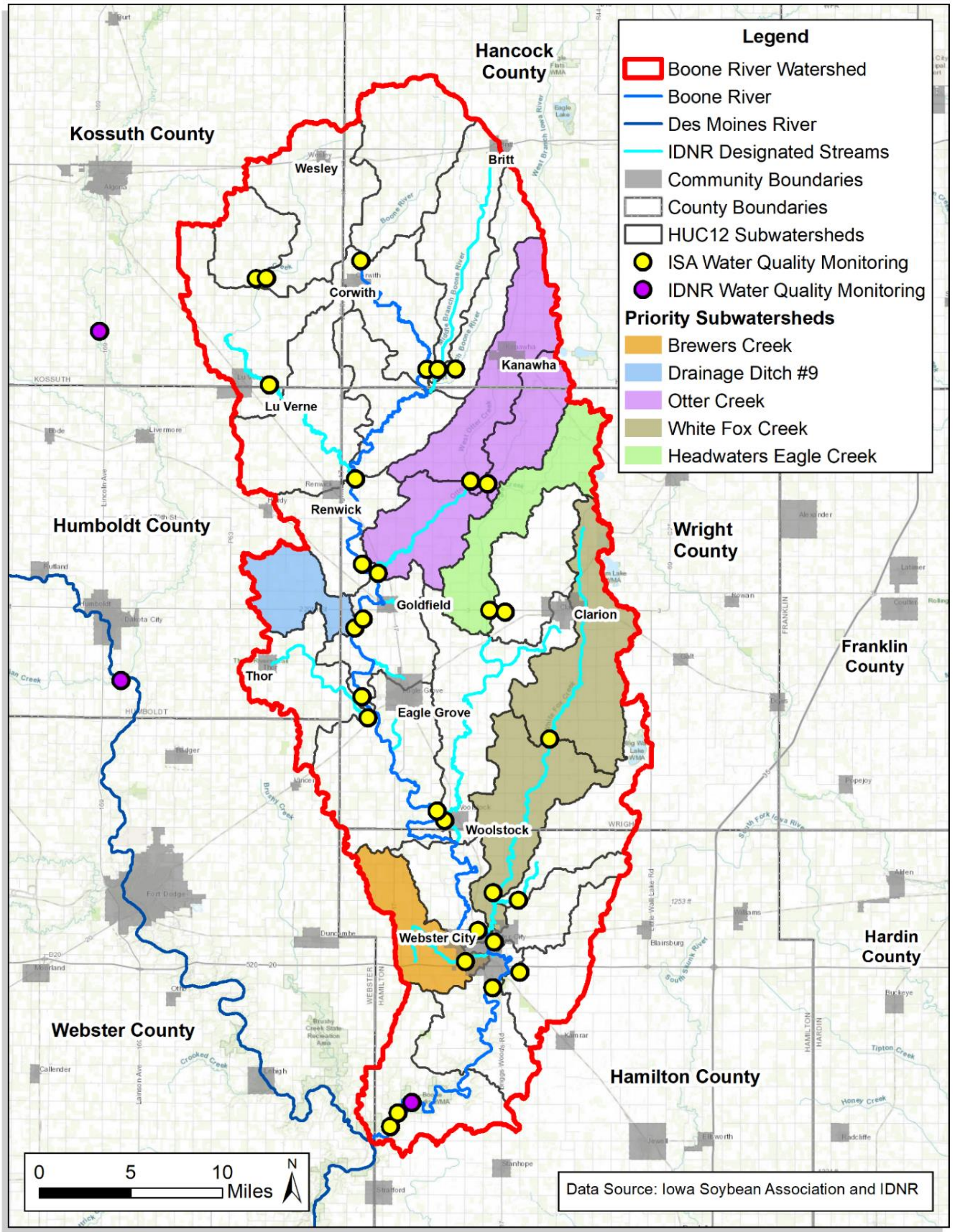

Figure 34: Water Quality Monitoring Sites in the BRW

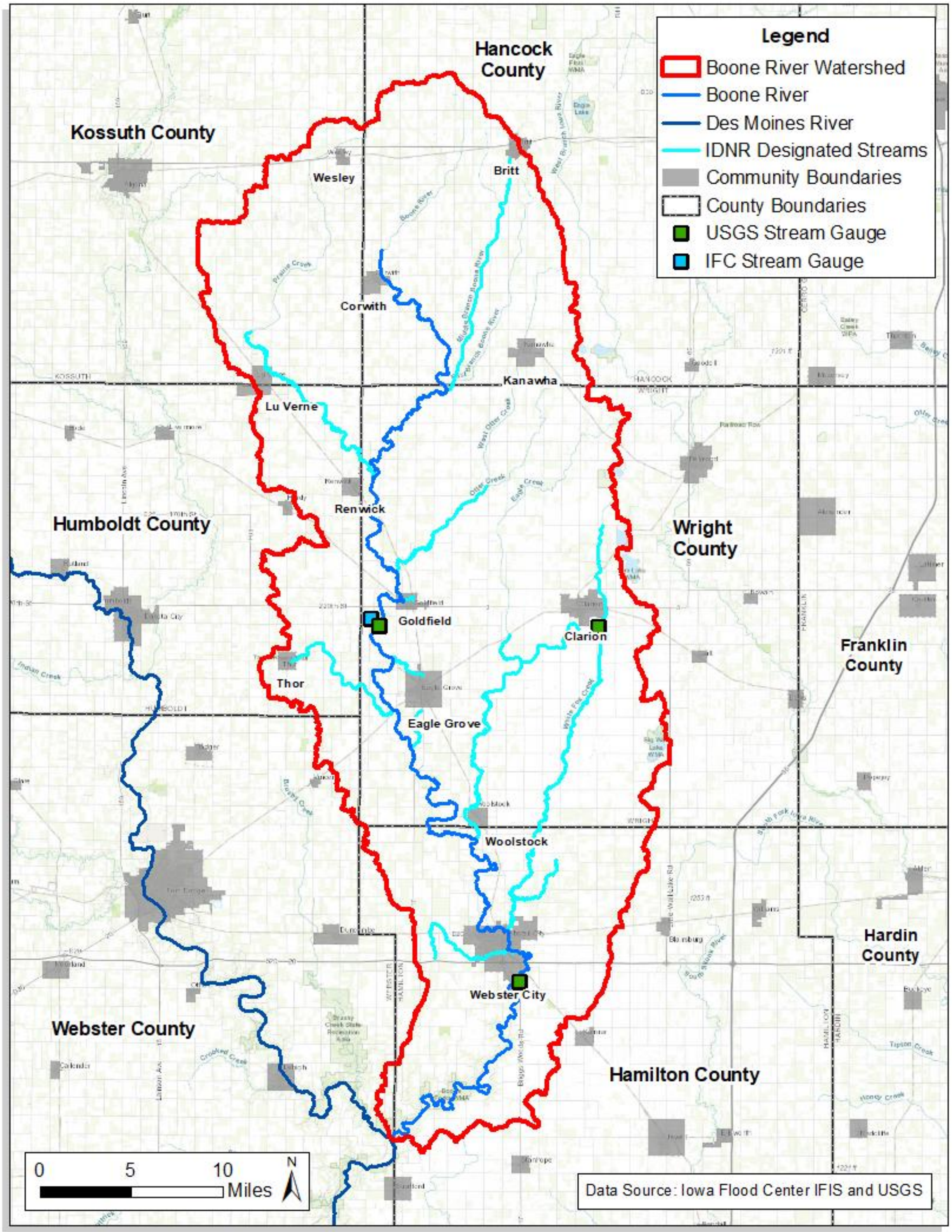

Figure 35: Streamgage sites in the BRW

3.02 WATER QUALITY ASSESSMENT

IMPAIRED WATERBODIES

9

Lakes and streams in the State of Iowa are assigned a designated use, which defines how a particular water body is or could be used. Water quality standards are then applied to each waterbody based on the assigned designated uses. Table 18 shows the designated lakes and streams in the BRW. Note that different designated uses can be applied to each stream segment but have been combined within the table for readability. On even numbered years the Iowa Department of Natural Resources (IDNR) prepares *Impaired Waters List and Integrated Report* (IR), which also includes the 303(d) list. The 303(d) listing is composed of those lakes, wetlands, streams, rivers, and portions of rivers that do not meet all state water quality standards, which are considered "impaired waterbodies". The most recently prepared IR (2020) was reviewed to identify the status of water quality conditions for each lake and stream segment in the BRW (IDNR, 2020f). Figure 36 summarizes the impaired lakes and streams in the BRW. Note that a single waterbody can be impaired for multiple reasons, and in the case of streams, at multiple locations or stream segments. Of the impaired waterbodies identified in Figure 36, only Lake Cornelia and Briggs Woods Lake have TMDLs.

Additional information on the 2020 IR can be found here:
https://programs.iowadnr.gov/adbnet/Assessments/Summary/2020

Table 18: Designated Waterbodies and their Uses in the BRW

Name	Designated Uses
Boone River	Primary and Secondary Contact Recreation
Middle Branch Boone River	Primary and Secondary Contact Recreation
Brewers Creek	Primary and Secondary Contact Recreation, and Children’s Contact Recreation
Buck Creek	Primary and Secondary Contact Recreation, and Children’s Contact Recreation
Buttermilk Creek	Children’s Contact Recreation
Eagle Creek	Primary and Secondary Contact Recreation
Otter Creek	Primary and Secondary Contact Recreation, and Children’s Contact Recreation
Prairie Creek	Primary and Secondary Contact Recreation, and Children’s Contact Recreation
White Fox Creek	Primary and Secondary Contact Recreation
Drainage Ditch 2	Secondary Contact Recreation
Drainage Ditch 3	Secondary Contact Recreation
Drainage Ditch 4	Secondary Contact Recreation
Drainage Ditch 34	Secondary Contact Recreation
Drainage Ditch 105	Secondary Contact Recreation

Source: IDNR, 2015

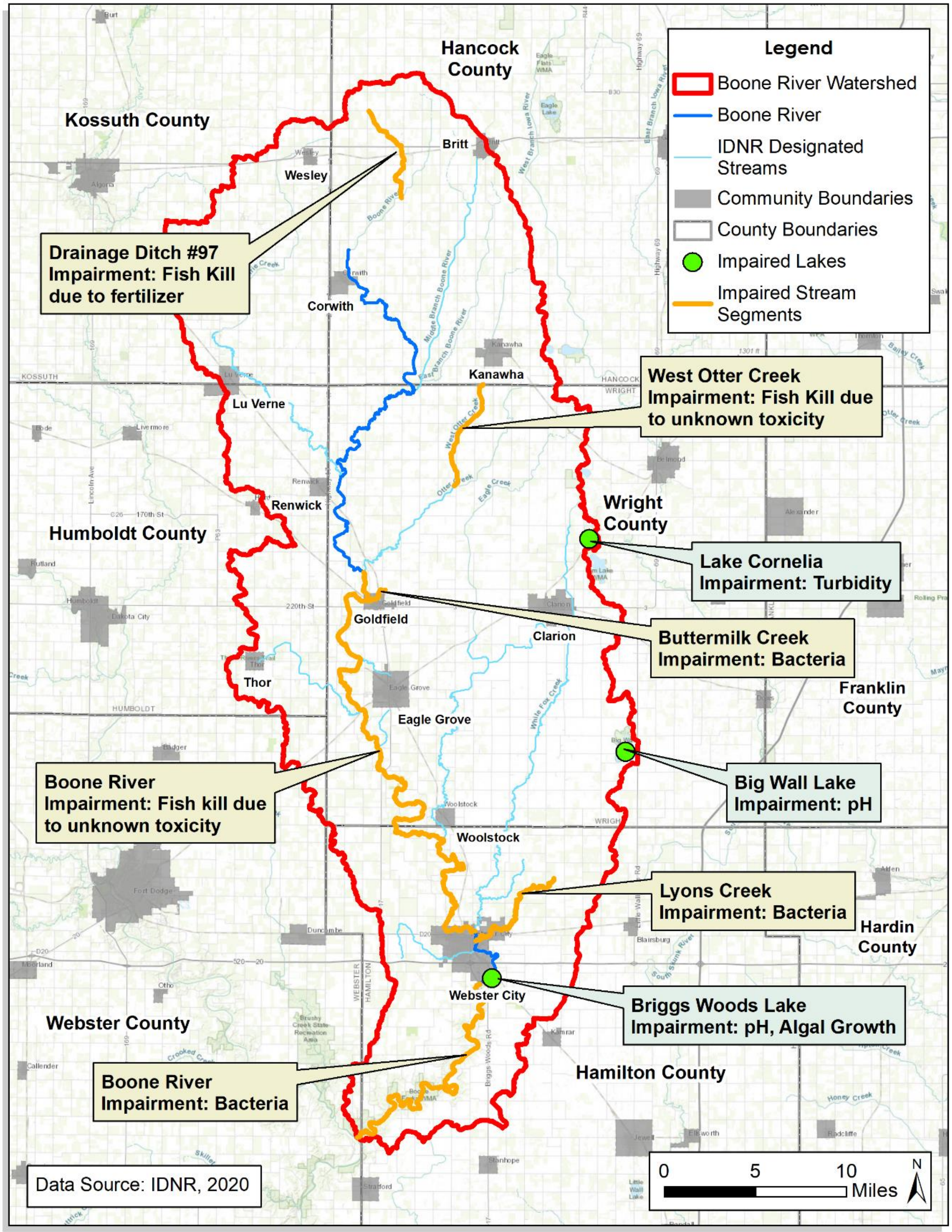

Figure 36: Impaired Waterbodies in the Boone River Watershed

STREAM BIOLOGICAL MONITORING

The BRW's streams and rivers contain a rich diversity of aquatic life including aquatic insects, fish, amphibians, and mammals. Since aquatic communities are in constant contact with the water, the health of these communities can provide insight on stressors that may not otherwise present themselves through traditional chemical and physical parameter monitoring. The IDNR River and Stream Biological Monitoring Program uses fish and benthic macroinvertebrate communities to assess the biological conditions of Iowa streams.

IDNR has evaluated biological conditions at 25 locations on 9 streams in the BRW, 20 of which are impaired (Table 19). A variety of metrics are used to determine impairments in streams. The Fish Index of Biotic Integrity (FIBI) is the primary tool used by IDNR to assess fish health conditions (Wilton, 2015). The FIBI considers 12 metrics to measure fish species richness. The Benthic Macroinvertebrate Index of Biotic Integrity (BMIBI) is a combination of 12 metrics measuring the richness of invertebrate communities. The General Fish Habitat Index (GFHI) includes five habitat metrics that measure the quality of fish habitat. Rapid Habitat Assessments (RHA) give an overview of the habitat conditions based on ten easily observed physical stream traits.

Table 19: Biological Monitoring Sites in the BRW

Segment ID	Location Name	FIBI	BMIBI	GFHI	RHA	Impairment
04-UDM-6367	E. Branch Boone River Kanawha (FKF)	N/A	N/A	N/A	N/A	Indicator Bacteria- *E. coli*, Fish Kill by Unknown Toxicity
04-UDM-1257	Boone River Renwick (REMAP #91)	Fair	N/A	Fair	N/A	Indicator Bacteria- *E. coli*, Fish Kill by Unknown Toxicity
04-UDM-1256	Boone River Eagle Grove (BN001)	Good	N/A	N/A	N/A	Indicator Bacteria- *E. coli*, Fish Kill by Unknown Toxicity
04-UDM-1256	Boone River Nokomis Park- Webster City	N/A	N/A	N/A	Sub-Optimal	Indicator Bacteria- *E. coli*, Fish Kill by Unknown Toxicity
04-UDM-1252	Boone River Webster City (REMAP #10)	Good	Good	N/A	Sub-Optimal	Indicator Bacteria- *E. coli*, Fish Kill by Unknown Toxicity
04-UDM-1252	Boone River Webster City (REMAP #10)	Good	Good	N/A	Sub-Optimal	Indicator Bacteria- *E. coli*,

Segment ID	Location Name	FIBI	BMIBI	GFHI	RHA	Impairment
						Fish Kill by Unknown Toxicity
04-UDM-1252	Boone River Bells Mill Park-Stratford	Fair	Good	Good	Sub-Optimal	Indicator Bacteria- *E. coli*, Fish Kill by Unknown Toxicity
04-UDM-1252	Boone River Stratford	N/A	Fair	N/A	Optimal	Indicator Bacteria- *E. coli*, Fish Kill by Unknown Toxicity
04-UDM-1270	West Otter Creek Renwick (FKF)	N/A	N/A	N/A	N/A	Fish Kill by Unknown Toxicity
04-UDM-1269	Otter Creek Goldfield (REMAP #132)	Fair	Poor	N/A	Marginal	Indicator Bacteria- *E. coli*, Thermal Modifications, Fish Kill by Animal Waste & Spill
04-UDM-1269	Otter Creek Holmes	Fair	Good	Fair	N/A	Indicator Bacteria- *E. coli*, Thermal Modifications, Fish Kill by Animal Waste & Spill
04-UDM-1269	Otter Creek Otter Creek WA Goldfield	Fair	Excellent	Good	N/A	Indicator Bacteria- *E. coli*, Thermal Modifications, Fish Kill by Animal Waste & Spill
04-UDM-1826	Buttermilk Creek Goldfield (BMC2)	Fair	Poor	N/A	N/A	Indicator Bacteria- *E. coli*
04-UDM-1826	Buttermilk Creek Goldfield (BMC3)	Fair	Fair	N/A	N/A	Indicator Bacteria- *E. coli*
04-UDM-1826	Buttermilk Creek	Good	Poor	N/A	N/A	Indicator Bacteria- *E. coli*

Segment ID	Location Name	FIBI	BMIBI	GFHI	RHA	Impairment
	Goldfield (BMC1)					
04-UDM-1839	Drainage Ditch 49 Eagle Grove (REMAP #38)	Good	Fair	N/A	N/A	N/A
04-UDM-2033	Drainage Ditch 13 Woolstock (DD13)	N/A	N/A	N/A	N/A	Indicator Bacteria- *E. coli*
04-UDM-1266	Eagle Creek 2 miles N of Woolstock (EG001)	Fair	N/A	N/A	N/A	N/A
04-UDM-1261	White Fox Creek Webster City	Good	Good	Good	Sub-Optimal	N/A
04-UDM-1261	White Fox Creek Webster City (RBP)	N/A	N/A	N/A	Sub-Optimal	N/A
04-UDM-1260	Lyons Creek Webster City (LC3)	N/A	N/A	N/A	Marginal	Indicator Bacteria- *E. coli*
04-UDM-1260	Lyons Creek Webster City (LC2)	Fair	Good	N/A	Marginal	Indicator Bacteria- *E. coli*
04-UDM-1260	Lyons Creek Sketchley Park	N/A	N/A	N/A	Sub-Optimal	Indicator Bacteria- *E. coli*
04-UDM-1260	Lyons Creek Webster City (LC1)	Excellent	Fair	N/A	Marginal	Indicator Bacteria- *E. coli*
04-UDM-1259	Brewers Creek Webster City	N/A	N/A	N/A	Sub-Optimal	N/A

Source: IDNR River & Stream Biological Monitoring data via BioNet, 2020

POLLUTANT TYPES

Sources of pollution can be separated into two primary categories: point sources and nonpoint sources. A point source is any discernible, confined, or discrete conveyance from which pollutants can be discharged. Point source pollution can be easily tracked along the pollutant's travel path and identified at the source. Examples include any pipe, ditch, tunnel, conduit, or well that might discharge pollutants. The discharge from some point sources is regulated by the National Pollutant Discharge Elimination System (NPDES) permit program. Many industrial, municipal facilities, and some agricultural operations are required to obtain NPDES permit coverage. However, individual homes connected to a municipal or septic system typically do not need coverage under a NPDES permit.

Identifying permitted facilities is important in developing a water quality management plan. While it is assumed these facilities are meeting all their permit requirements, their pollutant load contributions do need to be accounted for. This allows nonpoint pollution loads to be clearly identified and separated from the total pollutant load. Nonpoint sources of pollution come from facilities, activities, or land uses that do not meet regulatory requirements to be considered point sources. Because these sources are not regulated, are typically smaller, or are otherwise not well defined, they are thus treated as nonpoint sources for management purposes. This is conceptually illustrated below in Figure 37.

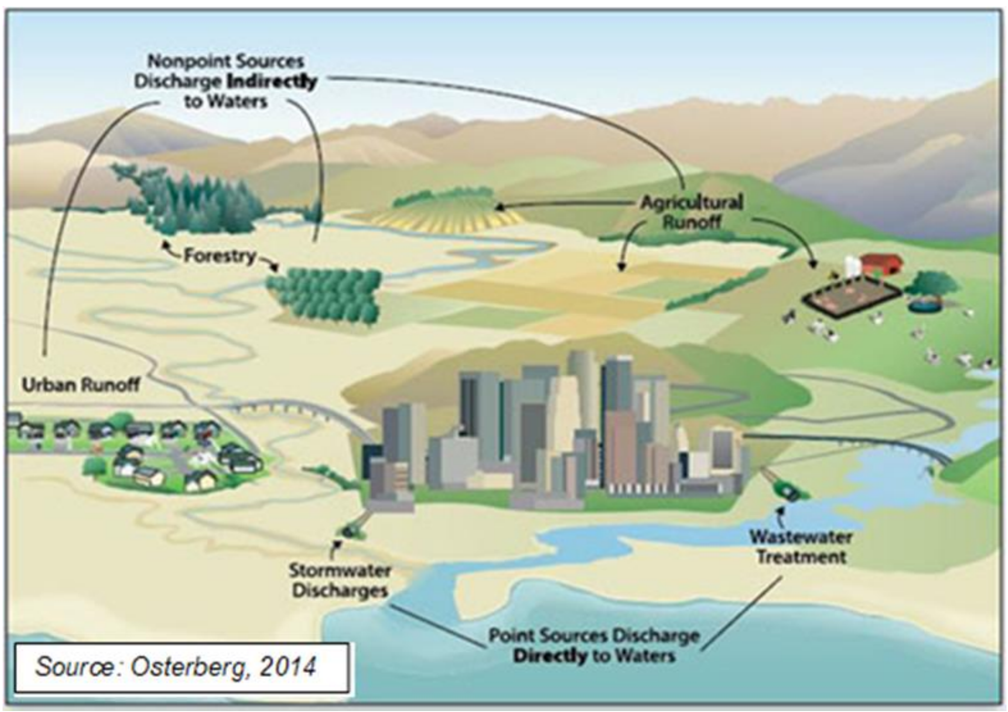

Figure 37: Examples of Point and Nonpoint Sources of Water Pollution

POLLUTANTS OF CONCERN

The pollutants addressed in this plan are bacteria (*E. coli*), nutrients (phosphorus and nitrogen), and sediment. **Ultimately, this plan addresses the link between high nitrate loads from the Boone River contributing to the impaired Des Moines River.** A summary of pollutants, their sources, and their impacts is shown in *Table 20*.

Table 20: General Summary of Pollutants and Sources

Pollutant and Sources		Potential Impacts on Waterbodies
Point Sources	Nonpoint Sources	
	Bacteria (*E. coli*)	
• **WWTFs** • **Registered AFOs or CAFOs**	• Small open feedlots & grazing livestock • Land application of manure • Underperforming septic systems • Wildlife and pets • Land application of wastewater/ sludge	• Human health risks • Recreation impairments
	Nutrients (phosphorus and nitrogen)	
• **WWTFs** • **Registered AFOs or CAFOs**	• Sheet, rill, and gully erosion from crop lands • Tile line drainage • Fertilizer application • Land application of manure or wastewater • Small open feedlots & grazing livestock • Stream erosion • Underperforming septic systems • Wildlife and pets	• Aquatic life impairments • Human health risks • Drinking water supply impacts • Recreational impacts
	Sediment	
• **Stormwater Systems** • **Construction Sites**	• Sheet, rill, and gully erosion from crop lands • Stream erosion • Erosion from construction, and gravel roads • Erosion from timber harvesting or tree clearing • Stream erosion	• Aquatic habitat • Reduces reservoir capacity • Recreational impacts • Human health risks – fish consumption

Note - WWTF – Wastewater Treatment Facility
AFO – Animal Feeding Operation
CAFO – Confined Animal Feeding Operation

POLLUTANTS NOT ADDRESSED

Point source facilities, including wastewater treatment facilities and permitted open feedlots, are not identified for management actions in this plan. For the purpose of this plan, it is assumed point sources are meeting their regulatory requirements and are not contributing beyond the pollutant limits set by NPDES permits. Permitted open feedlots are designed to contain any runoff generated by a storm event weaker in intensity than a 25-year storm event. Therefore, management recommendations were eliminated from consideration for these point sources. Should a water quality model be developed in the future, it is recommended that these regulated point sources are accounted for in the model.

Pollutants that originate from naturally occurring sources are not addressed in this plan. Typically, these types of water quality parameters serve as symptoms of impairments, rather than the cause of an impairment. Thus, any pollutant impairments caused by naturally occurring sources are expected to show improvements through implementation of this plan.

Fish tissue contamination was not addressed in this plan due to the global nature of the sources. Mercury is a naturally occurring substance which can enter the environment from human activities such as: atmospheric deposition from air emissions, and the improper disposal of products containing mercury. When mercury from human activities enters rivers and lakes, it can transform into methyl-mercury and can accumulate in fish tissue. Consumption of fish containing mercury is considered a primary path for human exposure. Since the majority of mercury contamination in water bodies is caused by air emissions, which are not contained by watershed boundaries, it is not a pollutant that can be addressed through recommendations in this plan.

POLLUTANT SOURCE LOCATIONS

9

Using available data, a map of the pollutant sources identified in Table 20 has been developed (Figure 38). The map illustrates the diffuse and widespread nature of both point and nonpoint pollutant sources across the watershed. Cropland, which is a key contributor to sediment and nutrients, dominates the watershed. Pollutant loads from wildlife are also diffuse as they are found across all land uses throughout the watershed. Permitted sources of pollution (OWTS, AFOs, CAFOs, and WWTFs) are also uniformly distributed across the watershed. A breakdown of land use, estimated livestock numbers, and drainage districts are available in Chapter 2.

Onsite wastewater treatment systems (OWTS) are used to treat wastewater from a home or business and return treated wastewater back into the receiving environment. They are typically referred to as septic systems because most involve a septic tank for partial treatment. OWTS permitting in Iowa is regulated at a county level, and therefore no mapped data was found to be available. The number of OWTS was therefore estimated using the Spreadsheet Tool for Estimating Pollutant Loads (STEP-L) data server (Tetra Tech, 2013). This tool provided a count of 2,737 systems in the watershed.

Animal feeding operations (AFO) are facilities that confine livestock in a limited feeding space for an extended period of time. The IDNR recognizes two types of AFOs:

1. A **confinement feeding operation (CAFO)** confines animals to areas that are totally roofed. All confinements, including small animal feeding operations, are required to follow some level of state regulations regarding manure management and land application when building or operating a facility. Figure 38 shows there are 96 CAFOs in the BRW.
2. **Open feedlot AFOs** are facilities where livestock are kept in unroofed or partially roofed areas, where they are fed and maintained in pens for at least 45 days per year. Unlike animals on pasture, manure from the open lot is concentrated and the ground is bare of vegetation. Not all open feedlot AFOs are required to follow permitting standards.
    a. Open feedlot AFOs with 1,000 or more animal units (1,000 beef cattle or 700 mature dairy cattle or 2,500 finishing hogs) are generally required to apply for a NPDES permit to regulate discharge of livestock waste from these operations. Some intermediate size lots may also need an NPDES permit if a stream runs through the lot or there is a man-made conveyance for discharging to a stream. For the purposes of this plan, these permitted facilities are considered zero discharging. Figure 38, shows 110 permitted open feedlot AFOs in the BRW.
    b. Nonpermitted small open feedlots are a potential source of bacteria, nutrients, and sediment. These operations are too small to be regulated by IDNR and are not required to retain any of their waste. However, there is no available mapping data to locate these potential pollutant sources. It is recommended that these small open feedlots be identified during future watershed plan updates through visual review of aerial photography.

While regulated open feedlots and CAFOs are required to manage their manure and wastewater at the facility, they may still land apply manure and wastewater as fertilizer. Therefore, land application of animal waste as fertilizer should not be considered part of the “zero” discharge assumption placed on these facilities. Land applied manure and wastewater are a potential source of bacteria, nutrients, and sediment. However, no centralized database exists for where land applications take place, or for estimates of the amount. It is recommended that future watershed plan updates include the development of estimates for the location and level of pollutant loading caused by land application of manure, using available nutrient management plans, animal census data, and GIS analysis.

Potential sources of sediment, nutrient, and *E. coli* point sources include stormwater outfalls from municipalities and wastewater treatment effluent. As stated in Chapter 2, there are no MS4 municipalities in the watershed, thus stormwater outfall location data is unavailable. Wastewater treatment facilities which discharge to surface waters are required to have an NPDES permit, therefore, IDNR maintains a database of these records. Figure 38, shows 43 WWTFs located within the BRW. However, not all of these are municipal WWTF, as some industrial facilities are also included in this count. It is recommended that during future updates to this plan pollutant loads be estimated for each WWTF facility based on a review of their permitted discharge permit. This information will be useful for water quality modeling efforts.

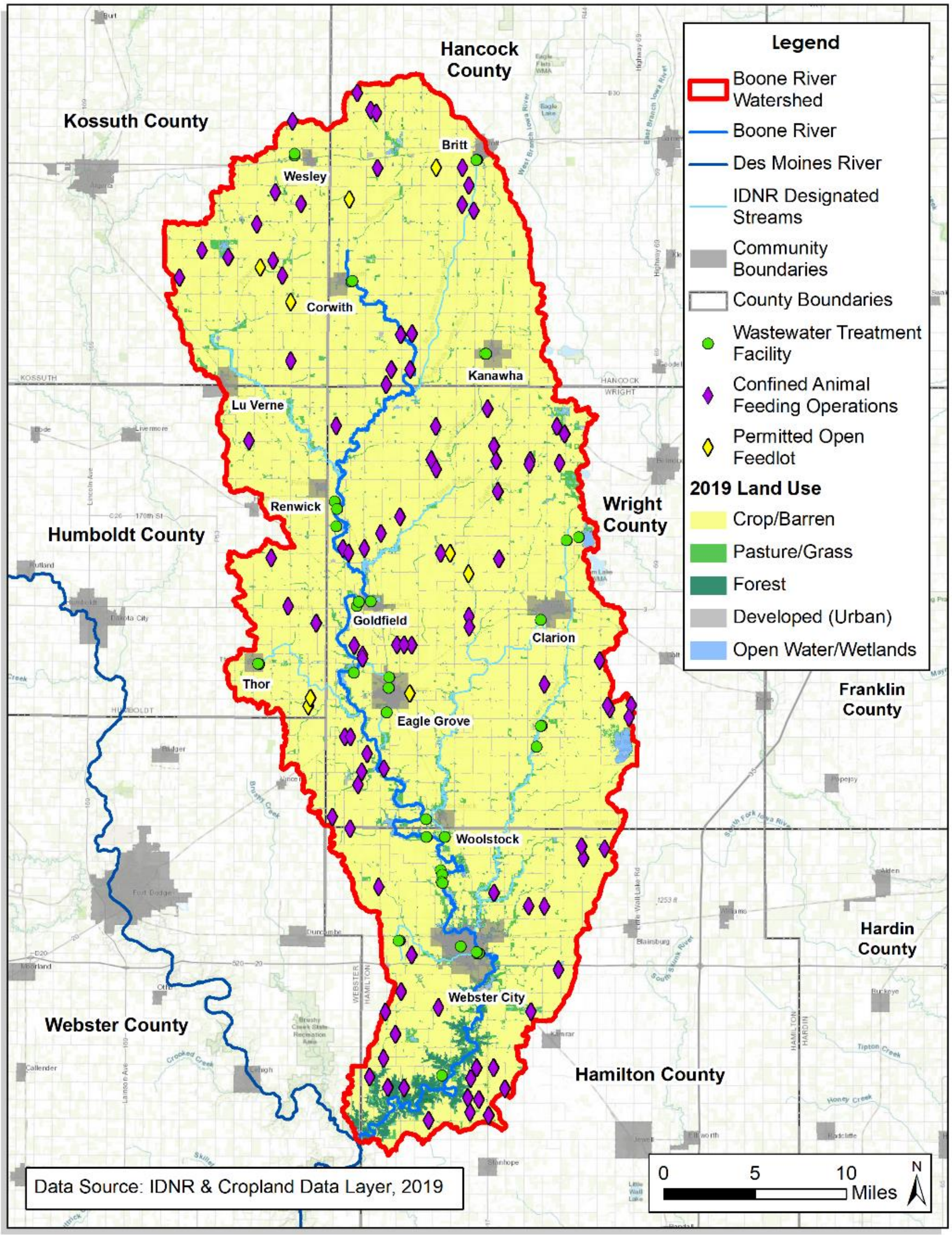

Figure 38: Map of Pollutant Sources

3.03 EXISTING WATER QUALITY

WATER QUALITY MODELING

A water quality model was unavailable for use during the development of this plan. Water quality analysis and trends were based on an evaluation of literature, 2020 Integrated Report assessment results, and water quality data provided by project partners.

It is recommended that future planning or evaluation steps include the development of a water quality model. One option may be the expansion of the Soil and Water Assessment Tool (SWAT) model developed as part of the 2009 Des Moines River TMDL for nitrate, which is already partially calibrated to the BRW. SWAT has the capability to model sediment, nutrients, and *E. coli*. It is well suited to integrate the complicated hydrology of the watershed due to the high levels of tiling, as well as handle the large amount of water quality and stream gaging data available for the BRW.

A water quality model allows quantitative estimates about existing pollutant loads to be made, as well as quantifies the effects of implementing various Best Management Practices (BMPs) (Figure 39). It can function as a tool to evaluate management strategies, demonstrate incremental progress towards meeting water quality standards or goals, and evaluate future water quality data.

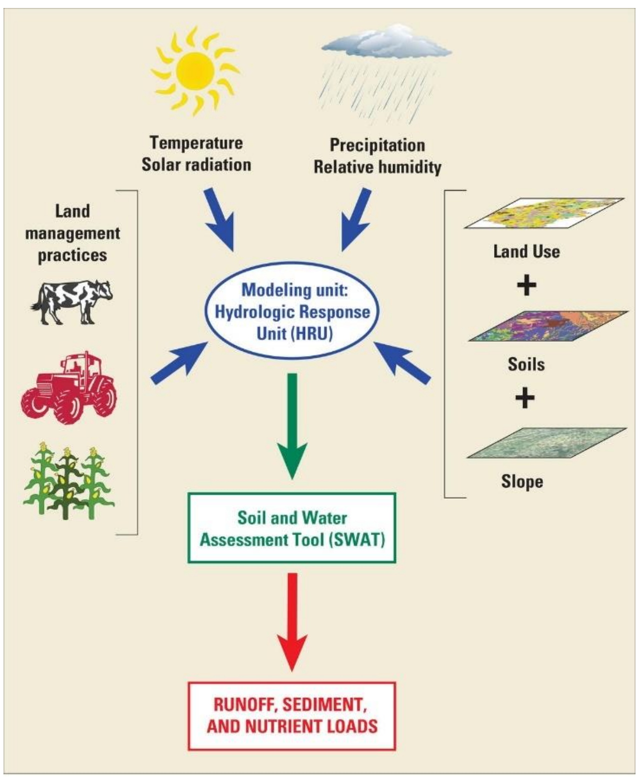

Figure 39: Illustration of the SWAT Modeling Process

BOONE RIVER WATERSHED STREAM NITRATE EVALUATION

The University of Iowa IIHR – Hydroscience & Engineering conducted an analysis of the ACWA water quality monitoring data, specifically as it relates to nitrates. The report (Jones, Schilling, and Gilles, 2018) summarizes the statistical analysis of the water quality data at each of the 30 sites that have been monitored from 2007-1017. Key findings included:

- Nitrate concentrations and yields do not diminish or become diluted from the headwaters to the mouth. Any in-stream processing of nitrogen is masked by tributaries near the bottom of the watershed that have high nitrate loads.
- The year 2012, which saw substantial drought, was used to divide the data into two periods (2007-2011 and 2013-2017) to see if any insight could be gained about how the drought may have affected pollutant loads:
    - Flow weighted average (FWA) concentrations of nitrate from sites not located on the mainstem were 65% higher after the drought.
    - Loading on the mainstem was 14% greater in the post-drought period.
- Of the 30 monitoring sites, FWA nitrate-nitrogen is increasing at each one for the period of record, and increases are significant at the $p<0.01$ level at 12 sites and $p<0.05$ at four sites
- Increasing amounts of cropped acres are likely not driving this trend, as most of the farmable land has been farmed for many years. It is likely that improvements in the widespread tile drainage system are driving these trends.

It is recommended that a similar statistical analysis of other water quality pollutants of interest (phosphorus, TSS, and *E. coli*) be completed. This analysis could be accomplished alongside the development of a water quality model.

WATERSHED LEVEL WATER QUALITY DATA

The BRW contains one ambient stream monitoring site, which is located on the Boone River near Stratford, IA. This site provides the best representation of overall water quality conditions for the watershed. Recent and historical water quality sampling data from the Stratford monitoring site is presented and discussed below. Additional water quality data for priority subwatersheds is discussed later in this chapter. Baseline data for the water quality goals (discussed in more detail in Chapter 4) are based on data from 2007-2013 baseline data. This baseline date matches those found in the recently completed subwatershed plans and is thus presented below.

Nitrogen

Nitrate-nitrogen sampling results are shown in Figure 40. The maximum contaminant level (MCL) drinking water standard for nitrate-nitrogen (10 mg/L) is also shown for reference. While the MCL is not directly applicable to the Boone River, it is an important benchmark to note, as it does apply downstream to the Des Moines River. In most years Boone River has been below the MCL except for during the summer months.

Statistics are provided below based on analysis of the water quality data and follow the metrics utilized in the water quality goals for nitrogen which are based on the median seasonal (April-August) concentrations of nitrate.

Baseline (2007-2013) Statistics:

- Number of samples: 35
- Seasonal median concentration: 9.3 mg/L
- Number of samples over 10 mg/L: 14

Statistics for the year 2020 (most recent year data was available for the plan):

- Number of samples: 12
- Annual median concentration: 5.35 mg/L
- Number of samples over the MCL: 0 samples

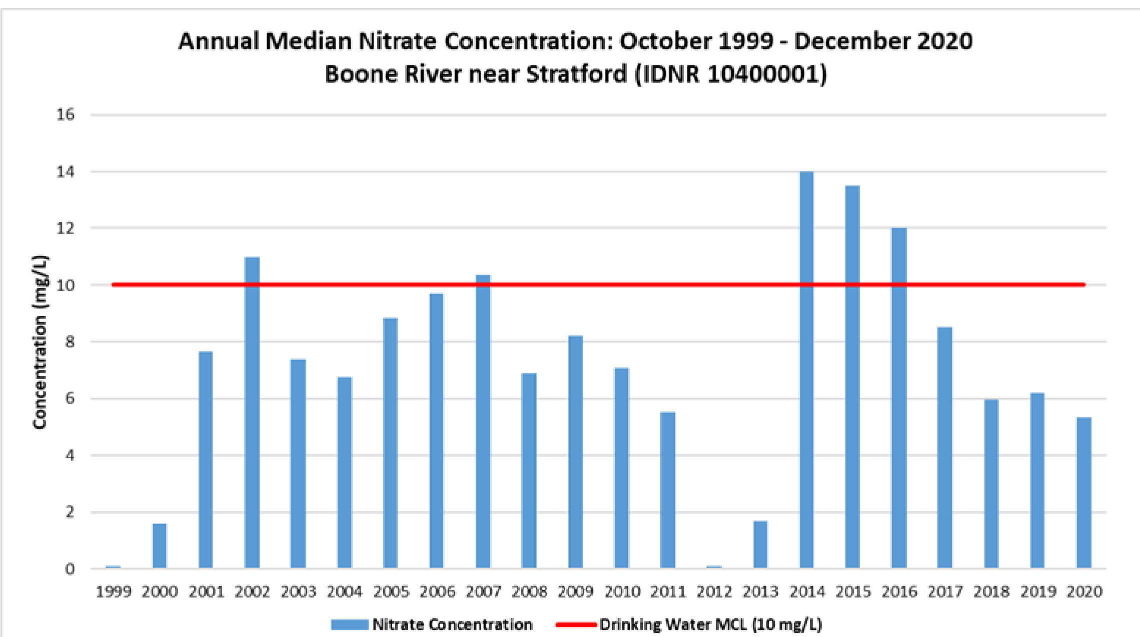

Figure 40: Annual Median Nitrate Concentrations in the Boone River

Phosphorus

Phosphate-phosphorus sampling results are shown in Figure 41. The water quality benchmark for phosphorus (0.7625 mg/L) is also shown for reference. While this guidance has no regulatory significance in Iowa, it does serve as a useful benchmark to understand water quality conditions of streams. Note that in the Iowa water quality database (AQuIA), phosphate-phosphorus is equivalent with total phosphorus (Balmer and others, 2016). The Boone River has been below the benchmark every year data was assessed.

Statistics are provided below based on analysis of the water quality data and follow the metrics utilized in the water quality goals for phosphorus which are based on the annual median concentrations of phosphorus.

Baseline (2007-2013) Statistics:

- Number of samples: 78
- Annual median concentration: 0.15 mg/L
- Number of samples over the benchmark: 1

Statistics for the year 2020 (most recent year data was available for the plan):

- Number of samples: 12
- Annual median concentration: 0.15 mg/L
- Number of samples over the benchmark: 0

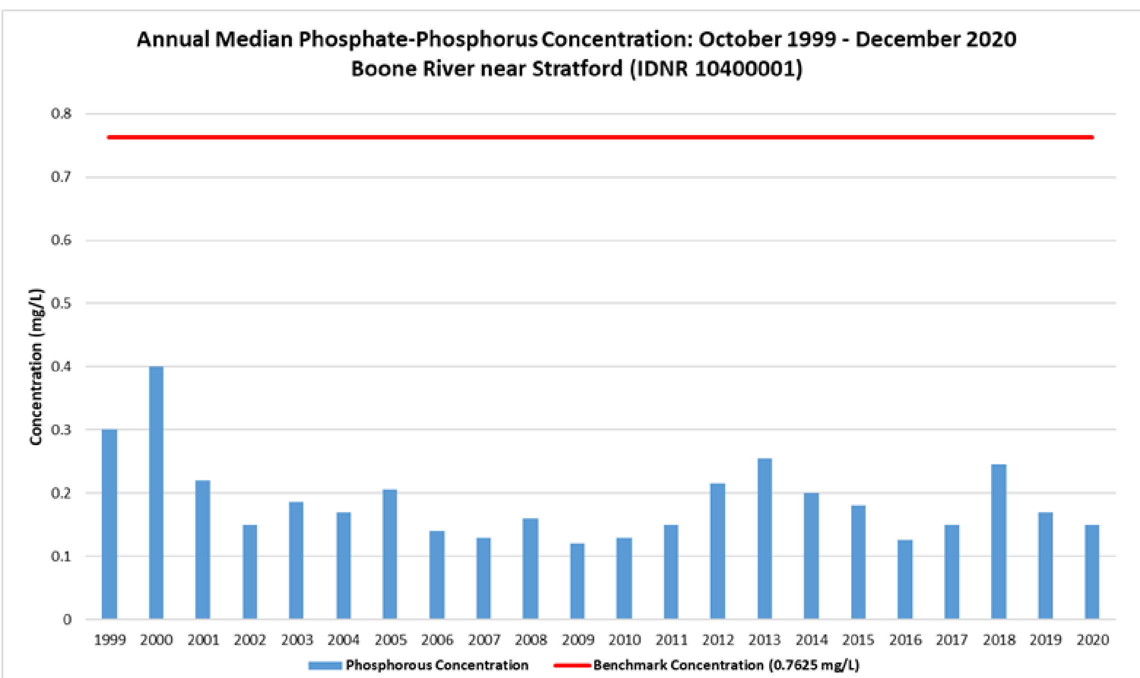

Figure 41: Annual Median Phosphate-Phosphorus Concentrations in the Boone River

Sediment

Total suspended solids (TSS) sampling results are shown in Figure 42. TSS is commonly used as a surrogate for sediment. The water quality benchmark for TSS (50 mg/L) is also shown for reference. While this guidance has no regulatory significance in Iowa, it does serve as a useful benchmark to understand water quality conditions of streams. The Boone River has been below the benchmark every year data was assessed.

Statistics are provided below based on analysis of the water quality data and follow the metrics utilized in the water quality goals. Note however that water quality goals for sediment are based on estimated levels of erosion; therefore, these statistics are for informational purposes only.

Baseline (2007-2013) Statistics:

- Number of samples: 78
- Annual median concentration: 14 mg/L
- Number of samples over the benchmark: 14

Statistics for the year 2020 (most recent year data was available for the plan):

- Number of samples: 12
- Annual median concentration: 27.92 mg/L
- Number of samples over the benchmark: 0

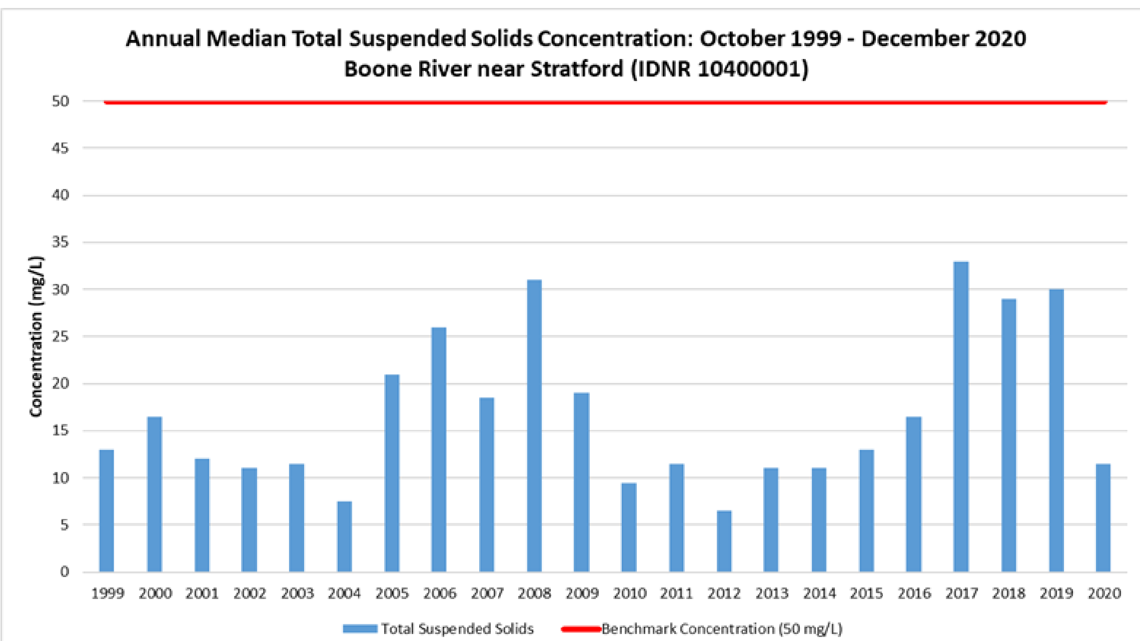

Figure 42: Annual Median Total Suspended Solids Concentrations in the Boone River

E. coli Bacteria

Statistics are provided below based on analysis of the water quality data and follow the metrics utilized in the water quality goals for bacteria which are based on the two sets of water quality standards that apply to *E. coli bacteria* in Iowa streams:

- **The chronic water quality standard** is based on a geometric mean of samples taken during the recreation season (between March 15th and November 15th) of each year. If this geometric mean exceeds the standard (126 bacteria per 100 milliliters of water) then the waterbody is considered impaired. Figure 43 shows three years that the Boone River has not met this standard; however, it has otherwise consistently been below the annual geometric mean water quality standard for *E. coli.*
- **The acute water quality standard** is based on individual samples exceeding a one-time maximum quality standard (235 colonies/100 mL). The Boone River has exceeded the individual sample maximum water quality standard (235 colonies/100 mL) 42 times during the period of record. Figure 44 displays this long-term trend of exceeding this standard.

Baseline (2007-2013) Statistics:

- Number of samples during the season: 55
- Seasonal geometric mean: 79.64 #/100mL
- Number of samples over the single sample maximum: 15
- Maximum value sampled: 9,500 #/100mL

Statistics for the year 2020 (most recent year data was available for the plan):

- Number of samples during the season: 8
- Seasonal geometric mean: 60.38 #/100mL
- Number of samples over the single sample maximum: 1
- Maximum value sampled: 2,000 #/100mL

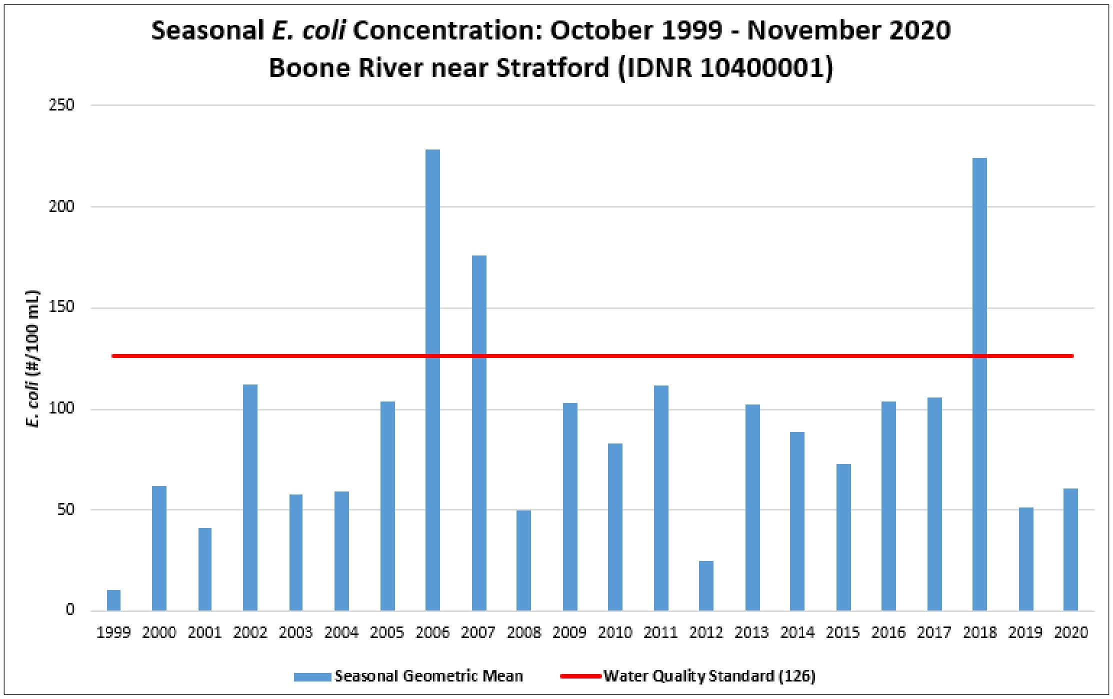

Figure 43: Seasonal E. coli Concentrations in the Boone River

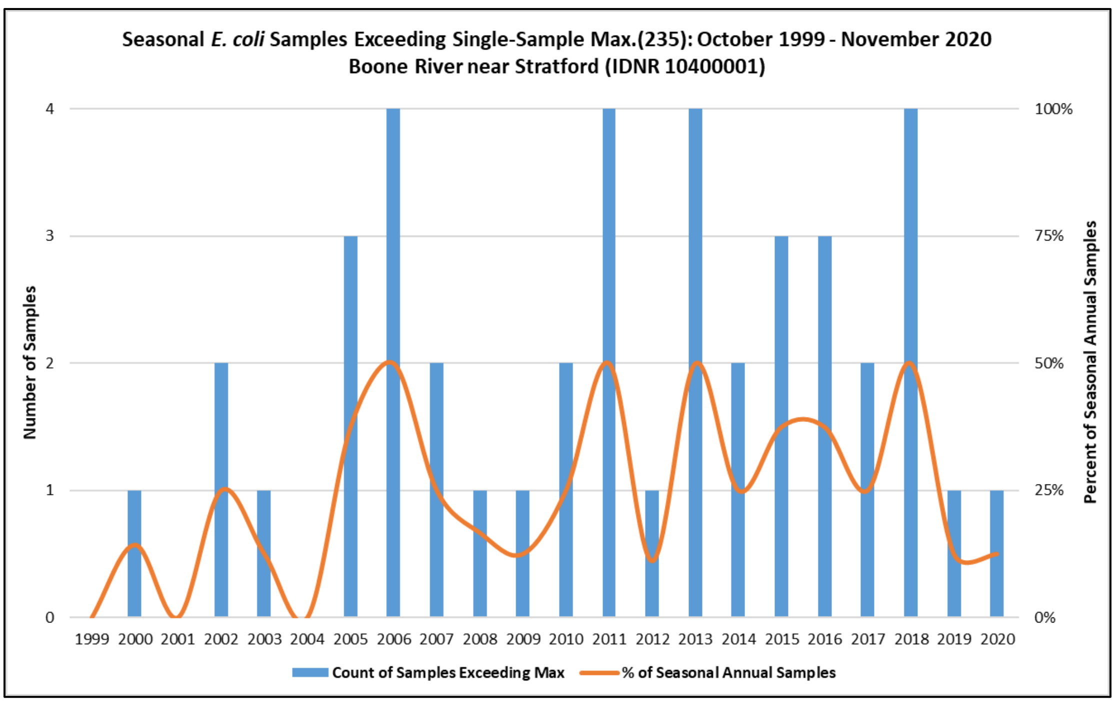

Figure 44: Seasonal E. coli Samples Exceeding Single-Sample Maximum Criteria

PRIORITY AREA WATER QUALITY DATA

Several areas, based on HUC 12 subwatershed boundaries within the BRW, were identified by WMA members and stakeholders as priority areas for BMP implementation efforts (Figure 34). Additional information regarding BMP implementation is presented in Chapter 5. To provide a better understanding of nitrate and phosphorus pollutant trends in those subwatersheds, additional analysis was completed using water quality data provided by the ACWA/ISA. The ISA monitors 30 sites, located at or near HUC 12 outlets, which are monitored seasonally (April - August), with a period of record from 2007 – present. Additional nutrient water quality data for all HUC 12s is found further in this chapter.

Brewers Creek Priority Area

Figure 45 shows recent annual water quality trends for this priority area, which contains one HUC 12 subwatershed, and is represented by the ISA/ACWA BR04 water quality sampling location. Nitrate concentrations during the monitoring season have exceeded or been near the MCL for 13 of 14 years. Phosphorus concentrations during the monitoring season have been much better, only approaching the monitoring benchmark 2 years, but never exceeding it.

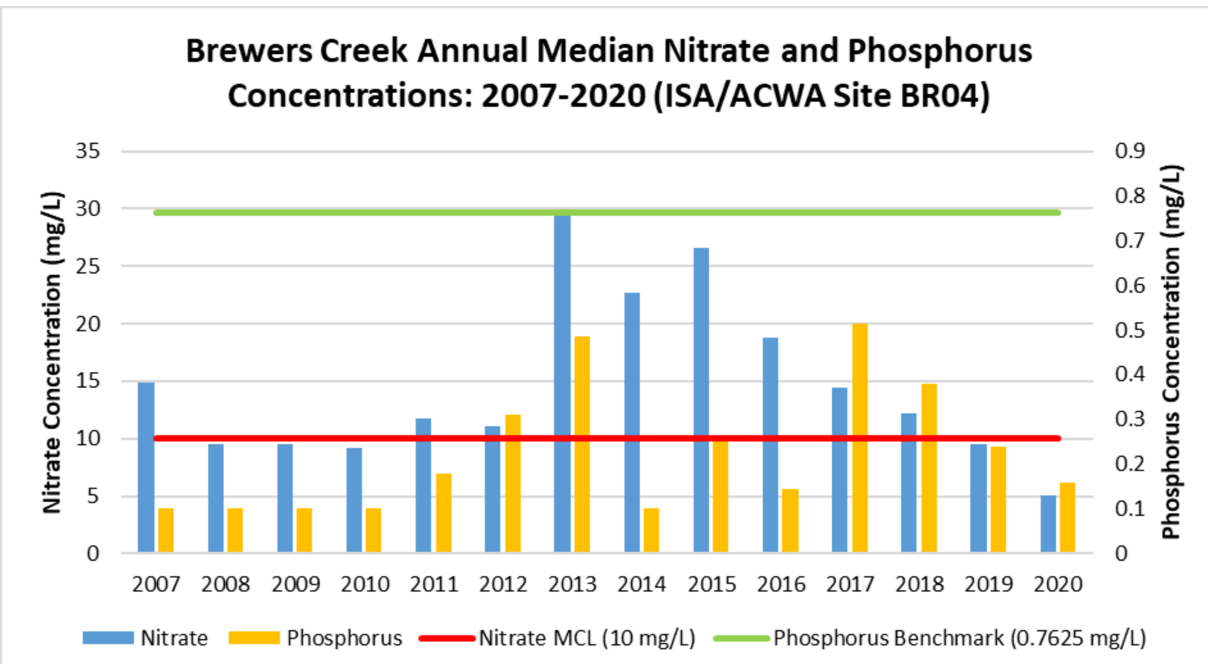

Figure 45: Nutrient Sampling Results for Brewers Creek Priority Area

Drainage Ditch #9 Priority Area

Figure 46 shows recent annual water quality trends for this priority area, which contains one HUC 12 subwatershed, and is represented by the ISA/ACWA BR15 water quality sampling location. Nitrate concentrations during the monitoring season have exceeded or been near the MCL 14 of 14 years. Phosphorus concentrations during the monitoring season have been consistently better, with no annual median concentrations approaching the monitoring benchmark.

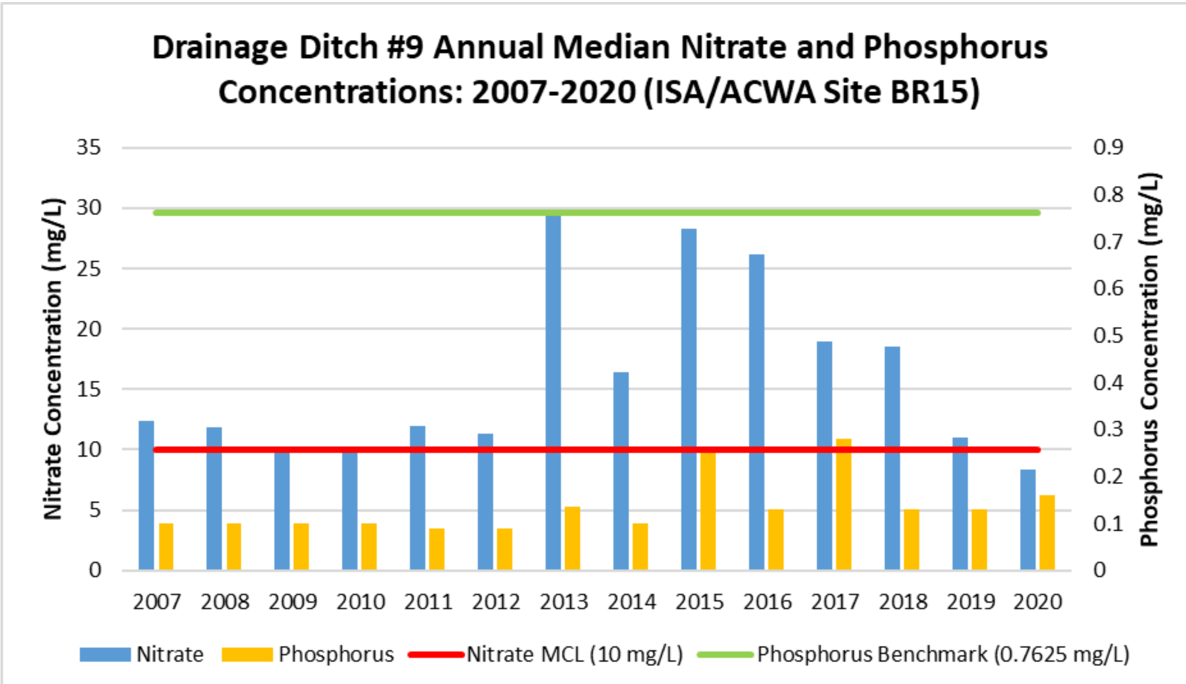

Figure 46: Nutrient Sampling Results for Drainage Ditch #9 Priority Area

Otter Creek Priority Area

Figure 47 shows recent annual water quality trends for this priority area, which contains three HUC 12 subwatersheds, and is represented by the ISA/ACWA BR19 water quality sampling location. Nitrate concentrations during the monitoring season have exceeded or been near the MCL 10 of 14 years. Phosphorus concentrations during the monitoring season have been much better, never exceeding the monitoring benchmark.

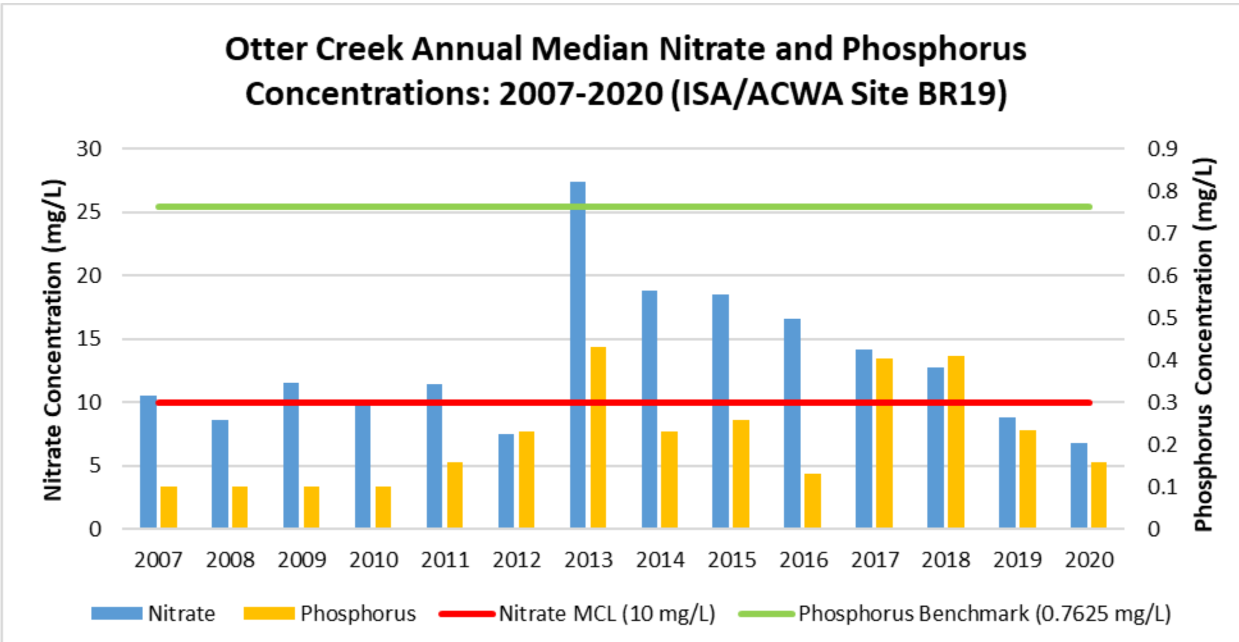

Figure 47: Nutrient Sampling Results for Otter Creek Priority Area

White Fox Creek Priority Area

Figure 48 shows recent annual water quality trends for this priority area, which contains two HUC 12 subwatersheds, and is represented by the ISA/ACWA BR08 water quality sampling location. Nitrate concentrations during the monitoring season have exceeded or been near the MCL 8 of 14 years. Phosphorus concentrations during the monitoring season have been much better, never exceeding the monitoring benchmark.

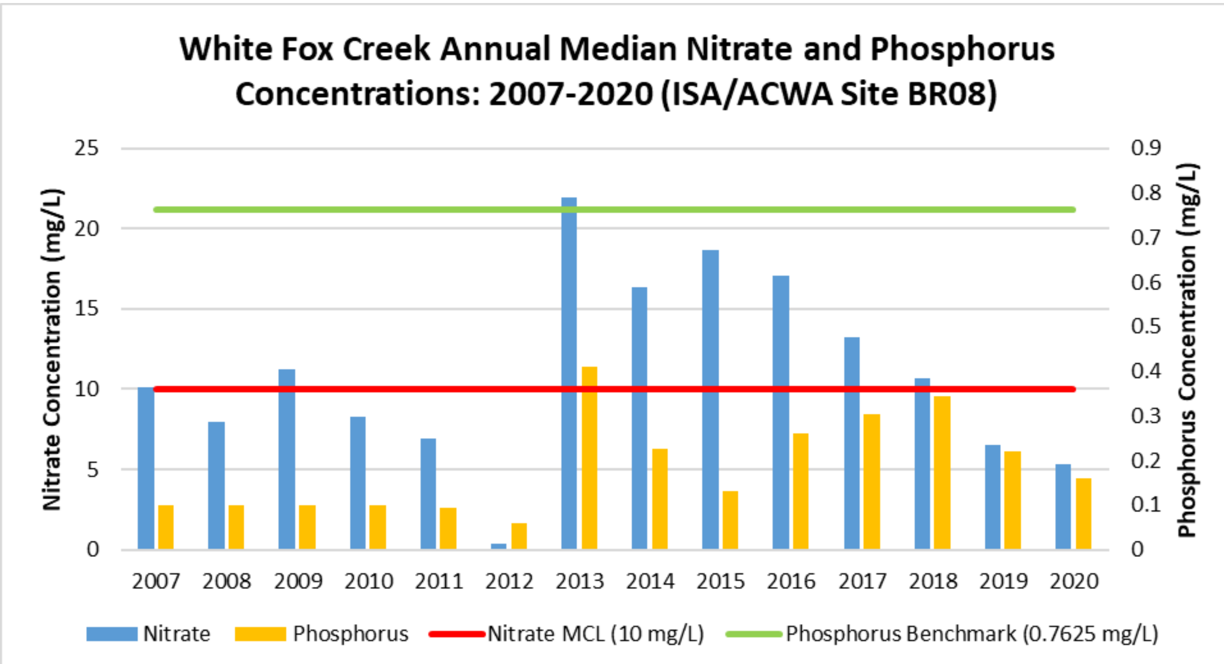

Figure 48: Nutrient Sampling Results for White Fox Creek Priority Area

Headwaters Eagle Creek Priority Area

Figure 49 shows recent annual water quality trends for this priority area, which contains one HUC 12 subwatershed, and is represented by the ISA/ACWA BR17 water quality sampling location. Nitrate concentrations during the monitoring season have exceeded or been near the MCL 13 of 14 years. Phosphorus concentrations during the monitoring season have been much better, never exceeding the monitoring benchmark.

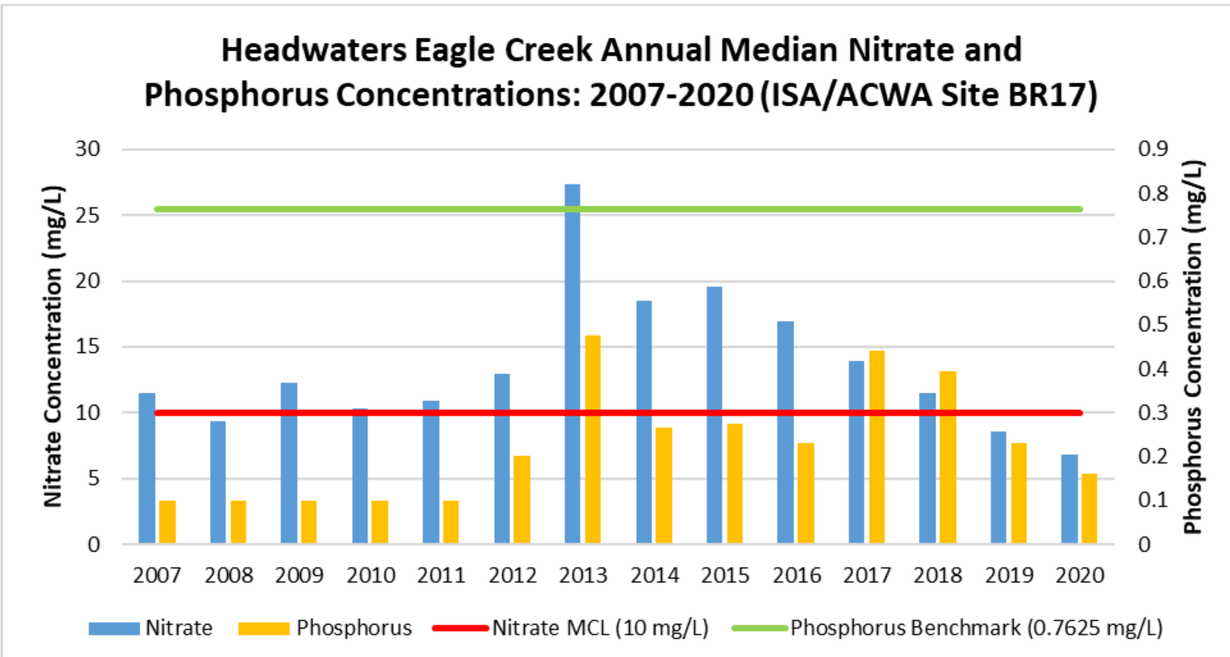

Figure 49: Nutrient Sampling Results for Headwaters Eagle Creek Priority Area

3.04 POLLUTANT SOURCES AND LOADS

INTRODUCTION

Current pollutant load estimates specific to the BRW are unavailable due to the lack of a water quality model, as previously discussed. However, the Des Moines River TMDL utilized a SWAT model to quantify pollutant loads, and a summary is presented below. Additionally, a literature review was conducted to provide information that could advance the current understanding of water quality in the watershed and support decision making. Future updates to the plan should include water quality modeling to obtain watershed specific pollutant load estimates. It is recommended that water quality modeling be completed at the HUC 12 subwatershed level to assist with BMP targeting and evaluation efforts. Additionally, a water quality model can provide pollutant loads by source, instead of a total aggregate load, as presented here. **Existing data on pollutant sources and locations is presented in Section 3.02.** Relevant findings from the literature review for each pollutant of concern are included below.

NITROGEN AND PHOSPHORUS

Nutrients such as nitrogen and phosphorus occur naturally. However, an overabundance of these nutrients may lead to impaired water quality. Nutrient enrichment in Iowa waterbodies can stem from both internal and external sources. Internal sources are those nutrients which originated from an external source but then became trapped in waterbodies and are recycled annually (primarily in lakes and reservoirs). External sources of nutrients are those which enter waterways through contaminated runoff. Excess nutrients in waterbodies produce algae, which often leads to decreased oxygen content that disrupts aquatic life. Contribution of nutrients can come from a variety of sources including fertilizer application, soil erosion, manure application sites, runoff from small open feedlots, tile line drainage, grazing livestock, stream erosion, and inadequate or malfunctioning wastewater treatment systems.

It should be recognized that sediment and associated phosphorus load are often dominated by erosion, with total phosphorus loads from streambanks ranging from for 3-38% in Iowa (Schilling and others, 2019). However, estimating total phosphorus loads with available water quality data is challenging. The majority of long-term water quality sampling efforts across Iowa, including the Boone River are taken through monthly grab sampling. There are not continuous monitoring data for total phosphorus (like there is for nitrates). This is partially because phosphorus often needs to be measured as two forms: “total phosphorus”, which refers to all forms of phosphorus present, whether attached to sediment being transported by the stream, or dissolved in stream water. The dissolved form is commonly referred to as ortho-phosphate. Typically, the majority of the total phosphorus is attached to sediment with lesser amounts present as ortho-phosphorus. Monthly sampling data likely misses a large amount of phosphorus that is transported during storm events that cause increased erosion. This points to the needs for data from stream erosion assessments (discussed later in this chapter).

Summaries of the literature review conducted for data related to nutrient loading estimates is presented below. While the specific loading numbers in each report are dated or have other limitations; given the lack of a water quality model for the BRW, they do help to provide a reasonable representation of water quality conditions in the watershed. Pollutant load estimates from each study are provided in Table 21.

Table 21: Summary of Nutrient Load Estimates

Data Source	Total Nitrogen Load (lbs/acre)	Total Phosphorus Load (lbs/acre)
2004 Iowa Nutrient Budget Study	23.4	0.65
2009 Des Moines River TMDL*	14.51	NR
2012 USGS SPARROW Modeling**	25.32	1.26
2018 IIHR Stream Nitrate Evaluation	20.7	NR

** Based on an average of HUC 12 load estimates*
***Based on delivered accumulated load*
NR = Not Reported

To help provide an understanding of nutrient losses across the watershed, several maps (Figure 50 and Figure 51) and Table 22 were prepared using ACWA water quality data. While these do not portray nutrient loads, they do help to provide a more detailed spatial understanding of where some of the highest sources of nutrients are originating within the BRW, on a HUC 12 basis. These figures illustrate the average concentration of nitrate and phosphorus in each HUC 12 in 2020. The tables provide additional information regarding long-term averages of nutrient concentrations in each HUC 12.

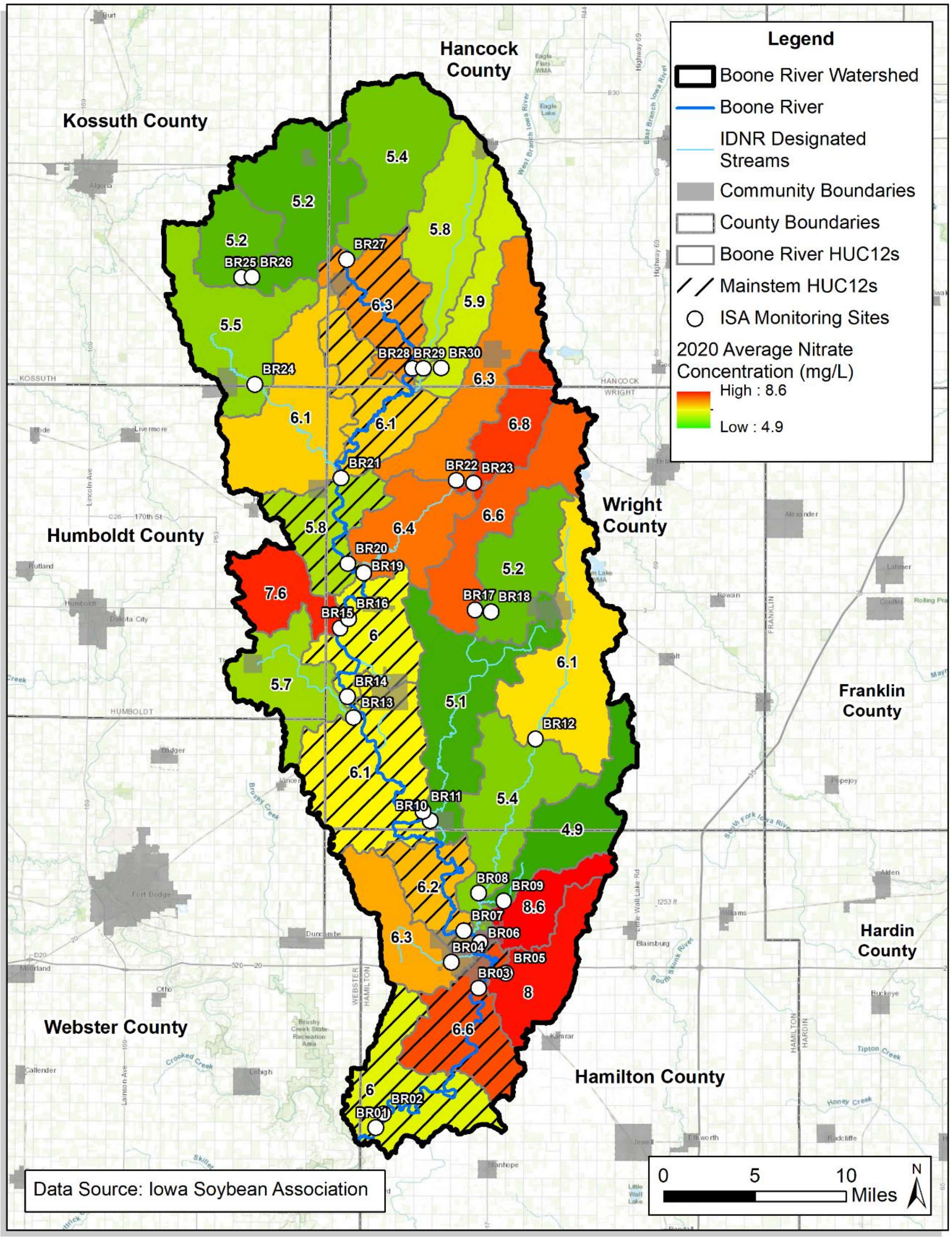

Figure 50: Average 2020 Nitrate Concentrations for HUC 12 Subwatersheds

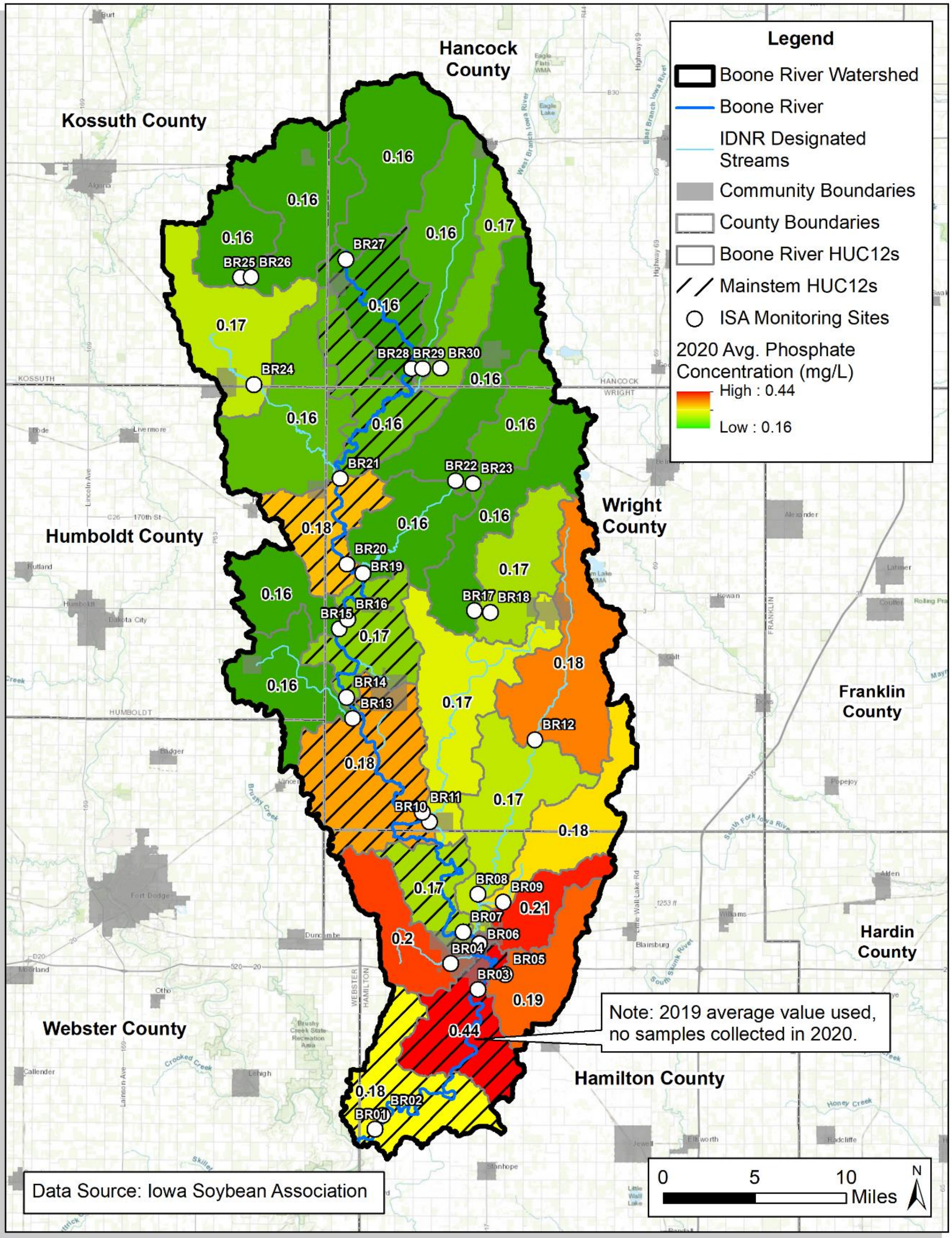

Figure 51: Average 2020 Phosphorus Concentrations for HUC 12 Subwatersheds

Table 22: Recent and Long-Term Nutrient Concentrations for HUC 12 Subwatersheds

Monitoring Site ID	HUC 12	HUC 12 Subwatershed Name	Average Nitrate Concentration (mg/L)		Average Phosphate Concentration (mg/L)	
			2007-2020	2020	2007-2020	2020
BR01	71000050705	Prairie Creek-Boone River	10.20	6.00	0.27	0.18
BR03	71000050704	Drainage Ditch 32-Boone River	9.10	6.60	0.29	*0.44
BR04	71000050702	Brewers Creek	13.30	6.30	0.31	0.20
BR05	71000050703	Drainage Ditch 206	11.80	8.00	0.25	0.19
BR06	71000050701	Lyons Creek	15.20	8.60	0.31	0.21
BR07	71000050606	Drainage Ditch 68-Boone River	10.90	6.20	0.24	0.17
BR08	71000050503	White Fox Creek	11.00	5.40	0.24	0.17
BR09	71000050502	Buck Creek	11.90	4.90	0.22	0.18
BR10	71000050403	Eagle Creek	11.20	5.10	0.26	0.17
BR11	71000050605	Drainage Ditch 46-Boone River	10.70	6.10	0.26	0.18
BR12	71000050501	Headwaters White Fox Creek	11.60	6.10	0.28	0.18
BR13	71000050603	Drainage Ditch 3	11.10	5.70	0.23	0.16
BR14	71000050604	Drainage Ditch 4-Boone River	10.80	6.00	0.24	0.17
BR15	71000050602	Drainage Ditch 9	14.10	7.60	0.19	0.16
BR17	71000050402	Headwaters Eagle Creek	12.70	6.60	0.28	0.16
BR18	71000050401	Little Eagle Creek	11.10	5.20	0.41	0.17
BR19	71000050303	Otter Creek	12.10	6.40	0.28	0.16
BR20	71000050601	Joint Drainage Ditch 3-Boone River	10.30	5.80	0.24	0.18
BR21	71000050104	Drainage Ditch 18-Prairie Creek	10.50	6.10	0.24	0.16
BR21	71000050205	Drainage Ditch 1-Boone River	10.50	6.10	0.24	0.16
BR22	71000050301	West Otter Creek	12.30	6.30	0.25	0.16
BR23	71000050302	Headwaters Otter Creek	12.70	6.80	0.23	0.16
BR24	71000050103	Drainage Ditch 116-Prairie Creek	9.60	5.50	0.23	0.17
BR25	71000050101	Drainage Ditch 117	8.80	5.20	0.19	0.16
BR26	71000050102	Headwaters Prairie Creek	8.80	5.20	0.20	0.16
BR27	71000050201	Headwaters Boone River	9.60	5.40	0.19	0.16
BR28	71000050204	Drainage Ditch 44-Boone River	10.40	6.30	0.21	0.16
BR29	71000050202	Middle Branch Boone River	10.80	5.80	0.24	0.16
BR30	71000050203	East Branch Boone River	11.30	5.90	0.19	0.17

**This is a 2019 value. Not samples were taken from this site in 2020*

2004 Iowa Nutrient Budget Study (Libra and others, 2004)

The Iowa Geologic Survey completed a statewide study titled *Nitrogen and Phosphorus Budgets for Iowa and Iowa Watersheds* (Libra and others, 2004). This study, which was supported by the IDNR's Section 319 program, estimated inputs and outputs of nitrogen and phosphorus across Iowa and its major monitored watersheds. Data represented average annual conditions for the period 1997-2002 and stream loading estimates were based on monthly water quality monitoring data across 68 watersheds (80% of the state) from 2000-2002. This report represented the first comprehensive mapping of the distribution of major nutrient sources across the state and presented a reasonable picture of the current nutrient status, at the time.

Pollutant load estimates for the Boone River, based on water quality data from the IDNR's Stratford site are provided in Table 21. While the specific loading numbers in the report are dated, it provides a full accounting of pollutant sources and offers several insights into relative levels of pollutant loads in watersheds across Iowa:

- Watersheds with a high percentage of row crop also tend to show statistically higher nitrogen concentrations.
- High stream nitrogen loads were statistically related to inputs of nitrogen fertilizer.
- High ortho-phosphorus loads in streams were statistically related to watersheds with high manure inputs.
- There was no statistical correlation of total phosphorus to other factors in the study. This lack of correlation was likely due to the stream monitoring data used, which was based on samples collected monthly and may not characterize total phosphorus concentrations adequately.
- State-wide point sources accounted for about 8% of stream nitrogen, with nonpoint sources accounting for the remaining 92%. For individual watersheds, point source inputs accounted for 1-15%.
    - The BRW was above the average, with 8.2% of nitrogen originating from point sources.
- State-wide point sources accounted for about 20% of phosphorus, with nonpoint sources accounting for the remaining 80%. For individual watersheds, point source inputs accounted for 1-52%. Due to inherent issues with quantifying stream loads, as previously discussed, this estimate was less reliable.
    - The BRW was below the average, with 9.4% of phosphorus originating from point sources.
- A variety of factors affect the delivery of nitrogen and phosphorus from pollutant sources to streams. These factors include soil, geologic, climate/weather, land management practices, and the amount of nutrients available. While this study addressed the "amount of nutrients available" factor, strategies and practices to reduce pollutant loading must take all of these factors into account.

2009 Des Moines River TMDL for Nitrate

As previously discussed, a TMDL was developed in 2009 for the Des Moines River to address nitrate. The TMDL reviewed water quality data from across the Des Moines River Basin, including the IDNR stream sampling site on the Boone River near Stratford. Water quality data from 1999-2006 period was used. Additionally, a SWAT water quality model was developed, which was used to estimate nitrate pollutant loads on a HUC 12 basis. The SWAT model was calibrated to river flows and then nitrate levels at Des Moines Water Work. Please note that this study did not include a review of phosphorus.

While this TMDL does not directly apply to the BRW, it is relevant as the Boone River is a major contributor to the Des Moines River. **Nitrate pollutant load estimates for each of the HUC 12 subwatershed were calculated in the SWAT model used in the development of the TMDL.** These have been averaged together for comparison purposes and are provided in Table 21. While the specific loading numbers in the report are dated, it provides a full account of pollutant sources and offers several insights into relative levels of nitrate pollutant loads in the BRW:

- Nitrate concentrations in the Boone River near Stratford were an average concentration of 8.0 mg/L, with 41.4% of samples exceeding the MCL of 10 mg/L, and the maximum concentration was 28 mg/L. Period of record used was 1999-2006.
- The TMDL also reviewed water quality sampling data from 2007 provided by ACWA. The highest concentrations were observed in Lyon’s Creek, Little Eagle Creek and Otter Creek where average concentrations exceeded 14 mg/L. Overall, monitoring data from the ACWA provided greater spatial resolution of the nitrate concentration patterns within the Boone River watershed.
- Eight subbasins across the Des Moines River Basin had nitrate losses greater than 17.9 lb/ac, with four of these subbasins located in the eastern half of the Boone River watershed (Upper White Fox Creek, Buck Creek, Lyon’s Creek, and Drainage Ditch 206). Much of the Boone River watershed had nonpoint source nitrate losses greater than 13.4 lb/ac, including Upper White Fox Creek with the greatest nitrate loss rate of any HUC 12 subwatershed in river basin at 25.5 lb/ac.

2012 USGS SPARROW Modeling

The United States Geological Survey (USGS) has developed the SPAtially Referenced Regression On Watershed attributes (SPARROW) water quality model (Robertson and Saad, 2019). SPARROW models streamflow, nitrogen, phosphorus, and suspended sediments across five regions in the United States, with Iowa falling into the Midwest Region. The nutrient and suspended sediment models have a base year of 2012, which means they were developed based on source inputs, management practices, and hydrologic conditions similar to those existing during or near 2012, which should be noted was a drought year for much of Iowa and may not represent typical conditions.

Care should be taking in interpreting the outputs from the SPARROW model. The model was developed to cover a very large area of the United States, was not developed to represent watershed specific characteristics of the Boone River Watershed, and does not provide load estimates on a HUC 12 basis. Additionally, the specific loading numbers in the report are dated. However, given the lack of a water quality model for the BRW, it does help to provide a reasonable representation of water quality conditions in the watershed. Pollutant load estimates from the SPARROW model are provided in Table 21.

Additional information on the SPARROW model can be found here:

https://www.usgs.gov/mission-areas/water-resources/science/sparrow-modeling-estimating-nutrient-sediment-and-dissolved

2018 IIHR Boone River Stream Nitrate Evaluation

The report (Jones, Schilling, and Gilles, 2018) summarizes the statistical analysis of the water quality data at each of the 30 sites that have been monitored from 2007-2017, specifically as it relates to nitrates. Additional discussion of this report and insights is provided earlier in this chapter. Nitrate loading estimates from the report are provided in Table 21. It should be noted that nitrate loads were calculated based on sampling points, some of which represent individual HUC12, others that represent the mainstem; therefore, HUC 12 level estimates were not included in this plan. Additionally, these estimates are based on seasonal sampling and not year-round sampling.

SEDIMENT

Sediment originates from stream erosion (streambank and stream bed), gully erosion in fields, and upland erosion (sheet and rill erosion). Sediment can increase turbidity and act as a transport mechanism for other pollutants. Excessive sedimentation diminishes the suitability of instream and streamside habitat for fish and wildlife as sediment buries substrate that support spawning and foraging habitat for benthic and other aquatic organisms. The primary sources of sediment are soil erosion from upland areas and streambed or bank erosion. Every land use type produces sediment through erosion; however, some are greater contributors than others. Farmland has higher sediment loss rates due to limited perennial vegetation. Developed regions can have high runoff rates due to the lack of natural vegetation and high concentrations of impervious materials.

Upland Sheet and Rill Erosion

Average erosion rates from upland sources for each HUC 12 were estimated using the Daily Erosion Project (DEP). The DEP uses elevation, soils, land use, precipitation, and other weather data information to estimate erosion on a HUC 12 subwatershed basis (Gelder and others, 2018). Note that these estimates include erosion from sheet and rill erosion, but not from gullies.

The long-term average sediment loss by year (2007-2020) for the entire watershed is displayed in Figure 52. These estimates are broken down further into long-term averages for each HUC 12 watershed and mapped (Figure 53). Table 23 provides the most recent (2020) averages for each HUC 12 for comparison purposes. Sediment loss is relatively uniform across the BRW with a low of 0.35 tons per acre in the far north portion of the BRW, and a high of 0.92 tons per acre in the middle south-east portion of the BRW.

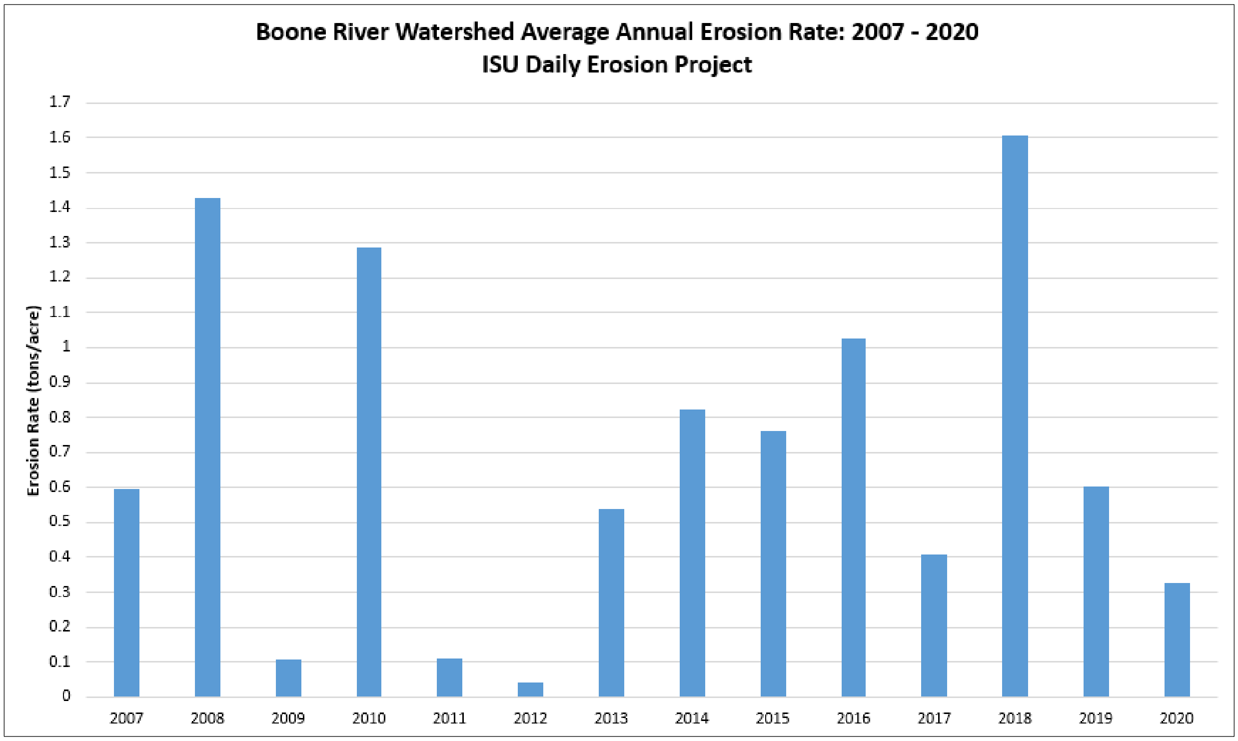

Figure 52: Average Annual Erosion Rate in the Boone River Watershed

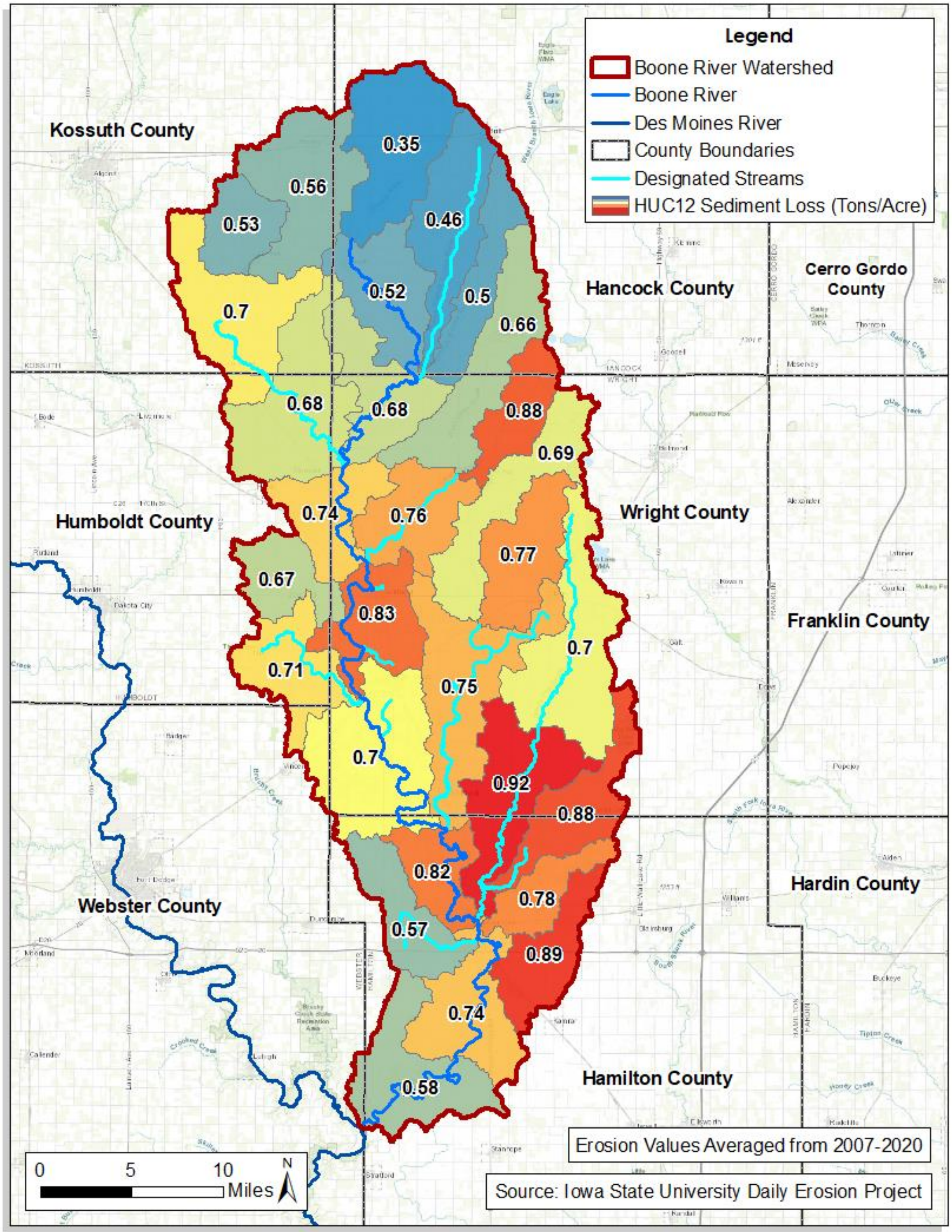

Figure 53: Average Erosion by HUC 12 Subwatersheds in the BRW, 2007-2020

Table 23: Recent and Long-Term Average Annual Sediment Loss by HUC 12

Watershed Name	HUC12	Avg Sediment Loss (tons/acre) 2007-2020	Avg Sediment Loss (tons/acre) 2020
Drainage Ditch 117	071000050101	0.53	0.06
Headwaters Prairie Creek	071000050102	0.56	0.17
Drainage Ditch 116-Prairie Creek	071000050103	0.70	0.14
Drainage Ditch 18-Prairie Creek	071000050104	0.68	0.18
Headwaters Boone River	071000050201	0.35	0.10
Middle Branch Boone River	071000050202	0.46	0.23
East Branch Boone River	071000050203	0.50	0.24
Drainage Ditch 44-Boone River	071000050204	0.52	0.32
Drainage Ditch 1-Boone River	071000050205	0.68	0.43
West Otter Creek	071000050301	0.66	0.32
Headwaters Otter Creek	071000050302	0.88	0.56
Otter Creek	071000050303	0.76	0.41
Little Eagle Creek	071000050401	0.77	0.06
Headwaters Eagle Creek	071000050402	0.70	0.15
Eagle Creek	071000050403	0.75	0.16
Headwaters White Fox Creek	071000050501	0.70	0.23
Buck Creek	071000050502	0.88	0.39
White Fox Creek	071000050503	0.92	0.29
Joint Drainage Ditch 3-Boone River	071000050601	0.74	0.29
Drainage Ditch 9	071000050602	0.67	0.18
Drainage Ditch 3	071000050603	0.71	0.36
Drainage Ditch 4-Boone River	071000050604	0.83	0.36
Drainage Ditch 46-Boone River	071000050605	0.70	0.38
Drainage Ditch 68-Boone River	071000050606	0.82	0.49
Lyons Creek	071000050701	0.78	0.36
Brewers Creek	071000050702	0.57	0.38
Drainage Ditch 206	071000050703	0.89	0.56
Drainage Ditch 32-Boone River	071000050704	0.74	1.08
Prairie Creek-Boone River	071000050705	0.58	0.61

Stream Erosion

Average erosion rates from the stream channel can be estimated by assessing stream channel stability. Stream channel stability generally refers to the capacity of a stream channel to transport water and sediment without changing dimensions (width, depth, cross-sectional area, and slope). However, there are several complicating factors including, but not limited to:

1. Streambank and bed mobility are natural phenomenon, and stable streams differ from unstable streams primarily in their rate of bank and bed mobility; and
2. Unnaturally high rates of bank and bed mobility can have multiple causes, ranging from small-scale, local causes (such as unrestricted livestock access) to large scale, regional causes (such as stream channelization or tile drainage).

Nature rarely operates on society's time scale; thus, it can be difficult to determine exactly when a change in the system reflects either an instability from short term impacts or a dynamic variation within a long-time frame.

A channel is considered stable and in equilibrium when the energy associated with flow and channel slope balances with the sediment load and bed material size. Channels in equilibrium balance these factors over time (Figure 54). Erosion is a constant and natural process in stream evolution, but it occurs at a much slower rate under stable conditions. Therefore, the concept of "stability" is better characterized as "dynamic equilibrium".

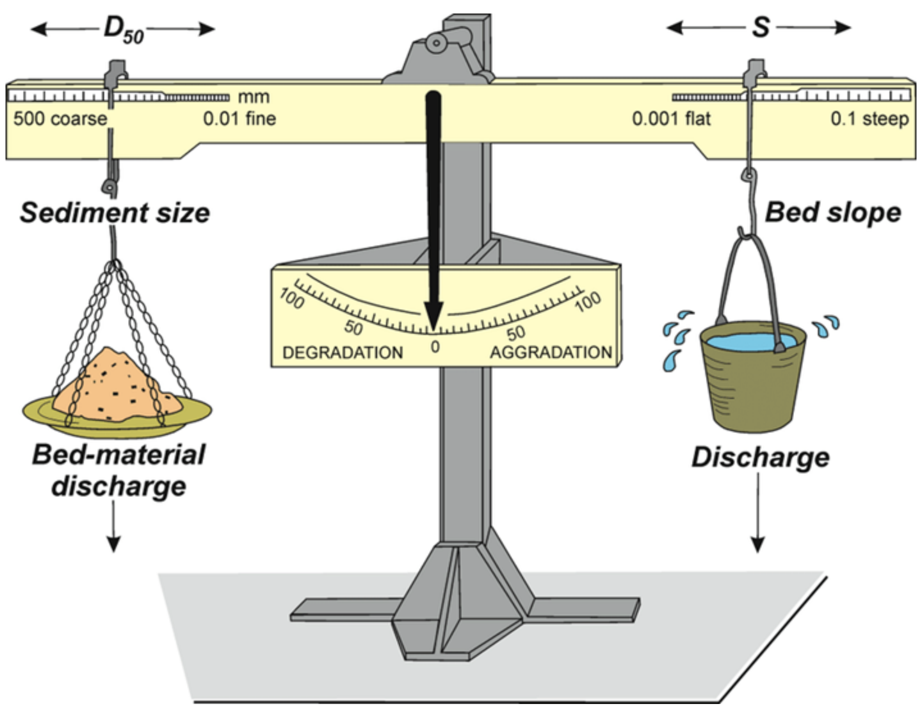

Figure 54: Lane's Balance, a Representation of Stream Stability (Rinaldi, 2015)

To regain dynamic equilibrium, destabilized streams generally adjust, or evolve, through a sequence of channel forms. The stream evolution model (Simon, 1989) provides a framework to understand how stream channel morphology changes throughout this evolutionary process and is broken down into six cyclical stages (Figure 55). Understanding this framework allows resource managers to evaluate present channel conditions, interpret historical conditions or activities that led to the current state, and predict future channel behavior. Stream assessments are conducted to gather this type of information.

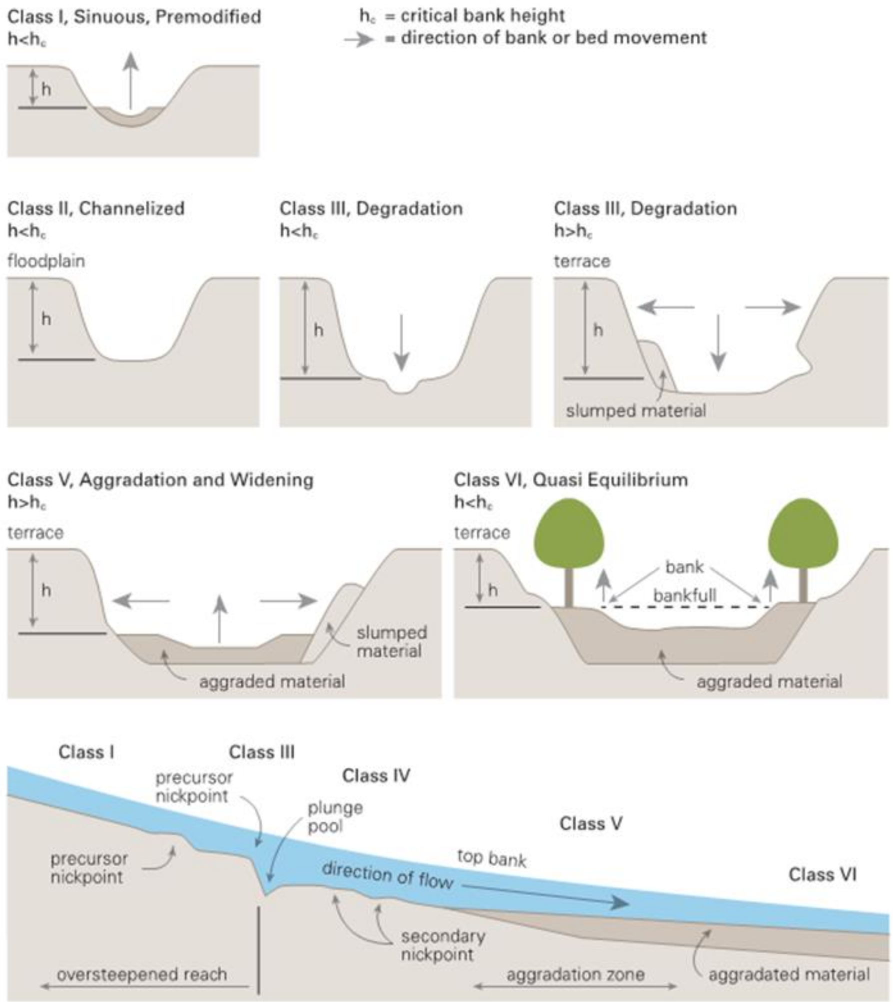

Figure 55: Simon Channel Evolution Model (Harman and others, 2012)

Information on the stability of streams is typically gathered through various types of rapid stream assessments. These evaluations provide a concise, reconnaissance-level overview of stream quality conditions and may also identify potential enhancements to improve stream health. These on-the-ground assessments focus (to varying degrees) on geomorphology, riparian conditions, and in-stream habitat. It can be useful to focus on high priority areas to protect, such as areas near bridges or other infrastructure. Desktop level assessments can either enhance in-field assessments or be used as a standalone effort to develop an initial, high-level understanding of stream stability. Desktop tools can include historic aerial photography, LiDAR, aerial oblique imagery, and local stakeholder input.

A limited number of on-the-ground stream assessments have been completed within the BRW. These are limited to the Eagle Creek and Prairie Creek Watershed Plans. Similar efforts across the watershed, or at least in priority subwatersheds, are recommended. As part of these surveys, drainage tile infrastructure should be located and evaluated. Literature review indicates that approximately 15-35% of streams in the region are likely experiencing erosion (Schilling and others, 2019). Such a high level of erosion clearly places stream erosion as a major contributor to watershed sediment and phosphorus loads.

To develop an estimate of erosion and sediment loads originating from stream erosion, the values from existing watershed plans were averaged across the entire watershed, which has similar conditions. This equated to an average of 756 tons/year/HUC 12, or a total of 22,950 tons/year.

While stream erosion assessments can be done on small stream reaches with relative ease, quantifying the contribution of streambanks to pollutant loading at regional scales (such as the BRW) is particularly challenging due to the time and resources that would be required for an on-the-ground survey across the watershed. Several efforts are underway in Iowa to develop estimates using GIS and LiDAR based analysis paired with soil sampling. Further development of these technologies will be beneficial to future updates of this plan.

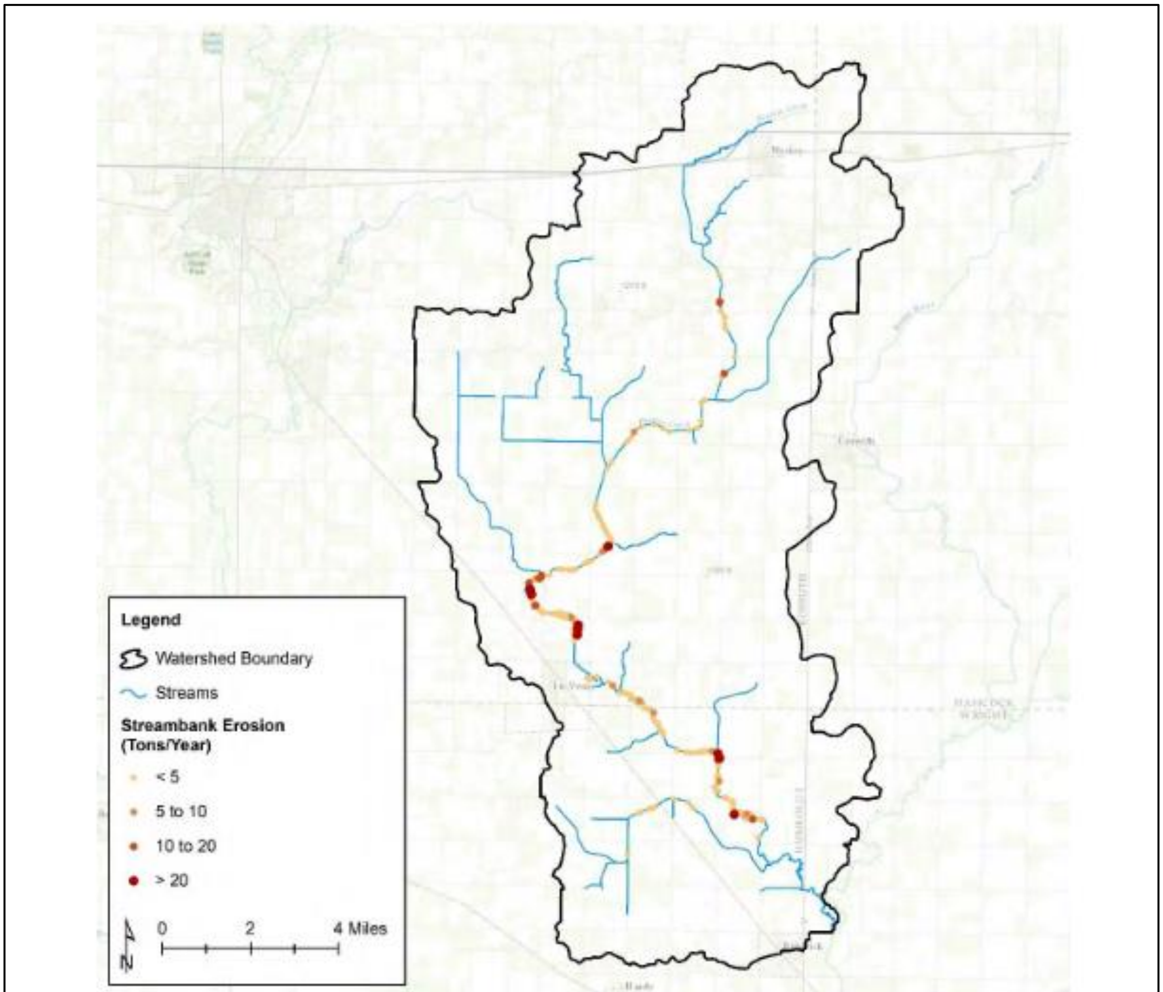

Figure 2.9.3. Estimated streambank erosion rates according to a 2017 Prairie Creek stream corridor assessment.

Figure 56: Example of Stream Stability Assessment Results

E. COLI BACTERIA

E. coli is a species of fecal coliform bacteria that is commonly found in the fecal matter of warm-blooded animals. Most strains of *E. coli* are harmless; however, certain strains (0157:H7) can cause mild to severe gastrointestinal illness. The EPA has recommended that *E. coli* be used as the primary indicator of health risk from recreational waters; therefore, identifying the sources of *E. coli* contamination is important.

Several nonpoint sources have been identified as contributors of *E. coli* contamination to waterbodies within the watershed. These include land application of livestock manure and sludge for fertilization; runoff from livestock pastures; small open feedlots; pet waste; underperforming onsite wastewater treatment systems; runoff from urban areas; and natural sources such as wildlife. Runoff from precipitation can cause *E. coli* to be washed into surface waters and it can also potentially enter groundwater through abandoned or poorly constructed wells.

No information containing *E. coli* loading estimates specific to the Boone River was found through literature review. Additionally, bacteria water quality data is limited to that collected by IDNR on the Boone River near Stratford, which represents the entire BRW, and was previously presented in this chapter. Unlike other pollutant sources discussed, no HUC 12 level water quality data was available for review. Therefore, to understand the pollutant sources and loads for *E. coli*, this plan presents several recommendations:

1. **Complete a load duration for *E. coli.*** Typically, when streams are identified as impaired due to *E. coli*, it is because the geometric mean of samples is not meeting water quality standards; however, data shows that the Boone River is generally meeting this water quality standard. The impairment is due to the single sample maximum standard being exceeded. A load duration curve will help answer the question if these spikes in the bacteria level sampling data are during high flow events (likely driven by nonpoint sources) or during low flow events (indicating loading is coming from point sources).
2. **Expand *E. coli* sampling across the watershed.** By expanding bacteria sampling across the watershed, it will be easier to determine where “hot spots” of pollutant sources might be. It is recommended that the ACWA sampling, which has established protocol and resources, be expanded on to provide this data at the HUC 12 level. At a minimum, major tributaries should be sampled to begin this process.
3. **Include *E. coli* in a water quality model.** Should future efforts of developing a water quality model be undertaken, *E. coli* should be included at that time.

3.05 EXISTING BEST MANAGEMENT PRACTICES

Estimating existing BMPs and treated areas is an important step in the planning process. This knowledge helps to prioritize installation of future BMPs and is necessary for calibration of water quality models. These estimates are also used to determine potential pollutant load reductions that additional treatment could have in the BRW. Unfortunately, no central listing or full inventory exists for this information. The Natural Resources Conservation Service (NRCS) works with many producers to install BMPs, however, that information is subject to privacy laws. Additionally, many landowners implement BMPs on their own without government assistance. To estimate existing BMPs, data was broken down into two general types: structural and non-structural, as discussed below. Suitability for future BMPs was identified using various methodologies, including the ACPF tool, and is included in Chapter 5.

STRUCTURAL BMPS

The Iowa BMP Mapping Project, sponsored by ISU, provides a baseline set of existing BMPs spanning from 2007 to 2010. Existing BMPs are identified and digitized through aerial photography, hill-shade and slope grids, and other remote sensing products (ISU, 2018b). ISU focused on identifying structural practices (edge of field) such as ponds, dams, terraces, water, and sediment control basins (WASCOBs), contour buffer strips, and grassed waterways. Previously completed sub-watershed plans within the BRW, TNC Database, and personal correspondence with TNC employees also aided in identifying additional BMPs. Figure 57 identifies the existing locations of structural BMPs in the BRW with available GIS data from the Iowa BMP Mapping Project and TNC Oxbow Restoration sites. Table 24 details the numbers of those structural BMPs identified in the BRW.

Table 24: Summary of Existing Structural BMPs in the BRW

BMP Type	Count Identified
Contour Buffer Strips	6 structures
Grassed Waterways	1,127,291 feet
Ponds	55 structures
Terraces	104,070 feet
WASCOBs	393 structures
Nutrient Reduction Wetland / CREP Wetland	5 sites
Bioreactors	8 structures
Prairie STRIPs	1 site
Drainage Water Management	1 site
Oxbow Restoration	32 sites
Saturated Buffers	1 site

Source: ISU, 2018b AND Compiled Data from Existing Watershed Plans, TNC Database, Personal Correspondence with Karen Wilke (TNC)

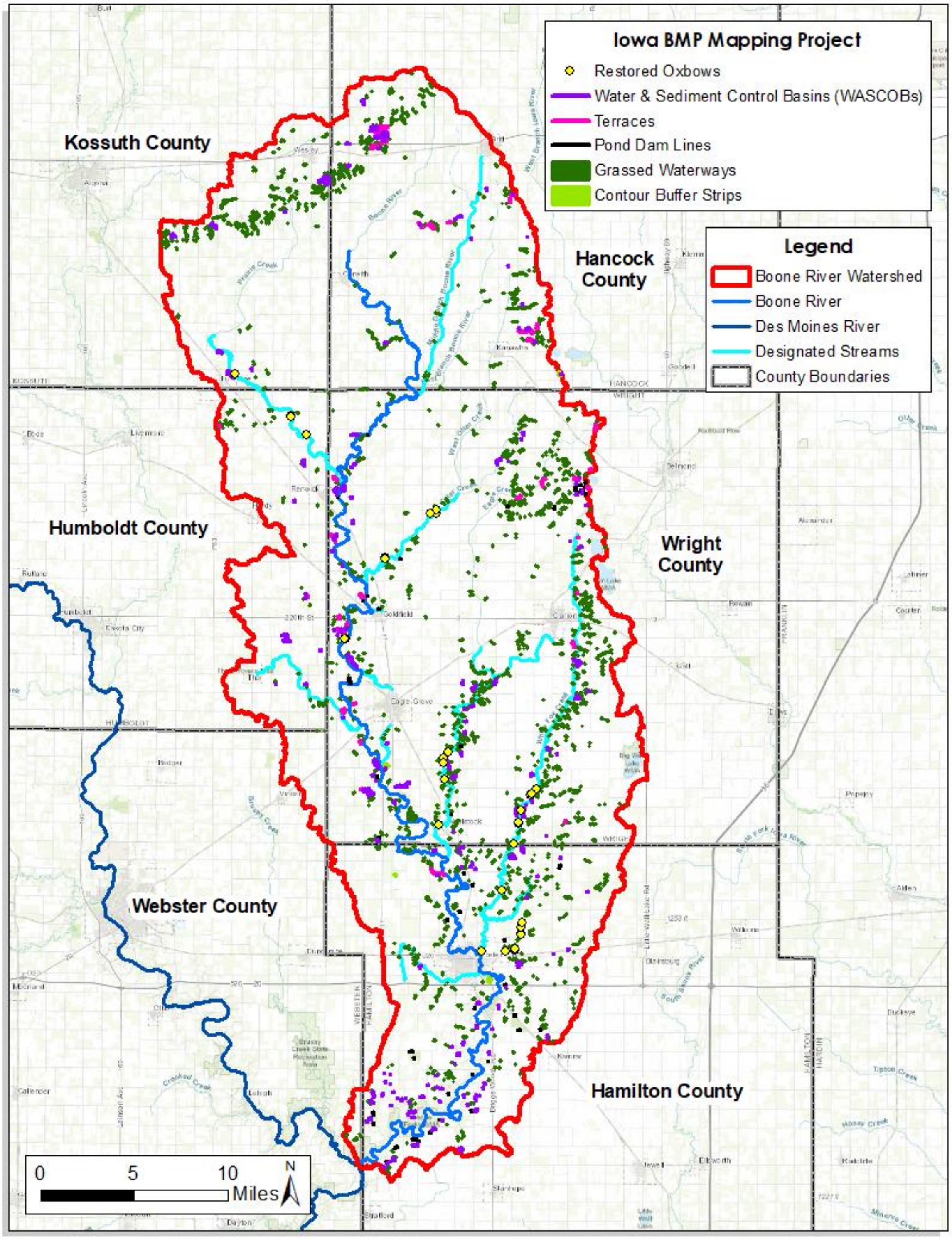

Figure 57: Map of Structural BMPs in the Boone River Watershed

NON-STRUCTURAL BMPS

Existing non-structural BMPs (which include in-field and nutrient management BMPs) are more difficult to identify as they cannot be easily identified in aerial photography. Non-structural BMPs are also not permanent, unlike structural BMPs. The adoption or implementation levels for non-structural BMPs can vary year-to-year based on landowner or producer management practices.

Data was available from TNC and WQI from 2011 to 2020, based on the practices that were enrolled through their programs. The data is presented below in *Table 25*. It is recommended that producer surveys or an on-the-ground inventory of BMPs be performed prior to the update of this plan.

To gain a better understanding of adoption levels of non-structural BMPs across the entire watershed, Operation Tillage Information System (OpTIS) data, provided by the Conservation Technology Information System (CTIC), was also reviewed. According to the data, from 2005-2018, an average of 36% (178,901 acres) of the watershed used some form of conservation tillage, while the rest of Iowa averaged 51%. Conservation tillage is broadly defined as a practice including strip-till, ridge-till, and mulch till systems. Occasionally, vertical tillage is also included in the definition. Also, from OpTIS, the data shows that from 2005-2018 an average of 0.19% (928 acres) of the watershed used cover crops, and the rest of Iowa averaged 0.91%. Looking at just 2010-2018, the use of cover crops in the watershed averaged higher at 2.6% (12,795 acres). These increased adoption rates correlated when TNC and WQI began offering additional cost share within the watershed. Complete findings and figures depicting the reviewed OpTIS data, as well as other information on existing BMPs is available in Appendix C.

Table 25: Summary (by year) of Non-Structural BMPs Funded by TNC and WQI

Year	Cover Crops (acres)	Strip / No-Till (acres)	Nitrogen Inhibitor (acres)
2011	0	0	0
2012	217	0	0
2013	375	500	0
2014	3,599	1,080	97
2015	2,568	2,199	149
2016	3,833	745	353
2017	4,636	3,801	0
2018	5,014	4,281	0
2019	2,157	0	0
2020	9,297	2,479	0

Source: Compiled data provided by The Nature Conservancy (TNC) and Water Quality Initiative (WQI)

URBAN STORMWATER BMPS

Identifying and summarizing existing urban BMPs was limited to input from watershed partners.

- Webster City
  - Webster City completed a stormwater project in 2018 by turning open space into a wetland to treat stormwater runoff from multiple outfalls before entering into the Boone River. This project received funding through WQI.
- Eagle Grove
  - Eagle Grove is currently working on water quality improvements funded through the Clean Water SRF Clean Water Loan Program and the Community Development Block Grant (CDBG) program.
  - The project is located in the downtown area, along West Broadway Street
  - Project elements include:
    - Permeable pavers (Figure 58)
    - Bioretention and vegetative plantings
    - Soil quality restoration

Figure 58: Permeable Pavers in Eagle Grove, Designed to Treat Urban Stormwater Runoff

PERENNIAL VEGETATION

Baseline data for the wildlife habitat goals (discussed in more detail in Chapter 4) are based on GIS analysis of the USDA-NASS's Cropland Data Layer data from 2007-2013. This date range was selected for analysis as this baseline date matches those found in the recently completed subwatershed plans and is thus presented below. It should be noted that in this analysis perennial vegetation included many types of land use, not just those acres with specific wildlife habitat, public access, or similar designations. It is unknown which, if any, of these acres are enrolled in habitat programs or other BMP programs (such as CRP, prairie STRIPS, etc.) that would be considered land use change BMPs.

The assessment showed that the total amount of perennial vegetation averaged 46,628 acres across the watershed over the 2007-2013 baseline (Table 26). One observation of note is that perennial vegetation has declined significantly between the baseline years and 2020 (most recent year data was available for the plan). A 23% reduction was identified, mostly related to the conversion of grass/pasture and forest to corn.

Table 26: Land Use Assessment Data for Perennial Vegetation

Perennial Vegetation	2007-2013 Avg. (acres)	2020 (acres)	Change (acres)
Alfalfa	773	1,136	363
Clover/Wildflowers	2	1	(1)
Deciduous Forest	10,967	10,858	(109)
Evergreen Forest	3	41	38
Forest	114		(114)
Grassland/Pasture	34,591	22,772	(11,819)
Mixed Forest	1	394	393
Other Hay/Non-Alfalfa	302	624	322
Other Tree Crops	7		(7)
Shrubland	2	9	7
Switchgrass	2		(2)
Total	**46,628**	**35,835**	
Corn	285,193	297,382	12,189
Soybeans	200,484	200,875	391
Grassland/Pasture	34,591	22,772	(11,819)

Source: USDA-NASS Cropland Data Layer

3.06 EXISTING ACPF MAPPING DATA

The Agricultural Conservation Planning Framework (ACPF) is a concept for agricultural watershed management. ACPF includes a GIS-based tool that utilizes modern, high-resolution geospatial datasets that assists in identifying a broad range of opportunities to install BMPs at the field level. Conceptually, the ACPF tool is based on the “Conservation Pyramid” (see Chapter 5).

This non-prescriptive, yet site-specific, approach provides a menu of conservation options to facilitate conservation discussions on farms and in community halls. This framework in conjunction with local knowledge of water and soil resource concerns, landscape features, and producer conservation preferences was used to provide a better understanding of the options available during the development of the Boone River WMA Watershed Management Plan.

While no ACPF mapping was completed during the planning process, existing ACPF data was available from several sources for 22 of the 29 HUC 12 subwatersheds (Figure 59). Available ACPF data was used in the development of this plan. It is recommended that the Boone River WMA complete ACPF mapping for the remaining seven (7) HUC 12 subwatersheds. At a minimum, the ACPF mapping should be completed for any priority subwatersheds that are identified for BMP implementation in Chapter 5. It may also be valuable to update ACPF mapping for all priority subwatersheds to the latest version of the program.

While not utilized during the planning effort, the Statewide Saturated Buffer Database Viewer, could be utilized in future implementation efforts to supplement areas where the full suite of ACPF mapping is not available. The statewide database provides information on saturated buffers only (one of many BMPs available through full ACPF mapping). This database can be accessed here: https://acpfdata.gis.iastate.edu/ACPF/satbuff/

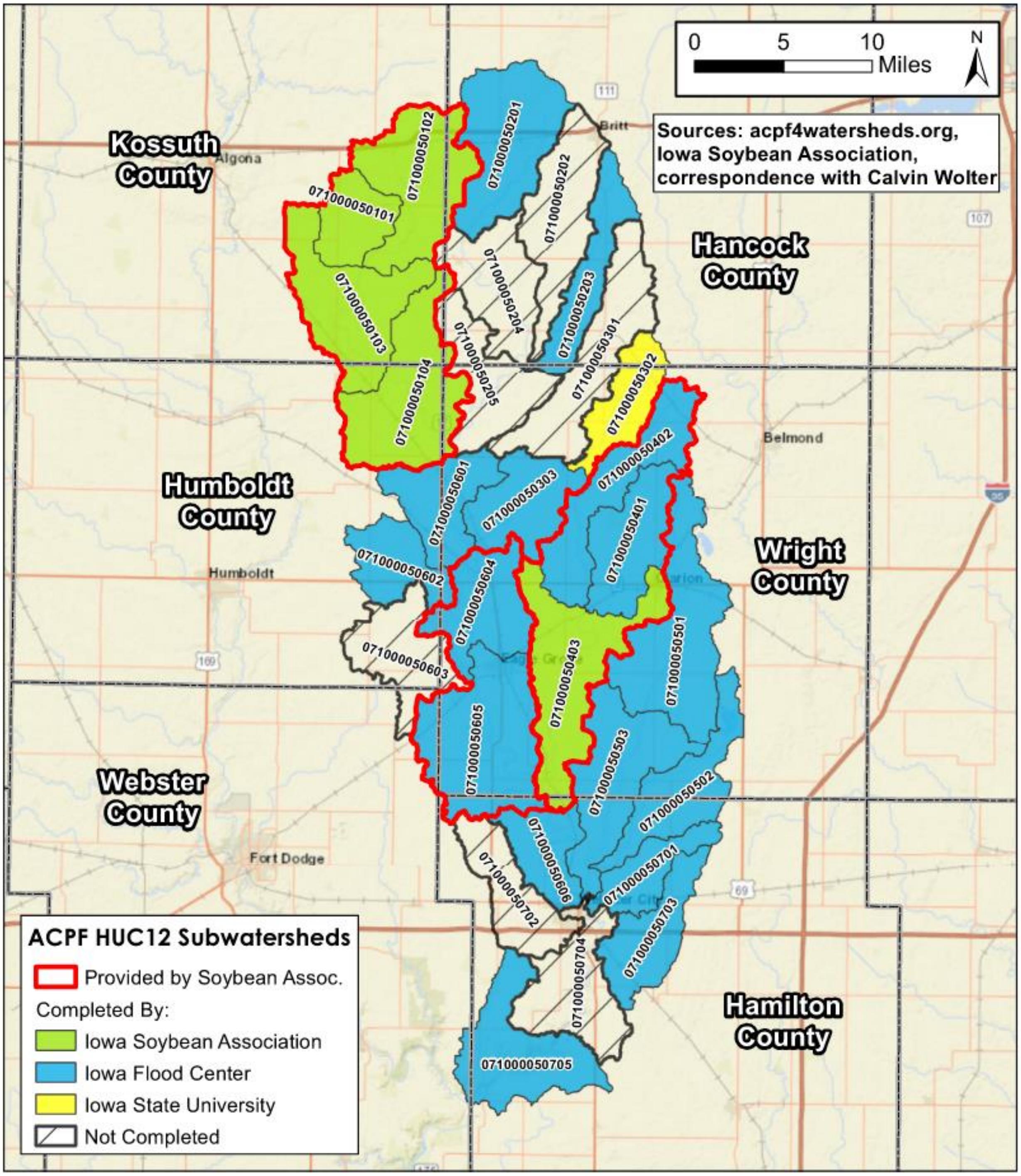

Figure 59: Current Status of ACPF Mapping within the Watershed

3.07 FLOOD RISK ASSESSMENT

Flood risks typically originate from three primary sources: mainstem flooding, tributary flooding, and flash flooding. Since 2009, the Iowa Department of Natural Resources (IDNR) has been working with the Federal Emergency Management Agency (FEMA) to create and maintain flood hazard data for the State of Iowa (IDNR, 2020). The goal of this collaboration is to create Flood Insurance Rate Maps (FIRMs) for every county in the state. Flood hazard maps only account for riverine flooding, which occurs when an existing stream channel, whether it is a tributary or main river branch, overflows its banks. Localized flooding caused by inadequate drainage systems will not be visible on these maps.

Chapter 2 provides an overview of flooding and regulatory floodplains within the watershed. A more detailed flood risk assessment was not available for inclusion in the plan. It is recommended that this be completed in the future. One approach to completing this is to expand the *Des Moines River Upstream Mitigation Study* (Arenas, 2020). This study, prepared by IIHR – Iowa Flood Center, documents the current hydrologic condition of the Des Moines River watershed upstream of the City of Des Moines and explores watershed-scale structural and nature-based strategies to decrease its flood hazards. A more detailed flood risk assessment and recommendations should be developed for the Boone River Watershed, either as a standalone study, or as an expansion of the *Des Moines River Upstream Mitigation Study*.

In lieu of a detailed flood risk analysis, communities can review online flood maps to begin to understand their risk. This can be done through the Iowa Flood Information System (IFIS), which is an online platform to access flood hazard maps and other flood-related products. IFIS helps communities prepare for and respond to floods before they occur, helping to minimize flood impacts and associated damages. The system includes real-time stream levels at nearly 250 locations; flood inundation maps showing the extent and depth of predicted flood waters for 24 Iowa communities; weather conditions including current and past rainfall accumulations; and much more.

IFIS can be accessed online at: http://ifis.iowafloodcenter.org/ifis/

3.08 SUMMARY AND RECOMMENDATIONS

This chapter provided an overview of current conditions within the watershed using existing data, studies, and other reports. Overall, water quality conditions in the watershed are "mixed" in as much as some indices are relatively good (phosphorus and TSS), others are concerning (*E. coli*), and others show a clear sign of a problem (nitrate). Additionally, it is clear there are "hot spots" in the watershed for pollutants, where a focused effort on BMP implementation would be most beneficial.

Nitrate is the most pressing pollutant of concern. The *Boone River Watershed Stream Nitrate Evaluation* (Jones, Schilling, and Gilles, 2018) found that at all monitored subwatersheds there were statistically significant increases in nitrate loading. The BRW also has been identified as one of Iowa's highest-nitrate watersheds (Libra and others, 2004) and had the highest nitrate yield (load per watershed area) of 35 Iowa watersheds in 2016 (Jones, Davis, and others 2018).

While a rich supply of information has been reviewed and presented in this chapter, there are further questions and data gaps. The following is a summary of recommendations found within this chapter that should be considered for completion prior to or during future updates to this plan.

- **Develop a water quality model.**
  It is recommended that future planning or evaluation steps include the development of a water quality model. Modeling should be completed at the HUC 12 subwatershed level to assist with BMP targeting and evaluation efforts. Additionally, the pollutant loads should be broken down by source, not just a total aggregate load. One option may be the expansion of the Soil and Water Assessment Tool (SWAT) model developed as part of the 2009 Des Moines River TMDL, which is already partially calibrated to the BRW. SWAT has the capability to model sediment, nutrients, and *E. coli*. It is well suited to integrate the complicated hydrology of the watershed caused by the high levels of tiling and can integrate the large amount of water quality and stream gaging data available.
- **Additional pollutant source identification.**
  Locations of small open feedlots, which can be a significant source of pollutants, especially bacteria, are not known. These should be identified during future watershed plan updates through visual review of aerial photography. Additionally, estimates of manure generated and locations of land application should be estimated for permitted and non-permitted animal facilities. Pollutant loads should be estimated for each WWTF facility based on a review of their permitted discharge permit. This work could be completed with the development of a watershed model and will vastly improve the understanding of pollutant sources and loads in the watershed.
- **Perform a statistical analysis of water quality data.**
  A statistical analysis, similar to the one performed by IIHR with nitrate sampling data, should be completed for the other water quality pollutants of interest (phosphorus, TSS, and *E. coli*). Additionally, development of a load duration curve for bacteria will help answer the question if spikes in the bacteria level sampling data are during high flow

events (likely driven by nonpoint sources) or during low flow events (indicating loading is coming from point sources). This work could be accomplished alongside or separately from the development of a water quality model.

- **Complete stream assessments.**
  A limited number of on-the-ground stream assessments have been completed within the BRW. Similar efforts across the watershed, or at least in priority subwatersheds, are recommended. As part of these surveys, drainage tile infrastructure should be located and evaluated.
- **Expand *E. coli* sampling across the watershed.**
  By expanding bacteria sampling across the watershed, it will be easier to determine where "hot spots" of pollutant sources might be. It is recommended that the ACWA sampling, which has established protocol and resources, be expanded to provide this data at the HUC 12 level. At a minimum, major tributaries should be sampled to begin this process.
- **Survey producers on adoption levels of non-structural BMPs.**
  Existing non-structural BMPs (which include in-field and nutrient management BMPs) are difficult to identify through existing databases or review of aerial photography. It is recommended that producer surveys and/or an on-the-ground inventory of BMPs be performed prior to the update of this plan. This will enhance efforts for prioritizing BMP implementation efforts and aid in calibration of water quality models.
- **Perform a detailed flood risk assessment for communities.**
  A more detailed flood risk assessment and recommendations should be developed for the Boone River Watershed, either as a standalone study, or as an expansion of the *Des Moines River Upstream Mitigation Study*. Another option might be to perform this during future updates to the county hazard mitigation plans.
- **Complete ACPF Mapping**
  It is recommended that the Boone River WMA complete ACPF mapping for the remaining seven (7) HUC 12 subwatersheds. At a minimum, the ACPF mapping should be completed for any priority subwatersheds that are identified for BMP implementation in Chapter 5. It may also be valuable to update ACPF mapping for all priority subwatersheds to the latest version of the program.

CHAPTER 4. GOALS

4.01 INTRODUCTION

Watershed management and flood resiliency plans at the HUC 8 level encompass a large geographic area and transcend traditional political boundaries, making the success of such plans dependent on the commitment and voluntary involvement of community members. As such, this plan was developed using a community-based planning process, through which both WMA members and other watershed stakeholders guided the development of the plan's vision, goals, and objectives.

ACHIEVING THE GOALS AND OBJECTIVES

To help guide the Boone River WMA towards the achievement of these goal and objectives, the watershed plan includes a long-term **Implementation Strategy in Chapter 5**, and a short-term **Action Plan in Chapter 7**. Because the WMA has no formal authority, it must rely on the commitment and voluntary involvement of community members. Therefore, since education and outreach will be the cornerstone of most activities undertaken to implement this plan, there is an **Education Plan in Chapter 6.**

4.02 GOAL-SETTING PROCESS

The first step in the goal-setting process was the development of a vision, or an optimal desired future state for the Boone River Watershed. To facilitate discussion, an initial draft vision statement was presented to the Boone River WMA during their June 4, 2020, quarterly meeting. The WMA worked through multiple rounds of review and revision to develop a vision statement that best represents what they would like to accomplish with the plan. The final vision statement (Table 27) was adopted by the WMA at the November 19, 2021, quarterly meeting.

Concurrently, the WMA also worked to establish goals and objectives for the plan. While the vision statement helps to set the stage within which efforts to implement the watershed plan will be bounded, goal and objectives help to identify key outcomes that can be used to measure progress. Additionally, goals help to clearly communicate to stakeholders what the WMA hopes to achieve. Goals are written to be long-term outcomes of watershed plan implementation. Objectives define strategies or implementation steps to attain the identified goals and provide a way of measuring movement towards each goal and the overall vision.

WMA members and stakeholders participated in multiple goal setting exercises during WMA quarterly meetings:

- June 4, 2020: Participants identified and discussed the issues and potential solutions that were important to both themselves and other interests of which they were knowledgeable.

- August 20, 2020: Participants worked to organize stakeholder input into themes, which were then further developed into draft goals and objective statements.
- November 19, 2020: Draft goals and objectives were presented and discussed. A decision to simplify and combine goals was made to reduce them to a more a manageable number that implementation efforts could focus on. However, the water quality focus was expanded from nitrate to three additional pollutants (phosphorus, sediment, and bacteria). Additionally, various metrics and indicators were discussed as additions for each of the goals.
- February 18, 2021: Updated goals and objectives were presented and discussed. Detailed water quality metrics and other indicators were added for each goal and objective.
- May 20, 2021: Final drafts of the goals and objectives were presented. Results from an online survey on the goals and objectives were used to make final edits. The goals and objectives were adopted.

The final goals and objectives are found in Table 27.

4.03 GOALS AND OBJECTIVES

The final vision, goals, and objectives that were collaboratively developed by the Boone River WMA members and stakeholders are found in Table 27. It is important to note that the vision, goals, and objectives reflect the needs and priorities of watershed communities at the time of this plan's development. These needs and priorities may change over time as resources, policy, and science continues to change; thus, these goals and objectives should be reviewed and adjusted as needed, and at a minimum of every five years during plan updates in accordance with the EPA's nine elements (EPA, 2008).

WATER QUALITY BASELINES AND TARGETS

The overarching goal of the Boone River WMA, and this watershed plan, is to improve the water quality of the Boone River. Each of the goals and objectives are written to address this overarching goal either directly or indirectly through mutually supporting efforts and interests. Baseline measurements for water quality are based on the median (or other appropriate statistic) measurement of each pollutant from 2007-2013 baseline data. This baseline date matches those found in the recently completed subwatershed plans for Prairie Creek, Eagle Creek, and Eagle Grove.

Pollutant reduction goals for nitrogen and phosphorus are based on those set by the Iowa Nutrient Reduction Strategy, reduction targets for *E. coli* bacteria are based on state water quality criteria, and reduction targets for sediment/erosion are based on locally identified targets. **These targets are also consistent with existing subwatershed plans and with meeting the 2009 Des Moines River TMDL for nitrate.** The wildlife habitat target is based on meeting the goal of the Iowa Wildlife Action Plan. Additional background on each of these plans is discussed in Chapters 1 and 2.

Target dates for achieving these goals were set to be consistent with the Iowa Nutrient Reduction Strategy and/or the stakeholder identified 20-year window for plan completion.

Table 27: Vision, Goals, and Objectives of the Plan

Vision

The Boone River WMA will be a local voice in existing and new watershed efforts through community, county, state, federal, and private partnerships to improve water quality and increase flood resiliency across the watershed. This will be achieved through facilitation of education, outreach, and implementation of practices which are voluntary, compatible with agriculture, economically viable, environmentally sound, and that improve soil health, as well as enhance recreation and wildlife habitat.

Goal 1	**Ensure water quality is adequate for all uses, both within the watershed and downstream, by meeting state water quality standards and goals.**
Objective 1.1	Reduce seasonal (April-August) median nitrate levels by 41%, from 9.3 mg/L to 5.5 mg/L, by 2035.
Objective 1.2	Reduce average median total phosphorus levels by 29%, from 0.15 mg/L to 0.11 mg/L, by 2035.
Objective 1.3	Reduce sediment loading to streams 24% by 2040, by Reducing average in-field erosion rates 25%, from 0.59 tons/acre/year to 0.44 tons/acre/year; and Reducing stream erosion 10% from 22,950 tons/year to 20,655 tons/year.
Objective 1.4	Reduce *E. coli* bacteria levels by 98% to ensure no samples exceed 235 organisms/100mL and that the seasonal geometric mean is maintained below 126 organisms/100mL, by 2035.
Goal 2	**Reduce flood risks and improve wildlife habitat within the watershed.**
Objective 2.1	Complete a study to better understand flood risks and identify mitigation actions by 2023.
Objective 2.2	Integrate the Boone River Watershed Plan with each local county hazard mitigation plan by 2025.
Objective 2.3	Double the amount of wildlife habitat (perennial vegetation) from 46,628 acres to 93,256 acres by 2041.
Goal 3	**Build an aware and engaged community that works towards improving watershed management.**
Objective 3.1	Expand WMA membership to all communities, counties, and SWCDs by the end of 2022.
Objective 3.2	Increase the number of individuals, businesses, organizations, state, and federal entities that participate in WMA meetings or watershed projects by 10% each year.
Objective 3.3	Utilize the education plan to guide outreach to targeted audiences about watershed conditions, the actions they can take, and resources available to them.

Objective 3.4 Develop a Boone River Water Trail Plan by the end of 2024.

MONITORING INDICATORS FOR EACH GOAL

Several quantitative metrics (indicators) were identified for each goal. Indicators are what is measured or monitored to determine whether progress is being made toward goals and objectives. Some have the capability to be measured nearly continuously, others at less frequent intervals; however, it will be important for the WMA to review these metrics on at least an annual basis. Monitoring and evaluating these metrics will allow the WMA to evaluate the effectiveness of implementation efforts. Additional discussion on monitoring and plan evaluation can be found in Chapter 5.

Due to the long time frame it may take to achieve many of these goals, indicators which can be measured and assessed at different intervals (long, medium, and short-term) have been identified. Additional indicators may be identified as implementation and updates to this plan are carried out. It is important to recognize that different indicators are suitable to document different types of outcomes. For instance, water quality parameters may take many years to change, so in the interim, it may be useful to document social or administrative indicators as a surrogate for water quality changes that are slowly happening. Additional discussion on indicators related to education and outreach can be found in Chapter 6.

1. Water Quality Indicators
    1.1. IDNR monitoring at the “Boone River near Stratford” monitoring site at Bell Mills Park.
    1.2. IIHR real-time nitrate sensors on the Boone River at Webster City and Goldfield.
    1.3. 30 tributary-level (subwatershed) monitoring sites provided by ACWA/ISA.
    1.4. ISU Daily Erosion Project’s estimates of hillslope erosion.
    1.5. Regular visual stream assessments.
2. Flood Resiliency and Wildlife Habitat Indicators
    2.1. Track flood resiliency indicators, such as: public assistance claims, flood insurance enrollment and claims, properties in the regulatory floodplain, properties removed from the floodplain, and projects completed.
    2.2. Track quantity and type (native vegetation, CRP, pasture, forest, etc.) of perennial vegetation within the watershed.
3. Partnership and Education Indicators
    3.1. Maintain a roster of WMA membership, and list of entities participating in meetings or projects.
    3.2. Utilize pre and post project public surveys that measure the knowledge and attitudes of target audiences.

4.04 RECOMMENDATIONS

A water quality model should be developed for the Boone River Watershed. This will allow for incremental monitoring of progress towards goals and BMP implementation to be better paired. Additionally, the goals could be updated to be based on pollutant loads rather than pollutant concentrations, which is dependent on stream monitoring.

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CHAPTER 5. LONG-TERM IMPLEMENTATION STRATEGY

INTRODUCTION

This chapter presents a long-term roadmap (20 years) for how the Boone River Watershed Management Authority (BRWMA), in partnership with federal, state, private, and nonprofit partners, will achieve the goals identified in Chapter 4. Included is an estimate of the full scope of financial and technical resources the WMA and partners will need to fully implement the plan. Due to the long time frame and large geographic extent of the watershed this strategy is broken down into multiple phases and priorities. This will allow interim progress to be measured and will require the plan to be updated at least every 5 years.

The long-term implementation strategy was developed from stakeholder input, technical analysis, and strategies identified in the current condition reports (provided in Appendix A). Previous chapters in this plan have laid the groundwork for understanding the resources, concerns, and threats within the BRW. This chapter provides the guidance on “what is to be done” in the watershed. Chapter 6 provides an education plan, the use of which should accompany any implementation effort. Action items for the first 5-year phase are provided in Chapter 7.

WILL THIS PLAN WORK?

While this plan is ambitious, this chapter also presents the estimated results or outcomes of what implementation would achieve. Using a mixture of BMPs, it has been shown that goals can be met without sacrificing the agricultural backbone of the watershed.

For example:

- A scenario involving implementation of Prairie STRIPS, cover crops, no-till, and ponds could achieve significant reductions in flooding, with peak flow reductions of 32.1%, while still maintaining large portions of the watershed in row crop production.
- A similar water quality scenario showed the lowest-hanging fruit to improve water quality is adhering to the recommended fertilizer rate; however, planting cover crops and a diverse rotation were also effective. In fact, planting cover crops alone achieved the Iowa Nutrient Reduction Strategy goal of a 41% nitrate load reduction by agricultural nonpoint sources – the same goal used in this watershed plan. As an additional benefit, simulated crop yields were not observed to drop significantly under these BMP scenarios.

To achieve these results, it will take education and buy-in of landowners, farmers, and communities, plus grants and other funds to help make this plan a reality.

5.01 OVERARCHING STRATEGIES

Both watershed-wide and targeted implementation efforts to improve water quality and flood resiliency will primarily be accomplished through both existing partner programs and projects and newly identified projects. Generally, existing programs provide landowners, producers, and communities access to technical and financial assistance. However, to enable targeted implementation, partners will need to work together to focus these programs (to the greatest extent possible) on the priorities identified in this plan. The following strategies have been identified to guide these activities:

1. **Voluntary** - Adoption of BMPs, projects, or other programs is through voluntary involvement for landowners, producers, and all partners.
2. **Compatible with Agriculture** – Agriculture is the primary economic engine and land use within the watershed. Therefore, implementation should work within this existing system and minimize land taken out of production.
3. **Phased** - Full implementation will require a long-term campaign, and thus has been phased to allow progress to be evaluated and strategies adjusted.
4. **Prioritized** - Initial priorities have been identified to focus energy and resources, which will allow results to be seen and measured more readily.
5. **Whole Farm Conservation** – Each farm, producer, and landowner has unique goals and production constraints; therefore, conservation decisions are also personal. A full menu of practices will be utilized including land use changes, soil health practices, and BMPs located in-field, at the edge-of-field, below fields, and within the riparian area of each farm.
6. **Sustainable Communities** - Encourage the development and adoption of policies that reduce runoff and protect the floodplain within communities.
7. **Flood Resiliency** – A watershed approach to flood resiliency benefits the entire watershed, which is accomplished through distributed storage, mitigation at key infrastructure, and improvements to watershed drainage and hydrology. This approach provides additional benefits of improved water quality, enhanced wildlife habitat, and recreation.

While these general strategies translate across the planning area, specific practices and actions will need to be tailored to the specific project area, producer, or landowner. A key to getting private landowners or producers to participate in implementation voluntarily is to identify and address barriers to adoption. These barriers may be related to a lack of understanding or knowledge; logistics; technical staff; costs; or other factors. To successfully address these barriers, it is necessary for partners to work together in developing creative approaches and to involve all available funding sources. Actions centered around outreach and education can help to identify and break down these barriers – see Chapter 6. Actions centered around working together with partners and identifying technical and financial tools to help implement these strategies are discussed in Chapter 8.

5.02 BEST MANAGEMENT PRACTICES

TOOLBOX OF PRACTICES

Implementation of the plan relies on the voluntary adoption and use of **Best Management Practices (BMPs), which are defined as a broad set of conservation practices that help to conserve soil and water resources.** These BMPs have been previously identified and discussed in detail by many other sources. Sometimes these BMPs are referred to as strategies, mitigation alternatives, practices, projects, etc. depending on the agency or scale of effort. The following resources are essentially the "toolbox" of practices and provide background and technical information on the BMPs included as part of this plan.

- **Iowa Nutrient Reduction (NRS) -** The NRS has identified multiple BMPs to reduce nutrients. Summary sheet SP435A provides information on pollutant reduction rates for select BMPs. Available at: http://www.nutrientstrategy.iastate.edu/
- **Clean Water Iowa -** Clean Water Iowa provides information on BMPs applicable to rural (agricultural), urban, and industrial areas. Available at: https://www.cleanwateriowa.org/
- **ACPF Toolbox Manual -** The ACPF tool is used to cite various structural BMPs according to NRCS practice standards. Available at: https://acpf4watersheds.org/
- **Iowa Stormwater Education Partnership (ISWEP) -** ISWEP has developed multiple information sheets for stormwater BMPs. Available at: https://iowastormwater.org/
- **Iowa Watershed Approach -** Multiple BMP informational sheets were developed by Iowa State University Extension. Available at: https://iowawatershedapproach.org/
- **Oxbow Restoration Toolbox -** This toolkit serves as a step-by-step guide for conservation professionals, landowners, and farmers to learn how to restore oxbow wetlands using cross-agency standards. Available at: https://booneriver.org/project-area/oxbow-restoration/
- **Small Open Beef Feedlots in Iowa – A Producer Guide -** Information on BMPs specific to livestock management can be found in this guide. Available at: https://store.extension.iastate.edu/product/Small-Open-Beef-Feedlots-in-Iowa-a-producer-guide
- **Iowa DNR River Restoration Toolbox -** A series of BMPs developed to assist designers in stream stabilization and restoration projects in Iowa with proven techniques with emphasis on incorporating natural materials. Available at: https://www.iowadnr.gov/Environmental-Protection/Water-Quality/River-Restoration/River-Restoration-Toolbox
- **Low-Tech Process Based Restoration of Riverscapes Design Manual -** This design manual provides restoration practitioners with guidelines for implementing a subset of low-tech tools—namely post-assisted log structures (PALS) and beaver dam analogues (BDAs)—for stream restoration. Available at: http://lowtechpbr.restoration.usu.edu/manual/.
- **Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards** (FEMA, 2013) – This publication identifies potential mitigation actions for reducing risk to all types of natural hazards, including flooding. The actions are summarized into four types: 1) local planning and regulation, 2) structures and infrastructure projects, 3) natural systems protection, and 4) education and awareness programs.

THE CONSERVATION PYRAMID

The conservation pyramid concept, which can be seen in Figure 60, recognizes that to be effective, implementation within agricultural watersheds must be taken through a systematic approach of a suite of BMPs. The foundation of the conservation pyramid relies on using BMPs to protect and improve soil health at the field level to improve erosion control, improve water infiltration and retention, increase soil organic matter, and improve nutrient cycling. Structural practices to control and treat runoff should then be targeted to specific in-field, edge-of-field, and riparian locations where maximum water quality benefits can be realized. Examples of BMPs that address soil health and control, or trap, pollutants are provided in the pyramid. However, there are many other actions that should be considered during implementation.

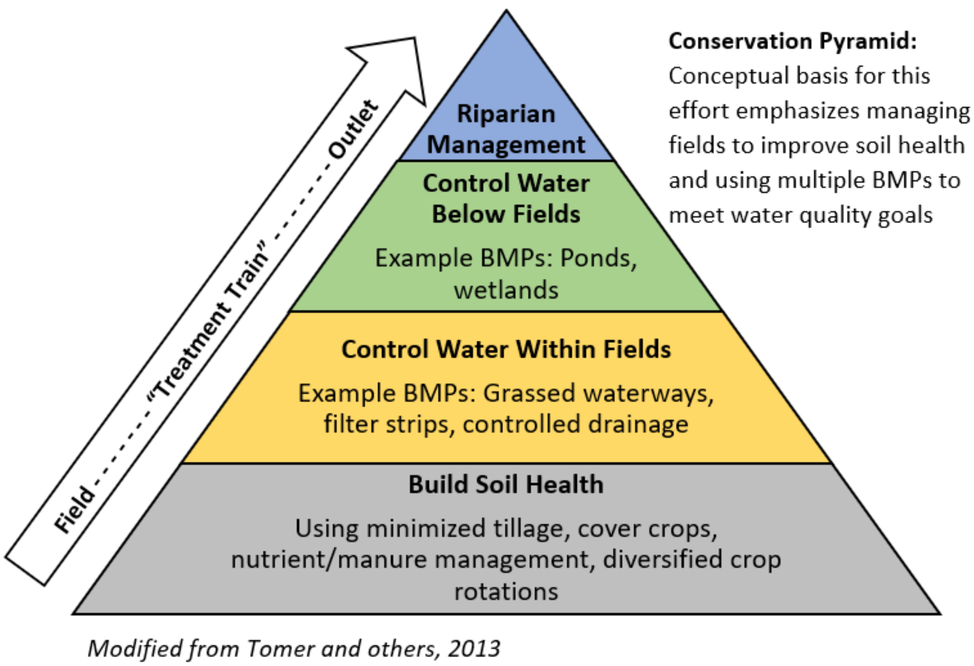


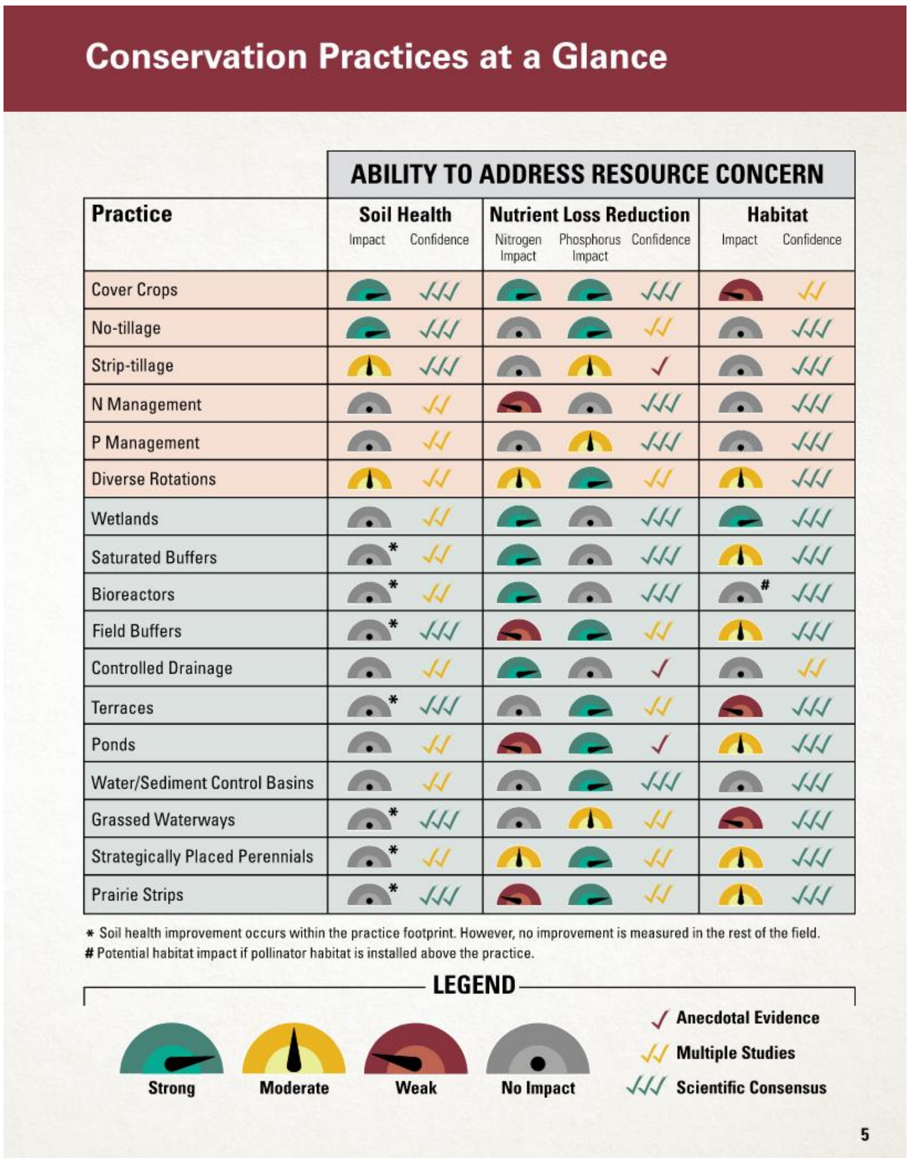
Figure 60: The Conservation Pyramid Provides a Framework for BMP Implementation

The conservation pyramid approach essentially means that BMPs are ideally implemented in a series or a "treatment train" with each other throughout the watershed, so their effects are multiplied as implementation is scaled up. This generally leads to multiple practices on each farm or project area within the watershed as implementation advances. This approach requires that the full suite of BMPs be made available for implementation, so that the correct practice can be selected based on individual site characteristics and landowner or producer preferences.

While this watershed plan is based upon this approach, analysis was limited to BMPs with available data, which were prioritized though stakeholder input based on applicability to the watershed. Where possible, analysis was provided on these BMPs to evaluate feasibility, possible benefits, and costs.

WHOLE FARM CONSERVATION

Guidance on implementation of priority BMPs to agricultural areas is provided through within the *Whole Farm Conservation Manual* (ISU, 2020). This manual was developed by ISU Extension and summarizes the existing scientific consensus of BMPs and streamlines the BMP recommendation process for landowners, producers, and natural resource professionals. The manual complements the NRCS conservation planning process and integrates BMPs from the Iowa Nutrient Reduction Strategy. Figure 61 is an excerpt from the manual and provides a clear overview of these practices and their impacts on resources.



Source: Whole Farm Conservation Best Practices (ISU, 2020)

Figure 61: Priority Agricultural BMPs

LIVESTOCK PRACTICES

While the NRS identifies the best BMPs to reduce nitrogen and phosphorus runoff from agricultural lands, it does not fully address grazing lands and small open feedlots. These can be some of the largest sources of *E. coli* bacteria runoff, which has impaired the water quality of the Boone River. Priority BMPs for these sources are identified in Figure 62.

Figure 62: Priority BMPs for Livestock

URBAN STORMWATER MANAGEMENT

Residential and urban landscapes generate runoff with almost every rainfall event. Conservation measures capture and infiltrate stormwater and reduce a property's contribution to water quality degradation, flashy stream flows, and flooding. Communities benefit from urban conservation in installing new systems and retrofitting existing infrastructure so that water will move off streets, keeping soil and pollutants out of our waterways. The practices identified in Figure 63 are the best practices for preventing runoff and promoting infiltration within urbanized areas.

Image Credit: Clean Water Iowa, 2021

Figure 63: Priority Urban Stormwater BMPs

POLLUTANT TREATEMENT EFFECTIVENESS

It is important to understand the effectiveness that BMPs have in reducing pollutant loads, often referred to as treatment efficiency. The suitability and performance of BMPs can vary significantly based on site conditions, therefore detailed feasibility, design, and analysis may be needed prior to implementing a BMP.

Treatment efficiencies for nitrogen and phosphorus were identified in the Iowa Nutrient Reduction Strategy and summarized in the ISU Extension publication titled *Reducing Nutrient Loss: Science Shows What Works* (Lawrence and Benning, 2019). Excerpts from this are provided in Figure 64 and Figure 65. Treatment efficiencies for *E. coli* were identified through an analysis of scientific peer reviewed literature and are summarized in Table 28. A representative efficiency was selected for display in the table.

Table 28: Summary of BMP Treatment Efficiencies for E. coli bacteria

Best Management Practice (BMP)	**Estimated Treatment Efficiency**
	***E. coli* bacteria**
Watershed Education and Information	10%
Onsite Wastewater Treatment System (OWTS) Upgrade	Change OWTS failure rate from 40% to 5%
Pet Waste Pick-up	20%
Non-structural & Avoidance BMPs	10%
Drainage Water Management	0%
Grazing Lands Management BMPs*	40%
Cover Crops	40%
Riparian Buffers	70%
No-Till Farming	0%
Contour Buffer Strips (Prairie STRIPS, etc.)	70%
Small Open Feedlot BMPs	75%
Wetlands/Farm Ponds/Sediment Basins	78%
Bioreactors	70%
Stream Restoration / Stabilization	35%
Terraces	70%
Water and Sediment Control Basins (WASCOBs)	70%
Grassed Waterways	70%
Land Use Change & Perennial Vegetation	Dependent upon land use type
Urban Stormwater BMPs	37%

*This includes multiple practices such as rotational grazing, fencing, etc.

Iowa Strategy to Reduce Nutrient Loss: Nitrogen Practices

This table lists practices with the largest potential impact on nitrate-N concentration reduction (except where noted). Corn yield impacts associated with each practice also are shown as some practices may be detrimental to corn production. If using a combination of practices, the reductions are not additive. Reductions are field level results that may be expected where practice is applicable and implemented.

	Practice	Comments	% Nitrate-N Reduction*	% Corn Yield Change**
			Average (SD†)	Average (SD†)
Nitrogen Management‡	Timing	Moving from fall to spring pre-plant application	6 (25)	4 (16)
		Spring pre-plant/sidedress 40-60 split Compared to fall-applied	5 (28)	10 (7)
		Sidedress – Compared to pre-plant application	7 (37)	0 (3)
		Sidedress – Soil test based compared to pre-plant	4 (20)	13 (22)††
	Source	Liquid swine manure compared to spring-applied fertilizer	4 (11)	0 (13)
		Poultry manure compared to spring-applied fertilizer	-3 (20)	-2 (14)
	Nitrogen Application Rate	Nitrogen rate at the MRTN (0.10 N:corn price ratio) compared to current estimated application rate. (ISU Corn Nitrogen Rate Calculator – **http://cnrc.agron.iastate.edu** can be used to estimate MRTN but this would change Nitrate-N concentration reduction)	10	-1
	Nitrification Inhibitor	Nitrapyrin in fall – Compared to fall-applied without Nitrapyrin	9 (19)	6 (22)
	Cover Crops	Rye	31 (29)	-6 (7)
		Oat	28 (2)	-5 (1)
	Living Mulches	e.g. Kura clover – Nitrate-N reduction from one site	41 (16)	-9 (32)
Land Use	Perennial	Energy Crops – Compared to spring-applied fertilizer	72 (23)	
		Land Retirement (CRP) – Compared to spring-applied fertilizer	85 (9)	
	Extended Rotations	At least 2 years of alfalfa in a 4 or 5 year rotation	42 (12)	7 (7)
	Grazed Pastures	No pertinent information from Iowa – assume similar to CRP	85	
Edge-of-Field	Drainage Water Mgmt.	No impact on concentration	33 (32)	
	Shallow Drainage	No impact on concentration	32 (15)	
	Wetlands	Targeted water quality	52	
	Bioreactors		43 (21)	
	Buffers	Only for water that interacts with the active zone below the buffer. This would only be a fraction of all water that makes it to a stream.	91 (20)	
	Saturated Buffers	Divert fraction of tile drainage into riparian buffer to remove Nitrate-N by denitrification.	50 (13)	
	Multi-purpose Oxbow	Targeted water quality	42 (6)	

* A positive number is nitrate concentration or load reduction and a negative number is an increase.

** A positive corn yield change is increased yield and a negative number is decreased yield. Practices are not expected to affect soybean yield.

† SD = standard deviation. Large SD relative to the average indicates highly variable results.

†† This increase in crop yield should be viewed with caution as the sidedress treatment from one of the main studies had 95 pounds-N/acre for the pre-plant treatment but 110 pounds-N/acre to 200 pounds-N/acre for the sidedress with soil test treatment so the corn yield impact may be due to nitrogen application rate differences.

Source: *Reducing Nutrient Loss: Science Shows What Works (Lawrence and Benning, 2019)*

Figure 64: Summary of BMP Treatment Efficiencies for Nitrogen

‡ See Standard Practices (blue box) on page 2 of this publication.

Iowa Strategy to Reduce Nutrient Loss: Phosphorus Practices

Practices below have the largest potential impact on phosphorus load reduction. Corn yield impacts associated with each practice also are shown, since some practices may increase or decrease corn production. If using a combination of practices, the reductions are not additive. Reductions are field level results that may be expected where practice is applicable and implemented.

	Practice	Comments	% P Load Reduction[a]	% Corn Yield Change[b]
			Average (SD[c])	Average (SD[c])
Phosphorus Management‡	Phosphorus Application	Applying P based on crop removal – Assuming optimal STP level and P incorporation	0.6[d]	0
		Soil-Test P – No P applied until STP drops to optimum or, when manure is applied, to levels indicated by the P Index[f]	17[e]	0
	Source of Phosphorus	Liquid swine, dairy, and poultry manure compared to commercial fertilizer – Runoff shortly after application‡	46 (45)	-1 (13)
		Beef manure compared to commercial fertilizer – Runoff shortly after application‡	46 (96)	
	Placement of Phosphorus	Broadcast incorporated within 1 week compared to no incorporation, same tillage	36 (27)	0
		With seed or knifed bands compared to surface application, no incorporation	24 (46)	0
	Cover Crops	Winter rye	29 (37)	-6 (7)
	Tillage	Conservation till – chisel plowing compared to moldboard plowing	33 (49)	0 (6)
		No till compared to chisel plowing	90 (17)	-6 (8)
Land Use Change	Perennial Vegetation	Energy Crops	34 (34)	
		Land Retirement (CRP)	75	
		Grazed pastures	59 (42)	
Erosion Control and Edge-of-Field	Terraces		77 (19)	
	Buffers		58 (32)	
	Control	Sedimentation basins or ponds	85	
	Blind Inlet	Sediment control	50	

[a] A positive number is P load reduction and a negative number is increased P load.

[b] A positive corn yield change is increased yield and a negative number is decreased yield. Practices are not expected to affect soybean yield.

[c] SD = standard deviation. Large SD relative to the average indicates highly variable results.

[d] Maximum and average estimated by comparing application of 200 and 125 kilogram P_2O_5/hectare, respectively, to 58 kilogram P_2O_5/hectare (corn-soybean rotation requirements) (Mallarino et al., 2002).

[e] Maximum and average estimates based on reducing the average STP (Bray-1) of the two highest counties in Iowa and the statewide average STP (Mallarino et al., 2011a), respectively, to an optimum level of 20 ppm (Mallarino et al., 2002). Minimum value assumes soil is at the optimum level.

[f] ISU Extension and Outreach publication (PM 1688).

‡ See Standard Practices (blue box) on page 2 of this publication.

Source: *Reducing Nutrient Loss: Science Shows What Works (Lawrence and Benning, 2019)*

Figure 65: Summary of BMP Treatment Efficiencies for Phosphorus

FLOOD RESILIENCY PRACTICES

Flood resiliency recognizes that to improve a community's ability to recover from flooding, the risk from flooding must be reduced at both watershed and community levels. It will be important for the WMA to help all partners work together to implement these practices. This will involve implementing land management policies, structural and nonstructural measures, and mitigation against remaining risks. An additional benefit of flood resiliency practices is that many of them lead to improved water quality and wildlife habitat.

In Figure 66, the bars on the far left indicate the initial, unmitigated risk a community faces and the low amount of resiliency they may have. Taking strategic actions, as indicated in the subsequent bars, reduces the unmitigated risk. Some of these actions are taken at the federal, state, and local community levels, whereas others are taken by the homeowners and businesses at risk. The remaining risk after all actions have been taken is the residual risk (blue bar on the far right); however, resiliency is very high at this point. This approach leads to reductions in loss of property, improved safety, and an improved ability to recover from other hazard impacts. Individually each strategy contributes a certain amount of risk reduction; however, when the efforts are combined, a dramatic reduction in risk is achieved.

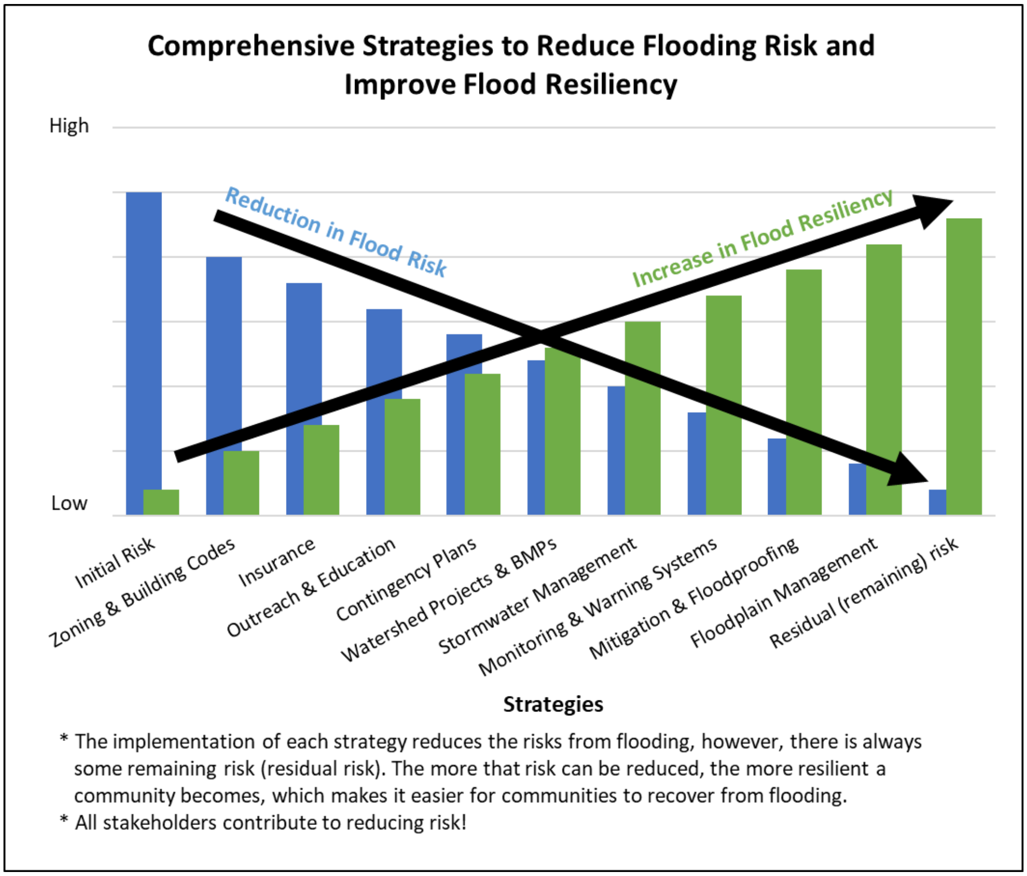


Figure 66: Illustration of how reducing flood risks leads to an increase in flood resiliency

Strategies and projects related to flood resiliency and hazard mitigation were identified through a review of local county hazard mitigation plans (HMP). Mitigation actions directly related to the interests of the watershed are listed in Table 29. Additional information can be found in the *Flood Resiliency* and *Hazard Mitigation Current Condition Reports*, both located in Appendix A. It is recommended to further integrate the Boone River Watershed Plan with each county's local HMP by recognizing or amending this plan into each HMP.

Table 29: Mitigation Actions Identified in Local Hazard Mitigation Plans that are Related to the Watershed

Mitigation Action	Jurisdiction
Encourage farmers to engage in conservation practices	Humboldt County
Replacement of sewer and water damage	Britt
Reconstruct/repair DD15/15A to reduce the amount of flash flooding that occurs within town; Begin process of assessment of DD-15 infrastructure, classify drainage district if needed, explore mitigation and funding	Eagle Grove
Acquire flood prone properties for conversion into green space; or elevate structures to or above base flood elevation; construction of levees, dams, and culverts to ensure adequate capacity and protection levels for property and critical facilities.	Kossuth County, Lu Verne
Look into alternatives for protecting repetitive flood loss properties	Hamilton County)
Enforce the floodplain ordinances and update them as needed	Webster City, Goldfield
Participate in the National Flood Insurance Program (NFIP)	Webster City, Corwith, Kossuth County, Lu Verne, Wright County, Clarion
Purchase trash pumps	Humboldt County
Purchase portable sand barricades and sand filling machines	Humboldt County
Study and fix storm sewer	Renwick
Separating storm and sanitary sewer, eliminating connections to mitigate property damage due to backflow and flooding	Eagle Grove
Increase storm water handling capacity for entire community	Corwith
Upgrade county tiles	Humboldt County
When roads, ditches etc. are reconstructed evaluate the condition of the drainage tile	Wright County
Identify, pinpoint, and fix the inflow and infiltration of water into the tile system and its effects on the storm sewer. Knowing where all these sources are throughout town, a project could then be developed to reduce flash flooding and sewer backups	Eagle Grove
Wastewater Treatment Facility upgrade and repair	Britt
Construct, retrofit, or maintain water supply, drainage, sewage, retention, and detention systems to provide for the proper functioning of those systems	Kossuth County, Wesley
Continue monitoring current industrial discharges and consider ordinance to address future industrial discharge scenarios	Eagle Grove

5.03 PRIORITY SUBWATERSHEDS FOR BMP IMPLEMENTATION

PRIORITY SUBWATERSHED SELECTION

This plan covers a large geographical area and addresses many interrelated issues. To facilitate and focus BMP implementation efforts in a way that will lead to measurable results, priority areas, based on HUC 12 subwatershed boundaries, were utilized. The identification and selection process of these areas utilized water quality data and input from stakeholders and watershed planning partners. After a lengthy review and selection process, the WMA's final selection consisted of five (5) areas, identified in Table 30 and shown in Figure 67.

Table 30: Priority Subwatersheds for BMP Implementation

Name	Acres	Notes
Brewer Creek Subwatershed	15,223	
Drainage Ditch #9 Subwatershed	12,275	
Headwaters Eagle Creek Subwatershed	21,390	Located within a portion of the Eagle Creek WQI Project
Otter Creek Subwatershed	54,139	Consists of 3 HUC 12s
White Fox Creek Subwatershed	55,662	Consists of 2 HUC 12s
Total	**158,689**	

These areas were prioritized due to high levels of nitrates (water quality monitoring data provided in chapter 2), opportunities to address multiple resource issues (drainage ditches, habitat, urban stormwater, and others), options for both large and small projects, geographic dispersion within the watershed to maximize project opportunities, and proximity to WMA members to maximize partnership opportunities. These areas represent approximately 27% of the entire Boone River Watershed.

Following adoption of this plan, the BRWMA and/or its partners will need to select an area to pursue BMP implementation efforts. This will consist of obtaining funding that will be used for BMP cost-share for landowners, education and outreach efforts, and other supporting activities. A detailed project plan will be developed, specific to the priority area selected, and will include the following:

- Project sponsor and partners
- Project description
- Goals and objectives
- Proposed BMPs
- Pollutant source and load reductions
- Education and outreach activities
- Monitoring and evaluation procedures
- Schedules and milestones
- Budget

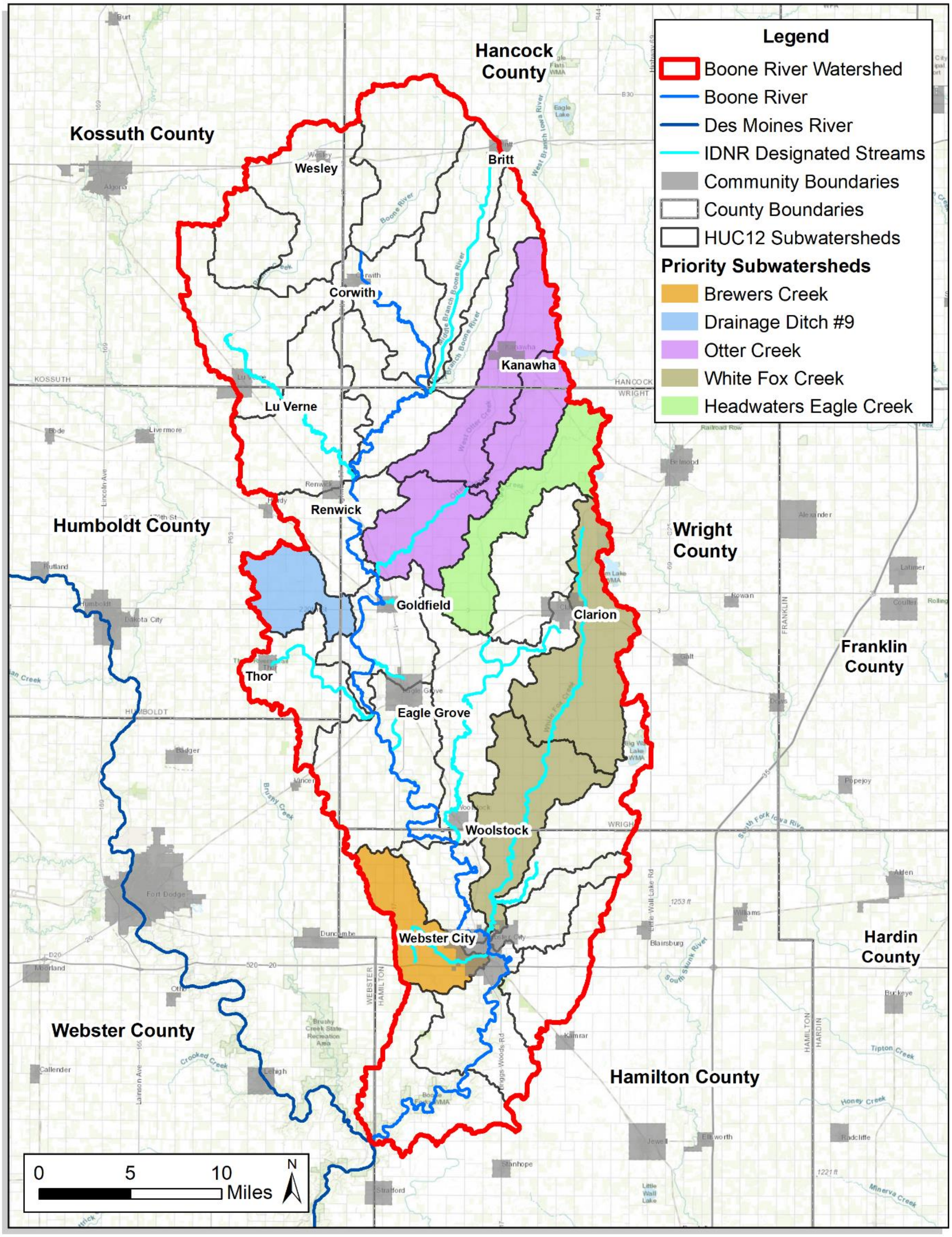


Figure 67: Priority Subwatersheds for BMP Implementation

BMP TARGETS FOR PRIORITY SUBWATERSHEDS

Target levels for BMP implementation in each priority subwatershed have been developed to aid the WMA and partners in estimating technical and financial resources needed to implement this plan. These targets have been identified for select BMPs only – those most likely to be the focus of implementation efforts or most likely adopted. Only available data was used. Targets were estimated from partner input, ACPF mapping data, and through a review of existing BMP levels (discussed in Chapter 3). ACPF data was not available for West Otter Creek, Headwaters Otter Creek, and Brewers Creek. Prior to project development ACPF mapping should be completed for these priority subwatersheds. It may also be valuable to update ACPF mapping for all priority watersheds to the latest version of the program.

It should be noted that some of these potential BMPs may overlap with existing BMPs. Due to this potential overlap, the targets provided should be considered an estimate of BMP needs within the subwatershed. A detailed review of LiDAR, aerial photography, and in-field surveys should be completed to compare these estimated needs with actual BMP levels. This review should be completed prior to landowner consultation for BMP siting. Please note that the direct and indirect costs of any BMP can vary considerably from site to site and are largely contingent on initial conditions, hydrology, soils, cropping system, practice design, management characteristics and experienced opportunity costs (which can be highly variable). The costs presented here are simply baseline numbers and are meant to be informative rather than prescriptive.

The preliminary cost opinion of BMP implementation within each priority subwatershed is provided in Table 31 through Table 38. This estimate does not include costs for final designs of engineering projects as these costs would be contingent on project scoping. Additionally, costs for education, monitoring, or other special studies are not included here. Additional information on the costs of full watershed plan implementation is provided later in this chapter.

Please note that costs are subject to change based on final designs, inflation, bidding climate at the time of construction, and project size and complexity. These cost opinions are based on the full cost of each BMP, not on the cost-share rates which can vary. This plan assumes that multiple funding sources will be utilized for implementation. Information on possible technical and financial resources to assist with plan implementation can be found in Chapter 8. Note that the costs given below are based on complete BMP implementation; however, those efforts may be spread over multiple years depending on funding availability or BMP adoption rates.

Table 31: Estimated BMPs Needed and Cost Opinions for the Brewer Creek Subwatershed

BMP Practice	Target Number for Cost Estimate*	Unit for Cost Estimate	Unit Cost	Total Cost
Bioreactors	*unknown*	Site	$ 10,150	$ -
Conservation Tillage	12,034	Acres	$ 30	$ 360,000
Cover Crops	12,034	Acres	$ 44	$ 528,000
Drainage Water Management	*unknown*	System	$ 1,656	$ -
Grassed Waterway	*unknown*	Acres	$ 5,277	$ -
Nutrient Management	12,034	Acres	$ 75	$ 900,000
Nutrient Reduction / CREP Wetlands	*unknown*	Site	$ 25,055	$ -
Oxbow Restoration	14	Site	$ 7,500	$ 105,000
Prairie STRIPs / Contour Buffer Strips	*unknown*	Acres	$ 298	$ -
Row Crop Conversion to Perennial Cover / Wildlife Habitat	850	Acres	$ 330	$ 282,150
Saturated Buffer	*unknown*	Acres	$ 360	$ -
Urban BMPs**	1	Community	$ 275,000	$ 275,000
Total				**$ 2,450,150**

** "Unknown" indicates that ACPF modeling was not available to estimate these BMP targets*

***Urban BMPs included due to Webster City being within the priority area*

Table 32: Estimated BMPs Needed and Cost Opinions for the Drainage Ditch #9 Subwatershed

BMP Practice	Target Number for Cost Estimate	Unit for Cost Estimate	Unit Cost	Total Cost
Bioreactors	23	Site	$ 10,150	$ 233,450
Conservation Tillage	10,950	Acres	$ 30	$ 328,500
Cover Crops	10,950	Acres	$ 44	$ 481,800
Drainage Water Management	133	System	$ 1,656	$ 220,248
Grassed Waterway	3.97	Acres	$ 5,277	$ 20,950
Nutrient Management	10,950	Acres	$ 75	$ 821,250
Nutrient Reduction / CREP Wetlands	0	Site	$ 25,055	$ -
Oxbow Restoration	3	Site	$ 7,500	$ 22,500
Prairie STRIPs / Contour Buffer Strips	7	Acres	$ 298	$ 2,217
Row Crop Conversion to Perennial Cover / Wildlife Habitat	437	Acres	$ 330	$ 144,210
Saturated Buffer	20	Acres	$ 360	$ 7,200
Urban BMPs	0	Community	$275,000	$ -
Total				**$ 2,282,325**

Table 33: Estimated BMPs Needed and Cost Opinions for the Headwaters Eagle Creek Subwatershed

BMP Practice	Target Number for Cost Estimate	Unit for Cost Estimate	Unit Cost	Total Cost
Bioreactors	82	Site	$ 10,150	$ 832,300
Conservation Tillage	16,650	Acres	$ 30	$ 499,500
Cover Crops	16,650	Acres	$ 44	$ 732,600
Drainage Water Management	214	System	$ 1,656	$ 354,384
Grassed Waterway	102	Acres	$ 5,277	$ 539,962
Nutrient Management	16,650	Acres	$ 75	$ 1,248,750
Nutrient Reduction / CREP Wetlands	10	Site	$ 25,055	$ 250,550
Oxbow Restoration	0	Site	$ 7,500	$ -
Prairie STRIPs / Contour Buffer Strips	102	Acres	$ 298	$ 30,359
Row Crop Conversion to Perennial Cover / Wildlife Habitat	1,927	Acres	$ 330	$ 635,910
Saturated Buffer	20	Acres	$ 360	$ 7,200
Urban BMPs	0	Community	$ 275,000	$ -
Total				**$ 5,131,515**

Table 34: Estimated BMPs Needed Cost Opinions for the West Otter Creek Subwatershed

BMP Practice	Target Number for Cost Estimate*	Unit for Cost Estimate	Unit Cost	Total Cost
Bioreactors	*unknown*	Site	$ 10,150	
Conservation Tillage	21,720	Acres	$ 30	$ 651,600
Cover Crops	21,720	Acres	$ 44	$ 955,680
Drainage Water Management	*unknown*	System	$ 1,656	
Grassed Waterway	*unknown*	Acres	$ 5,277	
Nutrient Management	21,720	Acres	$ 75	$ 1,629,000
Nutrient Reduction / CREP Wetlands	*unknown*	Site	$ 25,055	
Oxbow Restoration	0	Site	$ 7,500	$ -
Prairie STRIPs / Contour Buffer Strips	*unknown*	Acres	$ 298	
Row Crop Conversion to Perennial Cover / Wildlife Habitat	825	Acres	$ 330	$ 272,250
Saturated Buffer	*unknown*	Acres	$ 360	
Urban BMPs**	1	Community	$ 275,000	$ 275,000
Total				**$ 3,783,530**

** "Unknown" indicates that ACPF modeling was not available to estimate these BMP targets*
***Urban BMPs included due to Kanawha being within the priority area*

Table 35: Estimated BMPs Needed Cost Opinions for the Headwaters Otter Creek Subwatershed

BMP Practice	Target Number for Cost Estimate*	Unit for Cost Estimate	Unit Cost	Total Cost
Bioreactors	*unknown*	Site	$ 10,150	
Conservation Tillage	11,300	Acres	$ 30	$ 339,000
Cover Crops	11,300	Acres	$ 44	$ 497,200
Drainage Water Management	*unknown*	System	$ 1,656	
Grassed Waterway	*unknown*	Acres	$ 5,277	
Nutrient Management	11,300	Acres	$ 75	$ 847,500
Nutrient Reduction / CREP Wetlands	*unknown*	Site	$ 25,055	
Oxbow Restoration	0	Site	$ 7,500	$ -
Prairie STRIPs / Contour Buffer Strips	*unknown*	Acres	$ 298	
Row Crop Conversion to Perennial Cover / Wildlife Habitat	380	Acres	$ 330	$ 125,400
Saturated Buffer	*unknown*	Acres	$ 360	
Urban BMPs	0	Community	$ 275,000	$ -
Total				**$ 1,809,100**

** "Unknown" indicates that ACPF modeling was not available to estimate these BMP targets*

Table 36: Estimated BMPs Needed Cost Opinions for the Otter Creek Subwatershed

BMP Practice	Target Number for Cost Estimate	Unit for Cost Estimate	Unit Cost	Total Cost
Bioreactors	25	Site	$ 10,150	$ 253,750
Conservation Tillage	19,330	Acres	$ 30	$ 579,900
Cover Crops	19,330	Acres	$ 44	$ 850,520
Drainage Water Management	244	System	$ 1,656	$ 404,064
Grassed Waterway	2.05	Acres	$ 5,277	$ 10,818
Nutrient Management	19,330	Acres	$ 75	$ 1,449,750
Nutrient Reduction / CREP Wetlands	6	Site	$ 25,055	$ 150,330
Oxbow Restoration	31	Site	$ 7,500	$ 232,500
Prairie STRIPs / Contour Buffer Strips	2.81	Acres	$ 298	$ 837
Row Crop Conversion to Perennial Cover / Wildlife Habitat	2217	Acres	$ 330	$ 731,610
Saturated Buffer	20	Acres	$ 360	$ 7,200
Urban BMPs	0	Community	$ 275,000	$ -
Total				**$ 4,671,279**

Table 37: Estimated BMPs Needed Cost Opinions for the Headwaters White Fox Creek Subwatershed

BMP Practice	Target Number for Cost Estimate	Unit for Cost Estimate	Unit Cost	Total Cost
Bioreactors	118	Site	$ 10,150	$ 1,197,700
Conservation Tillage	25,780	Acres	$ 30	$ 773,400
Cover Crops	25,780	Acres	$ 44	$ 1,134,320
Drainage Water Management	277	System	$ 1,656	$ 458,712
Grassed Waterway	21.65	Acres	$ 5,277	$ 114,247
Nutrient Management	25,780	Acres	$ 75	$ 1,933,500
Nutrient Reduction / CREP Wetlands	20	Site	$ 25,055	$ 501,100
Oxbow Restoration	26	Site	$ 7,500	$ 195,000
Prairie STRIPs / Contour Buffer Strips	74.33	Acres	$ 298	$ 22,150
Row Crop Conversion to Perennial Cover / Wildlife Habitat	1629	Acres	$ 330	$ 537,570
Saturated Buffer	20	Acres	$ 360	$ 7,200
Urban BMPs*	0.5	Community	$ 275,000	$ 275,000
Total				**$ 7,149,899**

**Urban BMPs included due to Clarion being within the priority area*

Table 38: Estimated BMPs Needed Cost Opinions for the White Fox Creek Subwatershed

BMP Practice	Target Number for Cost Estimate	Unit for Cost Estimate	Unit Cost	Total Cost
Bioreactors	76	Site	$ 10,150	$ 771,400
Conservation Tillage	14,200	Acres	$ 30	$ 426,000
Cover Crops	14,200	Acres	$ 44	$ 624,800
Drainage Water Management	362	System	$ 1,656	$ 599,472
Grassed Waterway	5.2	Acres	$ 5,277	$ 27,440
Nutrient Management	14,200	Acres	$ 75	$ 1,065,000
Nutrient Reduction / CREP Wetlands	14	Site	$ 25,055	$ 350,770
Oxbow Restoration	76	Site	$ 7,500	$ 570,000
Prairie STRIPs / Contour Buffer Strips	15.44	Acres	$ 298	$ 4,601
Row Crop Conversion to Perennial Cover / Wildlife Habitat	1007	Acres	$ 330	$ 332,310
Saturated Buffer	20	Acres	$ 360	$ 7,200
Urban BMPs*	1	Community	$ 275,000	$ 275,000
Total				**$ 5,053,994**

**Urban BMPs included due to Webster City being within the priority area*

5.04 SPECIAL PRIORITIES

Special priority areas provide flexibility in addressing identified small-scale areas with specific, limited, and timely needs. These include areas which consist of important resources or pollutant sources that are limited in their geographic footprint; have specific BMP needs; offer unique water quality or flood mitigation benefits; or are important for public health reasons. These areas were identified through stakeholder input and analysis of available data. It is recommended that projects and BMPs be pursued for special priorities even when they lie outside of a priority subwatershed. Where possible, cost opinions have been provided. Projects in these areas are typically excellent candidates for partnering opportunities. The following special priorities have been identified:

ON-SITE WASTEWATER TREATMENT SYSTEMS

On-site wastewater treatment systems (OWTS) are private systems installed at homes and facilities to treat wastewater when no connection to a municipal wastewater treatment system exists. No central database exists to identify the status of OWTS or to ensure that these systems are adequately sized and functioning appropriately. However, many farmsteads and acreages throughout the BRW likely have these systems. OWTS are considered a special priority because when they fail, they become a potential bacteria and nutrient pollution source. OWTS should be targeted for pumping and inspections, with possible replacement of systems that are found to be failing. Homeowners with OWTS that are near streams and lakes should be prioritized.

LOW HEAD DAMS

Iowa has many low head dams across the state. “Low head” dams span a river and are less than 20 feet high (many are just 2-5 feet high). The dams are often deceptively dangerous as the drop below the dam can be nearly invisible from upstream. These dams are sometimes referred to as “drowning machines”, as the powerful recirculating hydraulics below the dam can trap and drown unsuspecting river users. Additionally, dams block the movement of fish and other aquatic life up and down rivers, harm the health and biodiversity of Iowa’s rivers, require costly repairs, and pose major liability concerns. Due to these concerns many low head dams have been prioritized for removal or mitigation projects by IDNR. Low head dams have been identified as a special priority because they offer unique opportunities for partnerships to benefit water quality, flood mitigation, and recreation.

During the development of this plan, several water trail specific meetings were held with stakeholders. During those meetings the following low head dams were identified that should be addressed:

- Kendall Young Park Ford (White Fox Creek), owned by Webster City
- Webster City Dam, owned by Webster City
- Sportsman Area Rock Dam, owned by Wright County Conservation
- Three Rivers Trail Dam, unknown ownership

- 240th Street Rock Dam, unknown ownership

SMALL OPEN FEEDLOTS

Almost all livestock operations have the potential to adversely impact water quality; however, those that are exempt by IDNR from regulatory requirements are a special risk. These are known as small open feedlots and are not required to retain any of their waste. They can be a potential source of bacteria, nutrients, and sediment. Additional details on these feedlots can be found in Chapter 3. Small open feedlots are identified as a special priority in order to provide a proactive approach to livestock waste management while demonstrating appropriate treatment technologies and BMPs. Only operations that are exempted by regulations or are deemed exempt by IDNR are considered. BMPs primarily include the following:

- Animal waste/manure storage systems
- Clean water diversion systems
- Vegetative treatment systems (VTS)
- Terraces
- Containment
- Evaporation ponds
- Open lot runoff management
- Heavy use area protection
- Feed management practices
- Education for manure application and planning

FISH PASSAGE

There are numerous man-made obstructions or obstacles on rivers and streams that create barriers to fish passage and migration. These primarily consist of low head dams and perched culverts. Surveys have been completed in Prairie Creek, Eagle Creek, Buck Creek, Lyons Creek, and Drainage Ditch 206 subwatersheds. Data from IDNR (K. Ament, written commun., 2020) and USFWS (J. Jarvey, oral commun., 2021) indicate there are numerous perched culverts throughout the watershed (Figure 68). Additional information is located within Chapter 2 and provided in the *Shorelines and Riparian Areas Current Conditions Report* (Appendix A) and the USFWS presentation (Appendix C).

These areas should be targeted for the following activities:

- Remove or modify high priority culverts
- Monitor and assess medium and low priority barriers
- Assess remaining watersheds

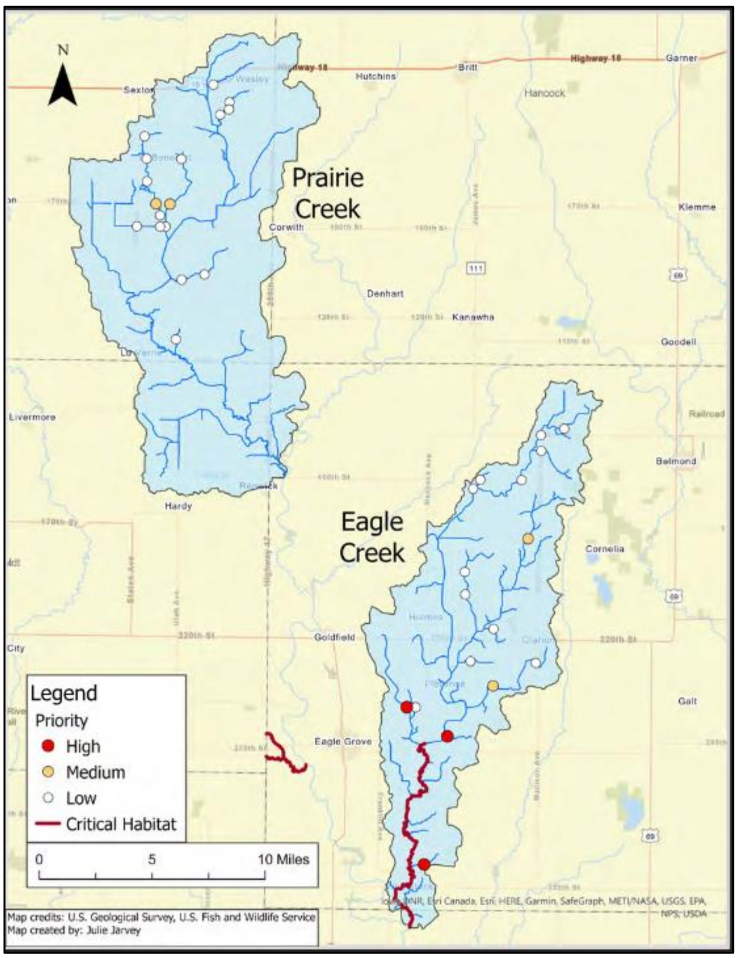
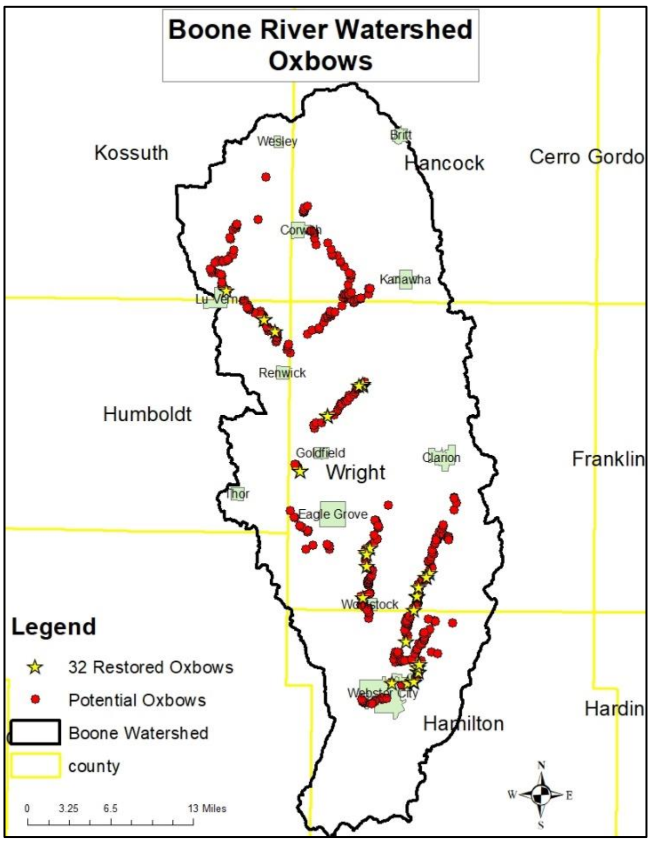


Figure 68: Map of Perched Culverts in the Watershed (Jarvey, 2021)

OXBOW RESTORATION

Oxbows are common, off channel habitats that are created over time by a stream's natural meandering process. Studies have shown that "restored oxbows frequently harbor significant populations of Topeka shiners in Iowa and southwest Minnesota, and the collective evidence to date suggests that restoring oxbows in this region will be an important strategy for recovery of this endangered species (Simpson and others. 2019). Additionally, oxbows improve riparian area functions including creating fish and wildlife habit; capturing nutrients and sediments; and providing floodwater storage.

TNC, USFWS, ISA, and NRCS have been working together to develop an oxbow restoration program in the watershed. Oxbow restoration has been a success, with 32 oxbows restored in the BRW; however, ample opportunities exist to continue these restorations. 416 potential oxbow restoration sites have been identified (Figure 69), however, it is unknown if all of these need to be restored. It is recommended that a conservation professional be consulted when evaluating restoration needs of individual oxbows. It should be noted that funding is available to cover 100% of the cost of restoring oxbows in the Boone River Watershed.



Source: Karen Wilke, TNC, Personal communication: 4/3/2020

Figure 69: Completed and Potential Oxbow Restoration Sites in the Watershed

CRITICAL SOURCE AREAS

Critical Source Areas (CSAs) are areas that make up a relatively small fraction of a watershed but generate a disproportionate amount of the pollutant load (Meals and others, 2012). CSAs occur where a pollutant source in the landscape coincides with an active hydrologic transport mechanism (Figure 70). Identifying CSAs can help prioritize areas most in need of BMPs, as well as positively impact flood risk reduction. This strategy allows implementation to be more cost-effective.

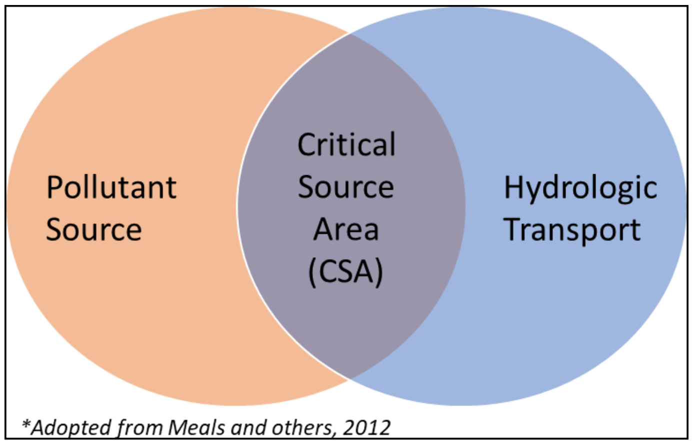


Figure 70: Illustration of the Concept of Critical Source Areas (CSA)

During BMP implementation projects, the BRWMA should identify and target CSAs using the ACPF toolbox within priority subwatersheds. ACPF can be used to find CSAs in two ways: 1) Critical Zones, which are riparian areas most likely to convey large amounts of runoff into streams, and 2) the Field Runoff Risk Assessment, which ranks agricultural fields according to potential for pollutant delivery.

The field runoff risk assessment in ACPF provides a relative risk rating based on two factors:

- Slope steepness – Steeper fields have a higher risk of generating runoff.
- Distance to stream – The closer a field is to a waterbody, the greater the risk a pollutant will be delivered to that waterbody.

Once the assessment is complete, each field receives a relative classification: A (highest risk – most critical), B (very high), C (high), or other (‘present’). Fields classified as A and B are considered critical source areas and should be prioritized for implementation efforts.

5.05 IMPLEMENTATION BENEFITS

INTRODUCTION

Multiple BMPs and priorities have been identified within this plan. To help understand the benefits to water quality and flood resiliency within the Boone River Watershed, it is recommended that projects and practices be evaluated using a watershed or water quality model. As previously discussed, a model was not available during the preparation of this plan. Therefore, an estimate of benefits of plan implementation are provided through a review of the following studies:

- *Des Moines River Upstream Mitigation Study* (Arenas, 2020) completed by IFC
- *A study of the Boone River Watershed: linking an agroecosystems model with a process-based Hydrologic Model* (thesis) (Weis, 2021)

It should be noted that these benefits were evaluated on a watershed basis. During future plan updates a watershed model should be developed to estimate benefits at a minimum of the subwatershed (HUC 12) scale. Ideally, benefits of individual structures or BMPs could also be included, however, that could be difficult due to the scale and complexity of data required. The models utilized in the following two studies (GHOST and APSIM) may be beneficial for these purposes.

Additionally, it is recommended that a more detailed flood risk assessment and recommendations be developed, either as a standalone study, as an expansion of the *Des Moines River Upstream Mitigation Study*, or during future updates to the county hazard mitigation plans. This would allow flood mitigation benefits to be identified at the community level. It is anticipated that a more detailed estimate of benefits will be completed for specific implementation projects at the time they move forward.

DES MOINES RIVER UPSTREAM MITIGATION STUDY

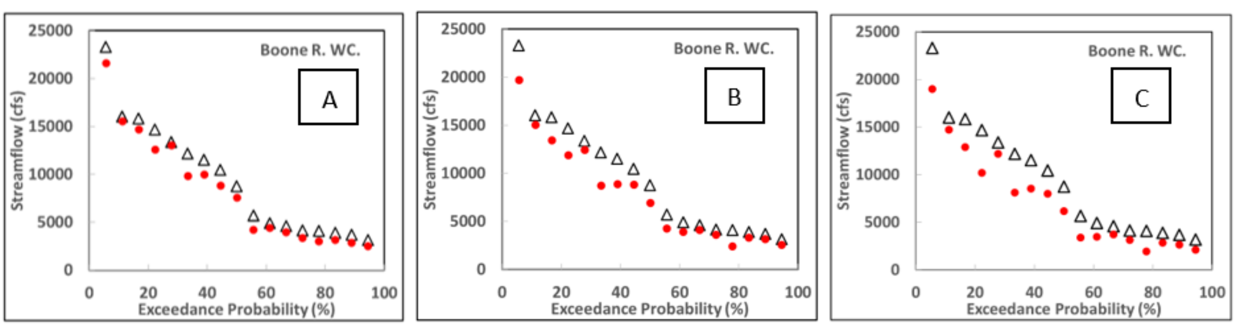
Through a separate study completed in April 2020, the IFC conducted the *Des Moines River Upstream Mitigation Study* (Arenas, 2020). Though the study is about the Des Moines River, a few key insights and findings regarding the Boone River were included. The report documents the current hydrologic condition of the Des Moines River watershed upstream of the City of Des Moines and explores watershed-scale structural and nature-based strategies to decrease its flood hazards. Relevant findings regarding current hydrologic conditions can be found in Chapter 2.

IFC utilized the Generic Hydrologic Overland-Subsurface flow Toolkit (GHOST) watershed model to help understand the potential impact of alternative flood mitigation strategies as well as the consequences of projected increases in heavy downpours in Iowa and the Midwest for the mid and late 21st century described in the latest Climate Science Special report. Focus for the scenarios was placed on understanding the impacts of (1) increasing infiltration in the watershed and (2) implementing a system of distributed storage projects (ponds) across the landscape. Modeling results for the Boone River are represented at the Webster City USGS gage location.

Increased Soil Health Practices BMPs

While the report evaluated several strategies, some were only intended as benchmarks or reference conditions to highlight the limitations of broad-scale land use changes and may not be economically desirable or are not practically feasible. Only strategies that are realistic are discussed here and in Figure 71.

- **Increased Adoption of Prairie STRIPS:** This scenario evaluated the effects of converting 20% of all current row crop acres back to native tall-grass prairie, based on the research developed in the Prairie STRIPS (Science-based Trails of Rowcrops Integrated with Prairie Strips) project. The model findings are consistent with higher infiltration, transpiration, and surface roughness that results from having deep-rooted perennial vegetation in the landscape year-round. Results for the Boone River show an average peak flow reduction of 14.6%
- **Increased No-till and Cover Crops**: This scenario evaluated the effects of 100% of all row crop acres adopting both no-till and cover crops. The results of this scenario, on average, showed higher reductions in peak flows than the native vegetation scenario above. Results for the Bone River show an average peak flow reduction of 18.0%
- **Combined Soil Health Practices:** This scenario evaluated a combination of cover crops, no-till practices, and planting of native vegetation. Specifically, 20% of the current row crop acres were replaced with native vegetation strips and in addition, cover crop/no-till practices were adopted in all the remaining 80% of the land. This scenario of combined implementation of BMPs showed the greatest reductions in peak flows. Results for the Bone River show an average peak flow reduction of 26.5%



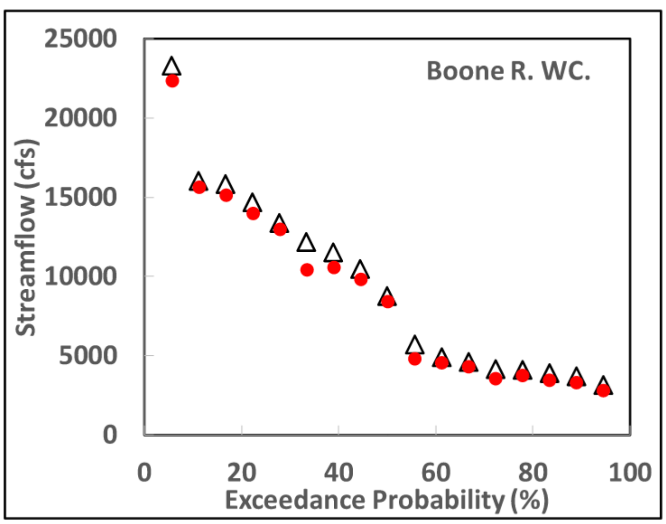
Explanation: Sample probability distribution of the simulated 17 annual maximum peak discharges (2002-2018) for the baseline and each scenario: A) 20% native vegetation scenario, B) 100% cover crop scenario, and C) Combined 20% native vegetation and 80% cover crops. Triangles: baseline calibrated model, red circles: scenario. (IFC, 2020)

Figure 71: Results of Flood Reduction for Soil Health Practice BMP Scenarios

Distributed Storage BMPs

In general, a system providing distributed storage does not change the volume of water that runs off the landscape. Instead, storage ponds hold floodwater temporarily and release it at a slower rate. Therefore, the peak flood discharge downstream of the storage pond is lowered. For this scenario an estimate of potential storage within the watershed was developed. Outputs from the ACPF tool were used to identify potential locations for nutrient reduction wetlands, which were then modified to be designed as a pond. An estimated 3,954 acre-feet of storage was identified within the Boone River.

This scenario did identify average peak flow reductions for the Boone River (Figure 72); however, they were considerably smaller than the native vegetation and cover crop scenarios. Results for the Bone River show an average peak flow reduction of 7.6%. However, it is important to mention that this practice can provide important benefits at smaller spatial scales and has the advantage of being in place proving flood attenuation for decades with little maintenance in contrast to cover crops that require planting and killing every year.



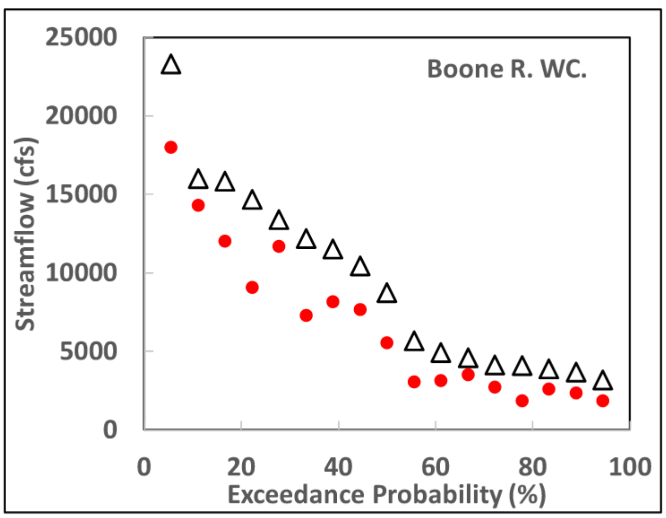
Explanation: Sample probability distribution of the simulated 17 annual maximum peak discharges (2002-2018) for the baseline and the ponds scenario. Triangles: baseline calibrated model, red circles: scenario. (IFC, 2020)

Figure 72: Results of Flood Reduction for the Pond BMP Scenario

Combined Soil Health and Pond BMPs

Implementation of actual flood reduction practices in the watershed will likely rely on a mixture of enhanced infiltration and distributed flood storage projects. This scenario is a combination of the previous two. The system of distributed storage ponds was kept in place, Prairie STRIPS replaced 20% of the current agricultural acres and all the remaining 80% of row crop acres adopted cover crops and no-till practices. This is a more realistic expectation for broad implementation of this practice, but it is still extremely ambitious.

This scenario displays the most significant peak flow reductions while still maintaining large portions of the watershed in row crop production. Results for the Bone River show an average peak flow reduction of 32.1% in this scenario (Figure 73).



Explanation: *Sample probability distribution of the simulated 17 annual maximum peak discharges (2002-2018) for the baseline and the combined soil health and pond scenario. Triangles: baseline calibrated model, red circles: scenario. (IFC, 2020)*

Figure 73: Results of Flood Reduction for the Combined Soil Health and Pond BMP Scenario

BOONE RIVER AGROECOSYSTEM AND HYDROLOGIC MODELING STUDY

A recent study titled *A study of the Boone River Watershed: linking an agroecosystems model with a process-based Hydrologic Model* (thesis) (Weis, 2021) evaluated the effects of cover crops, small grains, and reduced fertilizer rates on both flooding and nitrogen export in the Boone River Watershed. The study used the Agricultural Production Systems Simulator (APSIM) to simulate a farm field representative of the Boone River Watershed and linked with the GHOST model to explore the effects at the watershed scale. The linked model was then calibrated using observed discharges from the Boone River USGS gage at Webster City (2002 to 2018) and the measured nitrate loads in the Boone River (March 2012 to September 2017).

The study showed significant benefits to the hydrology and water quality of the Boone River Watershed. It was found that the lowest-hanging fruit to improve water quality is adhering to the recommended fertilizer rate; however, planting cover crops and a diverse rotation were also effective. In fact, planting cover crops alone achieved the Iowa Nutrient Reduction Strategy goal of a 41% nitrate load reduction by agricultural nonpoint sources – the same goal used in this watershed plan. As an additional benefit, simulated crop yields were not observed to drop significantly under BMP scenarios.

It should be noted that the simulations in this study all consisted of applying practices uniformly across all fields. In reality, farmers practice vastly different strategies from one another, and combining varying levels of adoption would help reflect that. Additionally, APSIM provides some useful non-hydrologic, non-water quality metrics. For example, the study took advantage of APSIM's plant modules to predict yields. There are many other agricultural management strategies that could be modeled, including the effects of tillage, irrigation, other diverse crops, more fertilizer application options, planting dates and options, different cultivars, and much more.

It is recommended that additional modeling, using the APSIM-GHOST or other appropriate model, be used to look at additional management practice combinations or implementation at different scales (i.e., HUC 8 vs HUC 12). This will help inform the watershed plan implementation strategy and may provide a way to evaluate progress during future plan updates.

Additional details on the benefits provided by BMP implementation are discussed below.

Flood Reduction Benefits

The linked model was used to simulate the flood reduction benefits of the following alternative cropping scenarios (rotations):

1. Corn-soybeans with a winter wheat cover crop (CSW)
2. Corn-soybeans-oats (CSO)
3. Corn-soybeans-oats-alfalfa (CSOA)

Cover crops and small grains showed considerable hydrologic changes and flood reduction benefits for the watershed. All three scenarios reduced the number of flood peaks exceeding the 2-year exceedance threshold from 18 to nine. Peak reductions averaged 32% for CSW, 38% for CSO, and 39% for CSOA. These benefits were most pronounced from April to mid-May and continue throughout the summer. These benefits are primarily seen in reducing low to moderately sized flood events. Table 39 identifies changes in peak discharge under each scenario, relative to the baseline, for the top 18 flood events in the watershed. April to mid-May events (highlighted in green) showed the greatest peak reductions, while late summer events (red) worsened due to brief window of vulnerability between the mid-July oats harvest and alfalfa establishment by late September. One event (dark red) was not a flood for the baseline but became one under CSO and CSOA scenarios.

Table 39: Change in Peak Discharge for Each Scenario

Rank	Date	CSW	CSO	CSOA
1	6/10/2008	-9%	-24%	-23%
2	6/28/2010	-9%	-26%	-27%
3	3/13/2010	-2%	-4%	-4%
4	5/29/2013	-6%	-18%	-19%
5	9/23/2018	-3%	-10%	-18%
6	5/25/2004	-93%	-92%	-90%
7	10/11/2018	-9%	-20%	-23%
8	4/28/2008	-80%	-78%	-76%
9	4/20/2013	-62%	-71%	-64%
10	9/26/2016	-4%	13%	1%
11	4/27/2007	-75%	-72%	-69%
12	6/21/2014	-19%	-53%	-52%
13	7/2/2014	-11%	-36%	-36%
14	5/5/2013	-35%	-42%	-40%
15	6/24/2018	-14%	-41%	-38%
16	5/15/2014	-63%	-68%	-66%
17	5/15/2005	-81%	-76%	-75%
18	9/8/2018	-1%	33%	20%
--	8/25/2007	0%	75%	78%
	Average:	*-32%*	*-38%*	*-39%*

Water Quality Benefits

The model was also used to simulate water quality benefits (nitrate load reductions) for each alternative cropping scenario. While hydrologic changes alone, as previously discussed, help lower nitrate loads due to flow reductions, cover crops and small grains also help reduce nitrate loading by consuming extra nutrients when fields would otherwise be bare. The combined effects of reduced water yield and nitrate scavenging produced considerable nitrate load reductions for each scenario (Figure 74). The total loads decreased 41% for CSW, 53% for CSO, and 47% for CSOA.

In addition to diversifying crop rotation, farmers can reduce nitrogen loads by applying fertilizer at recommended rates (lower than current conditions). Applying fertilizer on existing cropping systems (corn-soybeans) at the maximum return to corn (MRTN) recommended rate reduced the total nitrate load by 22% (Figure 74). The load reductions for each alternative cropping scenario were decreased even further once fertilizer rates were changed to recommended rates: 51% for CSW, 60% for CSO, and 50% for CSOA.

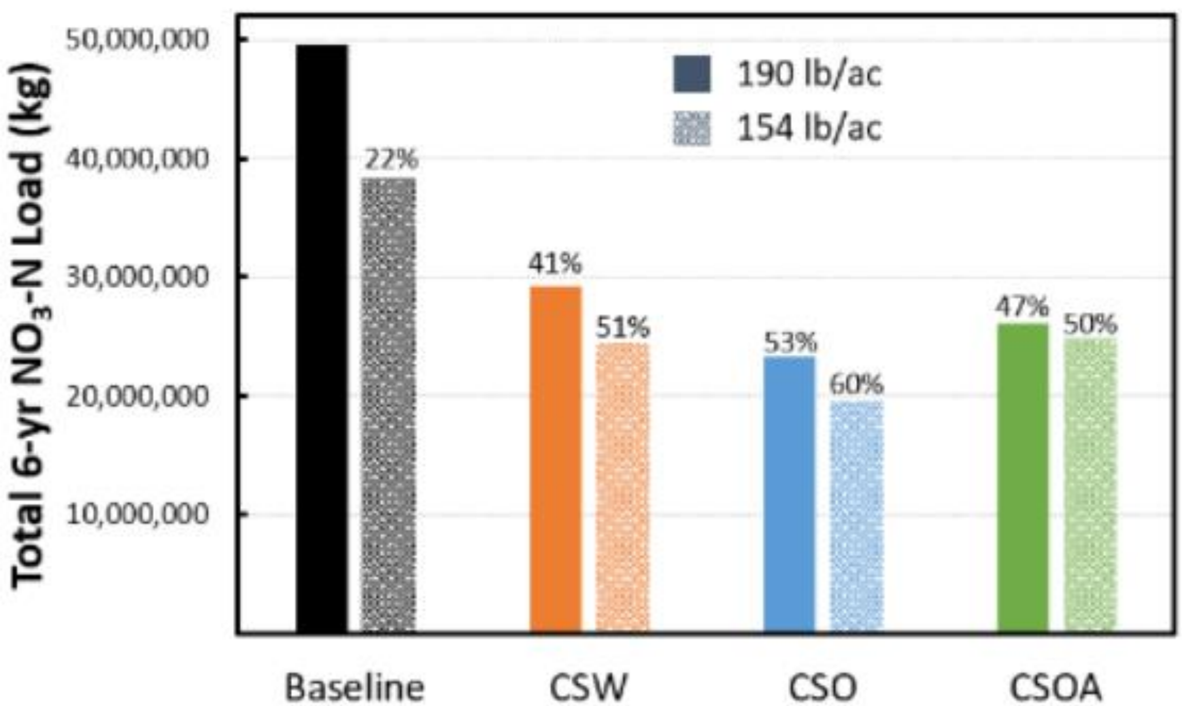


Figure 74: Total Nitrate Load Reductions for Each Scenario with and without MRTN Nitrogen Rates

Impacts to Crop Yields

Impacts to yield and profits are often cited as common reasons why landowners or farmers are hesitant to adopt new BMPs, change cropping patterns, or reduce nitrogen fertilizer rates. This study showed that average yields did not significantly change through incorporation of these practices (Figure 75). The following are key summaries of this analysis:

- Adding cover crops only reduced average corn yield by 2 bu/ac.
- While the four-year rotation did not change the average yield, the three-year rotation with oats did see a slight drop in corn yields, but this could likely be remedied by adjusting the rotation to corn-oats-soybeans (COS) instead of corn-soybeans-oats (CSO), so that corn would follow soybeans and obtain the benefits of the extra nitrogen fixation.
- Reducing fertilizer application rate had little detrimental effect on yields, with the worst reduction (19 bu/ac) on CSO rotation – again where corn was not following a legume.

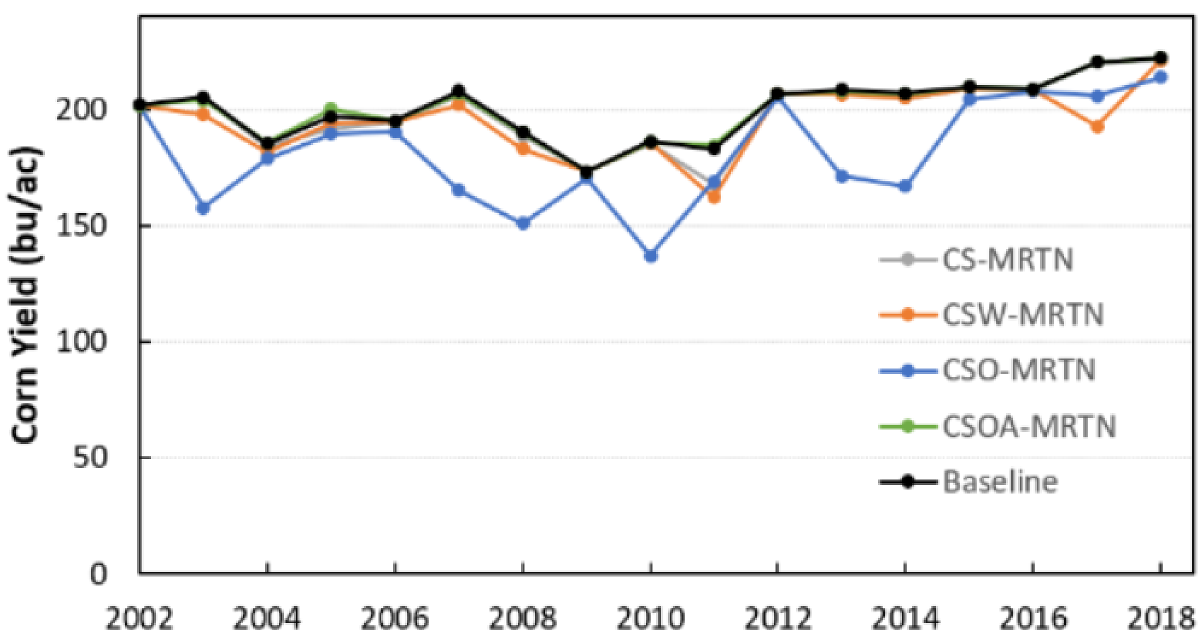


Figure 75: Corn Yield by Year for all Scenarios at the MRTN Reduced Fertilizer Rate

Although revenue on oats and alfalfa are far less than corn and soybeans, diverse rotations also reduce the cost of inputs. Past research on these rotations has shown that incorporating small grains and forage crops would not reduce overall profitability, since the reduced production costs outweigh reduced revenue from not growing a cash crop every year (Liebman and others, 2013).

5.06 COSTS

The implementation of this plan is expected to be a costly endeavor. Cost opinions presented here are provided at the most conservative levels (most expensive) to avoid underestimating the necessary funding levels. It should also be noted that some of these costs may overlap, or some projects may not be necessary depending upon other projects that are built; therefore, these cost estimates should be updated at a minimum of every five years when the plan is updated.

Cost opinions were calculated based on literature reviews, professional experience, and information provided by stakeholders. Cost opinions include anticipated staff time, design costs, materials cost, and implementation costs, where available. Every effort has been made to prepare realistic cost opinions; however, due to the broad scope and long-term implementation time frame of this plan and affiliated actions, actual costs may vary widely. This may be due to, but not limited to, the following factors: inflation, site specific conditions for BMPs, varying methodologies for BMP implementation, changes to the plan based on monitoring results, or other unforeseen changes to operational costs. Detailed cost estimates should be prepared for each BMP or implementation project prior to starting.

Table 40 provides a summary of the cost opinions for BMP implementation within priority subwatersheds (as presented earlier in the chapter) and is based upon the priority BMPs, but other practices may also be considered. Table 41 provides a cost opinion for full scale BMP implementation across the Boone River Watershed. For areas or practices that ACPF mapping was unavailable an average level from other HUC 12s was used for estimating purposes. It is not expected that this will be accomplished in the short-term, however, it does provide the order of magnitude that full scale BMP implementation will cost. Not included are costs for monitoring, plan maintenance/updates, or other evaluations/studies that have been recommended. It is recommended that individual cost estimates be prepared for those efforts based upon the scope desired by the BRWMA, and at the time services are needed.

These cost opinions should be used for general planning purposes only, as cost opinions and budgeting techniques can vary widely based on the type of project being planned. In addition, the reader should keep in mind that cost opinions are representative of the total cost of implementation, which may ultimately be shared among various stakeholders and landowners through financial assistance and other funding strategies. Information on possible partners and technical and financial tools to help implement this plan is discussed in Chapter 8.

Table 40: Summary of Cost Opinions for BMP Implementation within Priority Subwatersheds

Priority Subwatershed	Total Cost for BMP Implementation
Brewer Creek Subwatershed	$2,450,150.00
Drainage Ditch #9 Subwatershed	$2,282,324.81
Headwaters Eagle Creek Subwatershed*	$5,131,515.31
Otter Creek Subwatershed**	$10,263,909.23
White Fox Creek Subwatershed***	$12,203,892.91
Total	**$32,331,792.26**

** Located within a portion of the Eagle Creek WQI Project*

*** Consists of 3 HUC 12s*

**** Consists of 2 HUC 12s*

Table 41: Estimated BMPs Needed and Cost Opinions for BMP Implementation across the Boone River Watershed

BMP Practice	Target Number for Cost Estimate	Unit for Cost Estimate	Unit Cost	Total Cost
Bioreactors	1,977	Site	$ 10,150	$ 20,066,550
Conservation Tillage	272,728	Acres	$ 30	$ 8,181,840
Cover Crops	438,834	Acres	$ 44	$ 19,308,696
Drainage Water Management	7,823	System	$ 1,656	$ 12,954,888
Grassed Waterway	1,042	Acres	$ 5,277	$ 5,499,742
Nutrient Management	446,909	Acres	$ 75	$ 33,518,175
Nutrient Reduction / CREP Wetlands	670	Site	$ 25,055	$ 16,786,850
Oxbow Restoration	416	Site	$ 7,500	$ 3,120,000
Prairie STRIPs / Contour Buffer Strips	882	Acres	$ 298	$ 263,080
Row Crop Conversion to Perennial Cover / Wildlife Habitat	46,628	Acres	$ 330	$ 15,387,240
Saturated Buffer	594	Acres	$ 360	$ 213,840
Urban BMPs	10	Community	$ 275,000	$ 2,750,000
Total				**$ 138,050,902**

5.07 SCHEDULE AND MILESTONES

SCHEDULE

The schedule for implementation is based on a phased approach. The plan is required to be updated every five years; therefore, each phase will be in increments of five years. The following table (Table 42) provides a watershed-wide summary of major activities expected to be achieved during the first 5-year phase of this plan. Activities are subject to approval by the BRWMA, or other project sponsors, and may change as the plan is implemented. This schedule will be updated at a minimum of every five years when the plan is updated. It should be noted that not listing a major activity on this schedule does not preclude it from being executed by the BRWMA or one of its partners. Additional information for action items can be found in the action plan in Chapter 7.

The total schedule length was based on a 20-year timeframe; however, it is possible that the level of BMPs needed across the BRW will take much longer to implement. Phase I activities will include the initiation of watershed BMPs. Phase II will begin upon the five-year revision of this plan and will include any implementation that was not completed during Phase I. A summary of progress achieved during Phase I will be included in the plan revision. Guidance and resources on yearly evaluation of progress, and evaluation of BMP effectiveness can be found later in this chapter.

MILESTONES

While the purpose of this plan is improved water quality and flood resiliency, it is unlikely that these improvements will be seen overnight, during a project term, or even within one phase of plan implementation. **To evaluate short-term successes, other quantitative indicators are used to see whether the plan is meeting its milestones. Monitoring indicators are identified for each goal within Chapter 4.**

Milestones are checkpoints or special events that mark developments during or at the end of projects. In this way, they can be used to gauge progress towards meeting the project schedule and goals. **To gauge success of this plan, it was determined that BMP implementation was the most effective way to gauge success. Table 43 identifies milestones to be met during each five-year phase of implementation.**

The BMP targets used to develop these milestones were estimated from partner input, ACPF mapping data, and through a review of existing BMP levels (discussed in Chapter 3). For areas or practices that ACPF mapping was unavailable an average level from other HUC 12s was used for estimating purposes. It is assumed that achieving these BMP targets will take place through a phased and prioritized approach across each subwatershed. Due to the scale of estimates, existing BMP levels were removed (accounted for) in reaching the total target levels.

Milestones should be reviewed on a yearly basis and adjusted accordingly for changes to the schedule during 5-year updates.

Table 42: Schedule for Watershed Implementation

Major Activity	Phase 1					Phases 2 - 4
	2022	2023	2024	2025	2026	2027-2041
Plan approval and adoption	X					
Water Quality Monitoring (ongoing)						
Select Priority Subwatershed for BMP Implementation	X					
Apply for BMP project funding	X	X				
Implement BMPs using cost-share & education plan						
Project evaluation and report (varies by funding source)					X	
Complete at least 1 activity identified in the Action Plan	X	X	X	X	X	
Full evaluation and update of watershed plan					X	
Continue implementation as identified						X
Annual or Ongoing Administrative Activities						
BMP implementation tracking	X	X	X	X	X	X
Quarterly WMA meetings	X	X	X	X	X	X
Hold annual review meeting and distribute report	X	X	X	X	X	X

Table 43: Phased Milestones for BMP Implementation Across the Watershed

BMP	Existing Level	Unit	Phase 1: 2022 - 2026	Phase 2: 2027 - 2031	Phase 3: 2032 - 2036	Phase 4: 2037 - 2041	Total Implementation Target
Bioreactors	8	Site	494	494	494	494	**1,985**
Conservation Tillage	178,901	Acres	68,182	68,182	68,182	68,182	**451,629**
Cover Crops	12,795	Acres	109,709	109,709	109,709	109,709	**451,629**
Drainage Water Management	1	Sites	1,956	1,956	1,956	1,956	**7,824**
Grassed Waterway	1,127,291	Feet	567,482	567,482	567,482	567,482	**3,397,219**
Nutrient Management	4,720	Acres	111,727	111,727	111,727	111,727	**451,629**
Nutrient Reduction / CREP Wetlands	5	Site	168	168	168	168	**675**
Oxbow Restoration	32	Site	104	104	104	104	**448**
Prairie STRIPs / Contour Buffer Strips	7	Sites	757	757	757	757	**3,035**
Row Crop Conversion to Perennial Cover / Wildlife Habitat	46,628	Acres	11,657	11,657	11,657	11,657	**93,256**
Saturated Buffer	1	Sites	625	625	625	625	**2,500**
Urban BMPs	2	Community	3	3	3	3	**12**

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5.08 PLAN EVALUATION

EVALUATION MODEL

The BRWMA will utilize the Iowa Nutrient Reduction Strategy's (NRS) logic model to measure and evaluate implementation efforts. Using the NRS logic model provides the WMA access to a standardized state-wide reporting system and process. Additionally, this aligns with existing implementation efforts taking place through the Prairie and Eagle Creek WQI Projects.

In 2021, the process of reporting NRS efforts transitioned to publishing data and findings in a set of web-based dashboards. This revised reporting structure aims to increase the timeliness, frequency, and transparency of updates. The dashboards can be accessed here:

https://nrstracking.cals.iastate.edu/tracking-iowa-nutrient-reduction-strategy

Ultimately, the goal is to produce measurable changes in water quality or flood resiliency factors which are represented by the 'Water' category in Figure 76. However, changes in this category can be slow to develop and are reliant on many factors. There are significant challenges in measuring water quality and flood resiliency changes across a large watershed in the short-term. Statistically significant trends in water data can take decades to become apparent or be properly validated due to variability in weather or climate, watershed development, and legacy pollutant sources.

The NRS's logic model (Figure 76) was developed to assist in identifying short-term, quantifiable indicators of desirable change (IDALS and others, 2017a). Quantification allows for tracking and evaluation over time. While the NRS Logic Model is focused on water quality changes, flood resiliency concepts can also be incorporated.

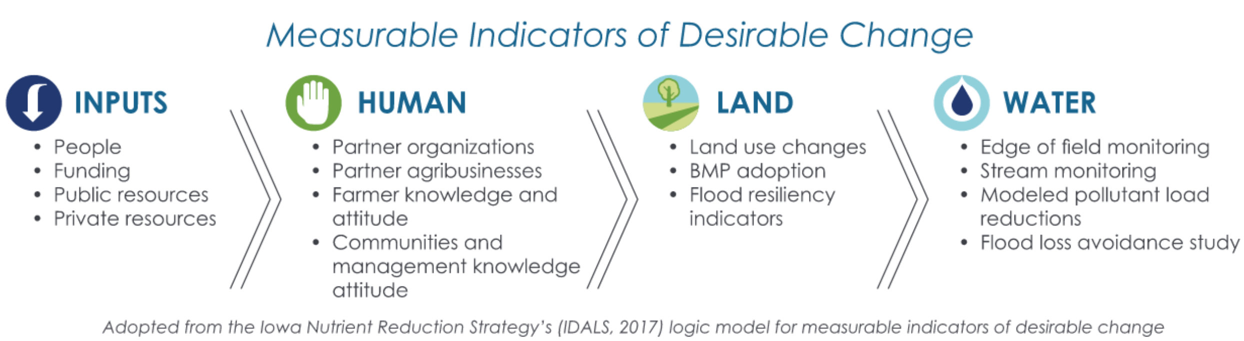


Figure 76: Logic Model Used to Identify Measurable Indicators of Desirable Change

EVALUATION CATEGORIES

To affect and measure change in water quality and flood resiliency, there are four categories to the NRS Logic Model (Figure 76). These are:

- **Inputs** - measured as funding, staff, and resources; affect changes in Human category.
- **Human** - measured as outreach efforts and shifts in attitudes and behaviors; affects changes in Land category.
- **Land** - measured as land use changes and adoption of best management practices (BMPs) or other mitigation projects; measuring these indicators over time leads to measurable, long-term indicators in the Water category.
- **Water** - indicators include changes in water quality or flood risk reduction - ultimately measured through both monitoring and modeling.

The measurable indicators that correspond to each category, as outlined in Figure 76, provide specific parameters in which to track annual changes and persistent trends. These factors are used to develop a standardized protocol for evaluating progress. Monitoring indicators are identified for each goal within Chapter 4.

EVALUATION METRICS

Evaluating success or failure is a critically important step in implementing any watershed plan. This section clarifies the metrics or products that the BRWMA will produce and/or utilize to evaluate the success of plan implementation. The metrics discussed below are organized by the four categories of the NRS Logic Model.

Inputs

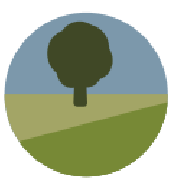
Inputs are the foundational indicator of change in efforts to improve water quality and flood resiliency within the Boone River Watershed (BRW). Inputs encourage and help realize changes in human behavior and help promote conservation practices and mitigation project adoption. To identify the inputs dedicated to the BRW, the following metrics should be monitored and recorded:

- Funding
- Grants (both applied for and received)
- Staffing
- Partnerships
- Others as they are identified

Human

In order to implement conservation practices and flood resiliency projects, people's attitudes must first shift in order to change perspectives and behaviors related to these efforts. A variety of metrics can be analyzed in order to measure the progress of this change. It is very important to coordinate with all partner organizations to ensure all metrics are accounted for and are not being needlessly duplicated. The following metrics should be monitored and recorded:

- **Events**
  The number and type of events conducted each year should be recorded. These could include, but are not limited to quarterly meetings, partner meetings, stakeholder meetings, flood resiliency tournaments, emergency exercises, site visits, demonstrations, field days, etc.
- **Attendance at Events**
  At a minimum, attendance at all events should be quantified. Additional information could also be gathered, such as: where attendees are from, motivating factors to attend, how they heard about the event, etc. This information can also be used to help better design future events. To gauge the impact of events, a short survey should be administered with the goal to determine if the attendee's understanding or attitudes were changed as a result of the event.
- **Self-reported awareness and attitudes**
  These can be tracked over time to identify geographical areas or subject matter areas that should be targeted for additional educational or research opportunities. Additionally, this metric can be an early indicator of changes in the watershed that may lead to additional adoption of BMPs or implementation of projects. It is recommended that a baseline survey be conducted by the BRWMA. This should be updated every five years.
- **Regional and Statewide Media Awareness**
  Media awareness and promotion of the BRWMA and affiliated projects should be tracked. All articles and stories related to the watershed should be collected and cataloged.



Land

Tracking the extent of BMPs and projects begins to illustrate the on-the-ground success or failure of the BRWMA. Thus, this metric often receives much interest. Additionally, changes in water quality and flood resiliency takes time to be accurately measured and evaluated. Tracking the existing treatment levels, as well as the rates of new BMP adoption, will provide the following benefits:

- Understand barriers to adoption
- Identify the need for additional BMPs
- Help to develop or refine watershed models

- Help the BRWMA quantitatively measure the success of this plan over time

Both urban and agricultural BMPs and projects should be included here. Quantifying and tracking the following metrics should be conducted:

- **Existing BMP Levels**
  As discussed in Chapter 3, no centralized list or full inventory exists for this information. It is recommended that the BRWMA use the ISU BMP Mapping Project to create an initial database of existing BMPs. The database should be supplemented with information gathered from producer surveys. Developing this local database will ensure both structural and non-structural BMP levels are captured, which can then be updated as landowners and operators implement the new practices recommended in this plan.
- **New BMP Adoption**
  Locations, types, and costs of implemented BMPs should be tracked. For reporting purposes, practice adoption rates should be aggregated in order to protect personal identifiable information.
- **BMP Retention**
  Long term success relies on the retention of BMPs. Randomized yearly follow-ups with operators who implement practices will help gauge retention levels.
- **Projects Completed**
  Many projects or studies, especially for flood resiliency, are “one off”, or do not fall into the category of BMP implementation. These projects and their impacts should also be tracked.
- **Resiliency Indicators**
  Existing indicators of flood resiliency can be tracked. As these indicators change over time, they help to showcase progress and identify areas in need of additional resources. These include but are not limited to public assistance claims; flood insurance enrollment and claims; properties in the regulatory floodplain; and properties removed from the floodplain. This data will not only be useful throughout the life of this plan but will also be necessary when a loss avoidance study is completed. It is recommended that the BRWMA complete a baseline study to identify current flood resiliency.
- **Land Use Change**
  Change in land use, particularly conversion of annual crops to perennial land uses (Conservation Reserve Program, buffers, open space, etc.) is important to track. Perennial land uses typically have lower pollutant loads and can serve as buffers to flooding. These are also commonly associated with wildlife habitat.

Water

This plan lays out various goals related to water quality and flood resiliency, as well as a strategy for achieving these goals through voluntary efforts. As shown in the NRS Logic Model, these goals will be met through effective changes in human behaviors, land uses, and adoption of projects. Identifying and measuring these changes will require the following metrics:

- **Edge-of-Field Monitoring**
  Tile water or edge of field monitoring results should be used to gauge water quality improvements at the field scale. Individual results should be provided only to individuals that are cooperating in the monitoring program. All monitoring data should be aggregated to the watershed scale and then shared with other operators, landowners, and partners. This aggregated data may also be used in publications to broaden recognition to these water quality efforts.
- **Stream Scale Monitoring**
  In-stream water monitoring sites should be used to determine if long-term water quality improvements are being realized. Annual improvements will likely be undetectable, but long-term progress may be evident if significant BMP adoption takes place.
- **Modeled Pollutant Load Reductions**
  The BRWMA should utilize pollutant reduction calculators to estimate soil and water improvements resulting from practice implementation. Additional discussion is provided later in this chapter.
- **Flood Loss Avoidance Study**
  A flood loss avoidance study identifies and quantifies the losses or damages avoided due to the implementation of a flood mitigation measure. The ability to assess the economic performance of mitigation projects is important to evaluate and justify public investments, encourage additional funding, and continue local support of mitigation projects and activities.

EVALUATION TIMEFRAME

The evaluation process of this plan will follow an adaptive management approach. Adaptive management is a systematic process of "learning by doing", as illustrated in Figure 77. This process is utilized in situations where there is uncertainty in precisely how selected actions will affect the outcome, but management decisions must be made. This process involves executing and evaluating various alternatives, allowing managers to make more well-informed and better decisions in the future. Overall, adaptive management is the process of using the best available science to implement management actions today, learn from those results, and revise actions as required.

The BRWMA will utilize an adaptive management scheme to evaluate and adjust plan implementation efforts over time. Monitoring assessments will take place continuously, with evaluation and adjustment actions taking place both as necessary and formally at yearly and 5-year increments.

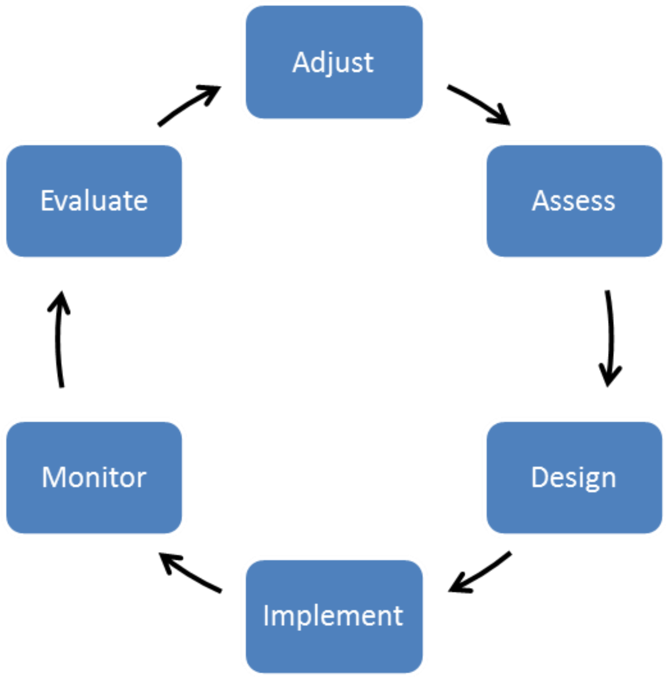


Figure 77: Basic Procedural Steps of Adaptive Management

The evaluation metrics laid out in this chapter are meant to help guide the BRWMA towards meeting its stated goals and objectives (Chapter 4). However, they are also useful to inform the public and partners on the work that is being done and the resources that are needed. The recommended frequency of reporting on these metrics is discussed below and summarized in Table 44.

- **On-Going / Quarterly Project Updates**
  On-going tracking is recommended for current projects, BMP implementation, public outreach, and partner updates. Quarterly board meetings provide a logical time to provide updates on these topics to board members and the public. By tracking some of these items regularly, yearly updates will be more manageable to accomplish.
- **Yearly Partner Review Meeting**
  Watershed project partners should host an annual review meeting to provide an opportunity to update the public on activities and evaluate progress. This may take the place of one quarterly meeting board meeting; however, extra effort should be made to invite the press and stakeholders to this meeting. Annual evaluation worksheets (see Appendix D) should be completed by all partners and board members of the BRWMA prior to this meeting, and the results summarized and presented. An annual report documenting metrics should be prepared by the BRWMA and widely distributed. These

annual reports can be evaluated to show changes over time and to help identify gaps where additional inputs are needed.

- **5-Year Annual Review**
  Every five years this plan will be completely reviewed, evaluated, and updated. Preceding annual reports will provide a good basis to begin this review; however, at this time an updated analysis should be done on key subjects such as water quality data, watershed modeling, public surveys, land use changes, loss avoidance studies, goal setting, and identifying priorities. Milestones, goals, and objectives should all be reviewed at this time.

The BRWMA will need to coordinate with many partners and other public agencies on an on-going basis, especially to identify the extent and level of implemented BMPs and public outreach efforts in the watershed. As progress is tracked, the BRWMA will be able to evaluate these records against milestones identified in this plan. Stakeholders and the public will have an opportunity to review yearly reports and will have explicit opportunities to provide input during the 5-year plan update.

Table 44: Summary of the Timeframe Each Evaluation Metric Should be Completed

On-Going / Quarterly	Annually	Every 5 Years
BMP tracking database	Summary of quarterly updates	Summary of annual reports
List of completed projects	Water quality monitoring report	Land use changes
Summary from pollutant reduction calculator tools	Funding report	Watershed studies
Summary of public outreach	Results of public input and comments	Watershed models updated with new inputs
Grants, staffing, and partner updates	Complete annual evaluation worksheet	Formal survey of landowners and producers on knowledge, attitudes, and behaviors
	Hold annual stakeholder meeting to review annual progress	Perform/update loss avoidance study
		Review goals and objectives
		Review milestones
		Complete plan update

Note: This summary is not meant to exclude any possible metrics which are useful towards plan evaluation or may be beneficial to plan updates

POLLUTANT REDUCTION CALCULATOR TOOLS

A BMP or pollutant load reduction calculator should be used to estimate loading reductions achieved through project implementation. This estimate can then be used to evaluate project milestones. Additionally, these tools may be useful when considering the potential benefits of future water quality projects.

The IDNR Pollutant Reduction Calculator (PRC) is a web-based tool developed to determine sediment, phosphorus, and nitrogen delivery reductions from BMP implementation in watersheds smaller than 250 acres (IDNR, 2004). The PRC may also be a useful tool for the BRWMA when planning BMP implementation on a landowner or parcel basis. The PRC can be accessed here: https://programs.iowadnr.gov/tmdl/PollutantCalculator.

There is currently no tool to estimate *E. coli* bacteria load reductions achieved by BMP implementation. It is recommended that when a water quality model is developed for the BRW, a tool be developed for this purpose.

5.09 SUMMARY AND RECOMENDATIONS

Improving water quality and improving flood resiliency throughout the BRW is possible with a long-term commitment by communities, counties, producers, and other entities within the watershed. Long-term funding, planning, and dedication to the implementation of this plan will be required.

While a long-term and comprehensive implementation plan has been presented in this chapter, there are several recommendations that should be completed as initial steps or during future plan updates – some of these have been included in the Action Plan within Chapter 7. Recommendations have been summarized below for easy reference.

- **Select Priority Area for BMP Implementation:** Following adoption of this plan, the BRWMA and/or its partners will need to select an area to pursue BMP implementation efforts. This will consist of obtaining funding that will be used for BMP cost-share for landowners, education and outreach efforts, and other supporting activities. A detailed project plan will be developed, specific to the priority area selected, and will include the following:
    - Project sponsor and partners
    - Project description
    - Goals and objectives
    - Proposed BMPs
    - Pollutant source and load reductions
    - Education and outreach activities
    - Monitoring and evaluation procedures
    - Schedules and milestones
    - Budget
- **BMP and ACPF Mapping and Updates:**
    - ACPF data was not available for West Otter Creek, Headwaters Otter Creek, and Brewers Creek. Prior to project development ACPF mapping should be completed for these priority subwatersheds. It may also be valuable to update ACPF mapping for all priority watersheds to the latest version of the program.
    - A detailed review of LiDAR, aerial photography, and in-field surveys should be completed to compare ACPF estimated needs with actual BMP levels. This should be completed prior to landowner consultation for BMP siting.
    - During BMP implementation projects, the BRWMA should identify and target CSAs using the ACPF toolbox within priority subwatersheds.
    - It is recommended that the BRWMA use the ISU BMP Mapping Project to create an initial database of existing BMPs. The database should be supplemented with information gathered from producer surveys. This would be used as baseline for implementation monitoring and future plan evaluation.
- **Don’t Ignore Special Priorities:**
    - It is recommended that projects and BMPs be pursued for special priorities even when they lie outside of a priority subwatershed.

  - Not included are costs for monitoring, plan maintenance/updates, or other evaluations/studies that have been recommended. It is recommended that individual cost estimates be prepared for those efforts based upon the scope desired by the BRWMA, and at the time services are needed.
  - It is recommended that a baseline survey of awareness and attitudes be conducted by the BRWMA. This would be used to help inform implementation planning and as baseline for future plan evaluation.
- **Watershed Hydrologic and Water Quality Modeling:**
  - During future plan updates a watershed model should be developed to estimate benefits at a minimum of the subwatershed (HUC 12) scale. Ideally, benefits of individual structures or BMPs could also be included, however, that could be difficult due to the scale and complexity of data required. The models utilized in the studies presented in this chapter (GHOST and APSIM) may be beneficial for these purposes.
  - It is recommended that additional modeling, using the APSIM-GHOST or other appropriate model, be used to look at additional management practice combinations or implementation at different scales (i.e., HUC 8 vs HUC 12). This will help inform the watershed plan implementation strategy and may provide a way to evaluate progress during future plan updates.
  - There is currently no tool to estimate *E. coli* bacteria load reductions achieved by BMP implementation. It is recommended that when a water quality model is developed for the BRW, a tool be developed for this purpose.
- **Complete a Flood Risk Assessment:**
  - It is recommended that a more detailed flood risk assessment and recommendations be developed, either as a standalone study, as an expansion of the *Des Moines River Upstream Mitigation Study*, or during future updates to the county hazard mitigation plans. This would allow flood mitigation benefits to be identified at the community level.
  - It is recommended that the BRWMA complete a study to identify current flood resiliency, which would be used as baseline for future plan evaluation.
- **Integrate the Watershed Plan with County Hazard Mitigation plans:** Each county's local HMP should be amended to recognize the watershed plan, recommendations, and other actions. Additionally, when a flood risk assessment is completed, this should also be included in the amendment of the HMPs. This will open additional partnership and funding opportunities for implementation.

CHAPTER 6. EDUCATION PLAN

6.01 INTRODUCTION

This chapter serves as an education plan, developed with stakeholder input, which provides a diverse framework of education and outreach efforts that will support the future implementation of this watershed plan. This framework includes strategies and methods to engage watershed residents, landowners, farmers, and producers. Additionally, this plan includes recommendations for monitoring, evaluating, and sharing lessons learned and success stories with other watershed projects in the region and downstream communities.

Education and outreach refer to the on-going process of informing and involving the watershed's population in the development and implementation of the watershed plan. This process is essential as the success of the watershed plan is dependent on the voluntary efforts of the watershed's communities, landowners, residents, and other stakeholders. An informed and involved public is needed not just for the initial implementation efforts, but the long-term adoption, and maintenance of best management practices (BMPs) within the watershed.

This education plan provides a framework that future efforts can be built on. These are anticipated to take place at both the full watershed scale and within prioritized subwatersheds through BMP implementation projects. Specific education plans should be developed for each BMP project, based on the unique target audiences and needs in the priority area. **The highest priority educational activities for the watershed are identified in the Action Plan in Chapter 7.**

In addition to the stakeholder input received during the watershed planning process, this education plan is based on communication and marketing best practices; public participation best practices; and principles outlined in *The Social Indicator Planning & Evaluation System (SIPES) for Nonpoint Source Management: A Handbook for Watershed Projects* (Genskow and Prokopy, 2011). The SIPES handbook is an excellent resource regarding the identification and monitoring of social indicators, or measures that describe the awareness, values, and behaviors of people and communities, related to water quality improvement.

Additionally, recommendations and key findings from the *Lyons Creek Watershed Project: Lessons Learned from Partner & Participant Reflections* (Losch and others, 2016) were reviewed and considered for inclusion in this education plan. This report provided lessons learned from the recently completed 319 Watershed Improvement Project in the Lyons Creek Subwatershed. Well-documented reviews of education and outreach efforts are not widespread, let alone within a watershed of interest. Therefore, this report provides very valuable insights for this plan.

A copy of the Lyon's Creek report can be found at: https://www.iowadnr.gov/Environmental-Protection/Water-Quality/Watershed-Improvement

6.02 TARGET AUDIENCES

While the watershed as a whole can be an audience for education and outreach efforts, it should not be the only audience. To be most effective, education and outreach should be based on the needs of a target audience. A target audience is a population subset that is the ideal recipient of a message based on shared characteristics or interests. The use of target audiences maximizes the effectiveness of education and outreach efforts because it helps to deliver a relevant message to the individuals who can readily use or act on that information.

Spanning the Boone River Watershed, several target audiences have been identified including, but not limited to:

- Land managers, property owners, and residents throughout the watershed and within each priority area.
- Producers who have already adopted some BMPs, and have the potential to implement similar or additional practices.
- Livestock producers
- Downstream communities
- WMA Board of Directors and/or member representatives.
- County government staff and elected officials.
- Municipal government staff and elected officials.
- Rural homeowners with private wells and septic systems.
- Urban landowners and residents.
- Absentee landowners, both local and distant.
- Crop consultants, agrochemical dealers, and other agricultural service providers.
- Recreational water trail users, both within and external to the watershed (this could be further broken down by summertime users [kayakers, canoers, etc.]; and wintertime users [i.e., snowmobilers]).
- Civic leaders, such as service organizations and non-profits.
- Youth (Future Farmers of America [FFA], agricultural students, science classes, etc.).
- Young or beginning producers.

In addition to identification of audience(s) to target, effective education and outreach requires an understanding of how to reach and lead an audience to take action. By developing this understanding, the WMA will be better positioned to influence people's awareness, values, and behaviors regarding watershed improvements. The type of information that would be helpful to have for each target audience includes:

- **Preferred delivery method:** what format (in-person, mailer, email, website, video, etc.) and frequency of communication does the audience prefer?
- **Motivators and incentives:** what drives the decision-making process of this audience?
- **Existing perceptions:** what do they currently think about water quality or flood resiliency?

- **Barriers and obstacles**: what would prevent this audience from engaging?

This type of information can be collected a variety of ways, such as through surveys, in-person interactions, and advisory boards. The initial research of target audiences can also serve as baseline information for on-going monitoring of the awareness, values, and behaviors related to water quality improvements. Monitoring social indicators alongside environmental indicators will offer meaningful insight regarding the progress made in achieving the goals and objectives described in this plan. Refer to the SIPES handbook for additional details on how to use social indicators to help plan, implement, and evaluate watershed improvement projects.

6.03 STRATEGIES

Education and outreach strategies are based on one of two things: information or behavior. These strategies will result in different outcomes. An information-based strategy seeks to fulfill information needs, while a behavior-based strategy seeks to motivate change. Typically, an information-based strategy should precede a behavior-based strategy, but that is not always the case. For example, information needs could be sufficiently met for common and readily understood topics, like household water conservation, using a behavior-based approach. To determine which strategy to use throughout the implementation of this plan, revisit the goals and objectives provided in Chapter 4 to identify whether the desired outcome is information- or behavior-based.

INFORMATION-BASED STRATEGY

The purpose of an information-based strategy is to increase awareness or understanding of a specific topic. When the desired outcome is increased awareness, the goal of the strategy is to make target audiences aware that issues are present, as well as what actions have been or are being taken. When the desired outcome is increased understanding, the goal of the strategy is to broaden or deepen the target audience's understanding of issues and projects. Table 45 provides an outline of efforts that would support an information-based education and outreach strategy. These information-based outcomes are to be considered a component of the overall education and outreach strategy for this plan. They are to be implemented and evaluated when appropriate but supplementary to, or in support of, the action items outlined in Chapter 7.

Table 45: Potential Education and Outreach Efforts for Information-Based Outcomes

Education or Outreach	Outcome
Create logos, taglines, and key messages for the watershed (or specific projects) to create a sense of place and value.	Awareness
Promote the watershed plan through newsletters, flyers, press releases, websites, and events.	Awareness
Acknowledge, recognize, record, and share previous and existing conservation efforts or other projects completed.	Awareness

Provide updates on plan progress and monitoring through newsletters, flyers, press releases, websites, and events.	Awareness
Identify and partner with other groups within the watershed that are already conducting conservation or flood resiliency efforts.	Understanding
Develop a reporting system to identify successes and failures of projects.	Understanding
Provide educational opportunities (fact sheets, public meetings, field days, classroom activities, etc.) that focus on specific issues, solutions, and funding opportunities.	Understanding
Showcase the relevancy and benefits of this plan's implementation to help audiences understand local impact.	Understanding
Develop and organize demonstration sites, tours, and field days.	Understanding

BEHAVIOR-BASED APPROACH

The purpose of a behavior-based approach is to provide information that leads to changes in values and behaviors. This plan seeks to address change at two levels. At the first level, education and outreach will seek to influence or change existing values and behaviors so as to gain acceptance and adoption of BMPs. At the second level, education and outreach will seek to influence generational change. Generational changes involve shaping the attitudes, values, and behaviors of future land managers, producers, residents, and decisions makers. Generational change will ultimately help enhance the sustainability of implementing BMPs throughout the watershed. Table 46 provides an outline of efforts that would support a behavior-based education and outreach strategy. These behavior-based outcomes are to be considered a component of the overall education and outreach strategy of this plan. They are to be implemented and evaluated when appropriate but supplementary to, or in support of, the action items outlined in Chapter 7.

Table 46: Potential Education and Outreach Efforts for Behavior-Based Outcomes

Education or Outreach	Outcome
Provide information directly to target audiences about the benefits of BMPs, as well as technical and financial programs available to assist in the implementation of BMPs.	Change in existing values and behaviors
Provide information directly to farm consultants, agricultural retailers, and other audiences that have a high degree of influence on landowner and producer decisions.	Change in existing values and behaviors
Hold targeted coffee shop meetings, tailgate sessions, and other informal information exchanges to build relationships and to learn	Change in existing values and behaviors

more about the barriers and obstacles audiences perceive regarding implementation of BMPs.	
Identify and work with local schools to develop a water quality monitoring program, with information developed for both students and parents.	Change in existing values and behaviors; Generation change
Include school-aged youth in project plans, such as field tours of project sites.	Generational change
Provide information about water quality and other benefits of BMPs to youth-based programs (FFA, agricultural students, science classes, etc.)	Generational change
Provide information targeted for younger generations at regularly used recreation areas (beaches, picnic shelters, water trails, etc.) about the importance of watershed management and its relation to water quality and flood resiliency, especially as it related to the location where information is posted.	Generational change

BOONE RIVER WATERSHED TARGETED STRATEGIES

The following strategies were identified by stakeholders and through literature review specifically for use during the implementation of this plan:

- **Utilize messaging from the *Whole Farm Conservation Manual*.**
    - The *Whole Farm Conservation Manual* (ISU, 2020) was developed in 2020 by ISU Extension and seeks to summarize the existing scientific consensus of BMPs and streamline the BMP recommendation process for landowners, producers, and natural resource professionals. The manual complements the NRCS conservation planning process and integrates BMPs from the Iowa Nutrient Reduction Strategy.
    - This is recommended reading for every WMA member, partner, landowner, and producer within the watershed.
    - The manual can be obtained from ISU Extension: https://store.extension.iastate.edu/product/15823
- **Provide farmers and landowners with information on the economics of conservation.**
    - Profitability was a theme that was brought up repeatedly by stakeholders throughout the development of this plan. It is important for producers to understand the economic consequences of adopting conservation practices. Providing this information will be important to the success of this plan. It is recommended that outreach and education efforts targeted to farmers emphasize this subject area, and where possible use real world data from within the watershed.

- The Soil Health Partnership (SHP), a farmer-led organization, released a report in 2021 titled *Conservation's Impact on the Farm Bottom Line* (SHP, 2021). It summarized the evaluation of the financial impact of conservation tillage and cover crop usage among Midwest corn and soybean farmers, including those in Iowa. The report showed that while conservation practices do not pay for themselves in all situations, there is a business case to be made for increased adoption.
- The following three key financial impacts of implementing conservation practices were identified in the SHP report, and could serve as standard messaging for the Boone River Watershed Plan outreach and education efforts:
  - Conservation tillage reduces operating costs.
  - Cover crops can be part of a profitable system, especially as experience grows.
  - Success with conservation practices is optimized with a targeted, stepwise, tailored approach.
- The report is available online, along with additional supporting economic evidence that can be used in outreach and education materials: https://www.soilhealthpartnership.org/farmfinance/achieving-profitability-with-on-farm-conservation/

- **Implement lessons learned from the Lyons Creek Watershed Improvement Project.** The WMA should become more familiar with this project and the key lessons learned, which are documented within the previously mentioned Lyons Creek Report (Losch and others, 2016). These lessons include, but are not limited to:
  - Create a sense of shared understanding, project goals, and criteria for success.
  - Employ a full-time watershed coordinator.
  - Find common ground between landowners and cash-rent operators.
  - Simplify access to the multitude of adjacent, concurrent, and/or overlapping BMP cost-share programs from various partners.
  - Utilize active-recruitment strategies for outreach and education to target audiences.
  - Provide data from local sources and or local demonstrations as much as possible.
  - Plan for a long-term timeframe of implementation. It will take a long-term "campaign" to gain trust and recognition from farmers.
  - Provide clear, consistent, and science backed information on pollutants, sources, impacts, and attributes of BMPs (costs, benefits, limitations, etc.).
  - Casting blame decreases farmers interest in participation or willingness to adopt BMPs.
  - Identifying and highlighting local "champion farmers" to help deliver messaging increases credibility and visibility.
- **Utilize water trails to create a sense of place and leverage opportunities for educational outlets.**
  - By highlighting, and possibly expanding, the Boone River Water Trail, the WMA could help to create local concern and ownership for improving the watershed. This

emphasis would focus the conversation on protecting local resources instead of more ambiguous goals set by outside entities.
    - Water trail access points could also serve as natural places for educational signs, events, and for people to connect with the river. This would help the public see and experience firsthand the resources this plan seeks to protect in a much more intimate way.
- **Utilize ACPF mapping to prioritize outreach to critical source areas.**
    - Within each priority subwatershed, outreach efforts should be prioritized and emphasized around getting producers and landowners in critical source areas to adopt conservation practices. Critical source areas, discussed in Chapter 5, produce a disproportionately high level of pollution compared to others within the watershed. Treating these areas with BMPs will therefore produce the largest impact on water quality per dollar spent on practices. ACPF can be used to identify these areas and site specific BMPs, which can then be reviewed with landowners.
- **Leverage virtual technology to expand outreach efforts.**
    - The Boone River Watershed spans across six counties and eleven cities, and approximately 50% of the land is owned by absentee landowners (many of them residing outside the watershed) – this is a huge geographic area to focus outreach and education on. While this plan does include targeted outreach within priority subwatersheds, virtual technologies can be used to expand the impact of all efforts relatively cheaply.
    - It is recommended that all, or at least some key events, have a virtual option for attendance and that some events include planning and coordination to increase attendance and interaction with virtual participants. This will also allow these events to be shared across social media and delivered to absentee landowners and other stakeholders that are unable to be reached locally.

6.04 DELIVERY METHODS

Education and outreach methods should be tailored to the target audience. This will make efforts more effective and more likely to achieve the desired outcome. A diverse outreach campaign utilizing multiple methods should be used to reach multiple target audiences or the general public regarding watershed-wide initiatives. Table 47 describes a variety of potential education and outreach methods.

Table 47: Education and Outreach Delivery Methods

Method	Description	Recommended Use
One-on-One Contact	On-site meetings to discuss location of projects or to answer questions about programs and projects.	For siting projects within targeted areas.
Direct Mailing	Targeting informational mailer sent to all properties within specified area.	For increasing attendance of public meeting or participation in area event or program.
Mass Media	Newspaper, radio, television news, agriculture-based magazines, outdoor magazines, etc.	For increasing awareness of activities and progress.
Electronic and Social Media	Websites, social media platforms (Listserv emails, Facebook, Twitter, etc.)	For supplementing other outreach methods
Signage	Billboards, cooperator recognition signs, traveling displays, demonstration signs, etc.	For high-traffic areas, such as major intersections, public beaches, entrances recreation areas, boat ramps, or area events.
Events	Events related to water resources, such as training opportunities, demonstration field days, and recognition picnics.	For use in conjunction with other area events, such as county fairs or other partner events.
Field Days or Workshops	Hands on and site-specific events, such as a site tour, outdoor recreation clinic, training, equipment calibration, water quality testing, etc.	For use in supporting the education or adoption of a specific management activity.
On-site Project Demonstration	Water quality monitoring and BMP installation or maintenance.	For use in supporting the education or adoption of a specific management activity.

Curriculum	Lesson plans and materials for formal and informal education.	For youth-based outreach.
Educators	Assist with the development and delivery of materials.	For youth-based outreach.

Consideration should also be given to the timing which education and outreach materials and efforts are employed. Timing of education and outreach can be based on target audience research, such as avoiding information distribution to producers during harvest, or timed to occur alongside relevant events, such as county fairs. Regardless of the basis, timing should be deliberate to help ensure target audiences will be receptive to education and outreach efforts.

6.05 EVALUATION

Education and outreach activities should continually be evaluated and conducted for each strategy for several reasons. First, evaluation supports mid-course adjustments and follow-up outreach to ensure the strategy is achieving its desired outcome. Second, evaluation provides an alternative means (i.e., social indicators) to measure the progress of this plan's goals and objectives. And third, evaluation will help the WMA refine its education and outreach strategies for future projects and initiatives.

Evaluation methods should be identified during education and outreach strategy development so they can be employed throughout a project or initiative. This early emphasis also prevents evaluation from being overlooked. Evaluation methods include, but are not limited to:

- Tracking if or how the target audience engaged in the education and outreach.
- Conducting pre-, mid-, and post-surveys.
- Providing and encouraging completion of evaluation forms.
- Offering and assessing the interest in participation incentives.
- Hosting formal or informal focus groups to discuss specific practices.
- Tracking media coverage.

Evaluation data should be summarized for each project to allow for side-by-side comparison of efforts and outcomes. Evaluation data can also be gathered to measure the collective progress in achieving this plan's goals and objectives.

As the implementation efforts are just getting started, there may be limited data regarding existing attitudes, behaviors, values, or beliefs of target audiences. Until this data can be collected, as discussed above, it will be useful to refer to the following data sources, which may serve as an interim baseline until local data can be collected:

- Lyons Creek Watershed Project: Lessons Learned from Partner & Participant Reflections (Losch and others, 2016).
- Public Perceptions of Water Quality in Iowa: A Statewide Survey (Wittrock and others, 2015)
- Informing the Cooperative Conservation Framework for Improving Watershed Health: Operator and Landowner Survey Results (Arbuckle, 2010)

6.06 SUMMARY AND RECOMMENDATIONS

This education plan provides a framework that future efforts will be built on. Given the importance of outreach and education to the success of this watershed plan, the WMA should begin implementing these activities right away. The following is a summary of initial recommendations for this process:

- **Begin implementing the strategies identified in the Action Plan in Chapter 7.** These were prioritized by watershed stakeholders and can be executed outside of project-level BMP implementation projects within subwatershed, and parallel to education efforts that other watershed partners are already pursuing.
- **Work with partners.** Partners have been working in the watershed for nearly two decades to accomplish conservation with many of the same target audiences identified in this plan. It will be important to learn from, strengthen, and build on these previous experiences and existing partnerships. For example, TNC currently provides website hosting and publishes a semi-annual newsletter for the Boone River Watershed, and USFWS Fishers and Farmers Partnership has a webpage about the watershed and regularly produces radio shows and webinars. Other previous and ongoing watershed efforts are highlighted in Chapter 1. Additionally, the WMA should continue to identify, pursue, and strengthen new relationships with credible organizations that have shared interests and goals. These partnerships may include, but are not limited to:
  - The Nature Conservancy (TNC)
  - US Fish and Wildlife Service (USFWS)
  - Iowa Soybean Association (ISA)
  - Iowa Department of Agriculture and Land Stewardship (IDALS)
  - Iowa State University (ISU) Extension
  - Iowa Department of Natural Resources (IDNR)
  - Natural Resources Conservation Service (NRCS)
  - Soil and Water Conservation Districts (SWCDs)
  - County Emergency Managers, Drainage Districts, and Conservation Departments
  - Iowa Learning Farms
- **Hire a Watershed Project Coordinator.** Employing a watershed coordinator ensures that there is someone to do the day-to-day work of engaging communities, producers, and other project partners; as well as work to bring in outside resources (such as funding and

technical assistance). At a minimum, the WMA should either maintain a watershed coordinator position or assemble a committee specifically to help direct and implement education and outreach efforts.

- **Learn from the Lyons Creek Watershed Improvement Project.** In addition to each member reviewing the summary report discussed in this plan, the WMA should host speakers during regular WMA meetings who either prepared the report or worked on the project, to share their lessons learned.
- **Collect additional data on farm economics.** Adoption of BMPs is often driven by economic decisions and situations that are specific to each farm, such as soil type, geography, and crop rotation. It is therefore important to provide more and increasingly refined financial information about conservation practices to farmers from local geographies, farm sizes, and crop productions. It is recommended to integrate financial data gathering as part the implementation of this plan. This information should be used to help farmers inform their conservation solutions and to support farmers in establishing profitable conservation systems.

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CHAPTER 7. SHORT TERM ACTION PLAN

7.01 INTRODUCTION

To help guide the Boone River WMA and other stakeholders in the successful implementation of this plan, a detailed action plan has been developed. This action plan is focused on specific actions that can be implemented over the short-term (less than five years). Actions focused on the implementation of BMPs are included as part of the long-term implementation strategy in Chapter 5. Implementation of BMPs will be concentrated in priority areas to maximize efforts, resources, and impact.

The action plan is comprised of groups of specific and independent activities that can be completed to work towards achieving the plan's goals and objectives. The activities were identified through evaluation of watershed data and input from WMA members and stakeholders. Additional consideration was given to ensure that action items were identified for each of the draft goals. Only the action items that were of highest priority and thought to be realistically achievable within five years were included in the action plan; however, all potential action items that were identified have been documented in Appendix C for future reference.

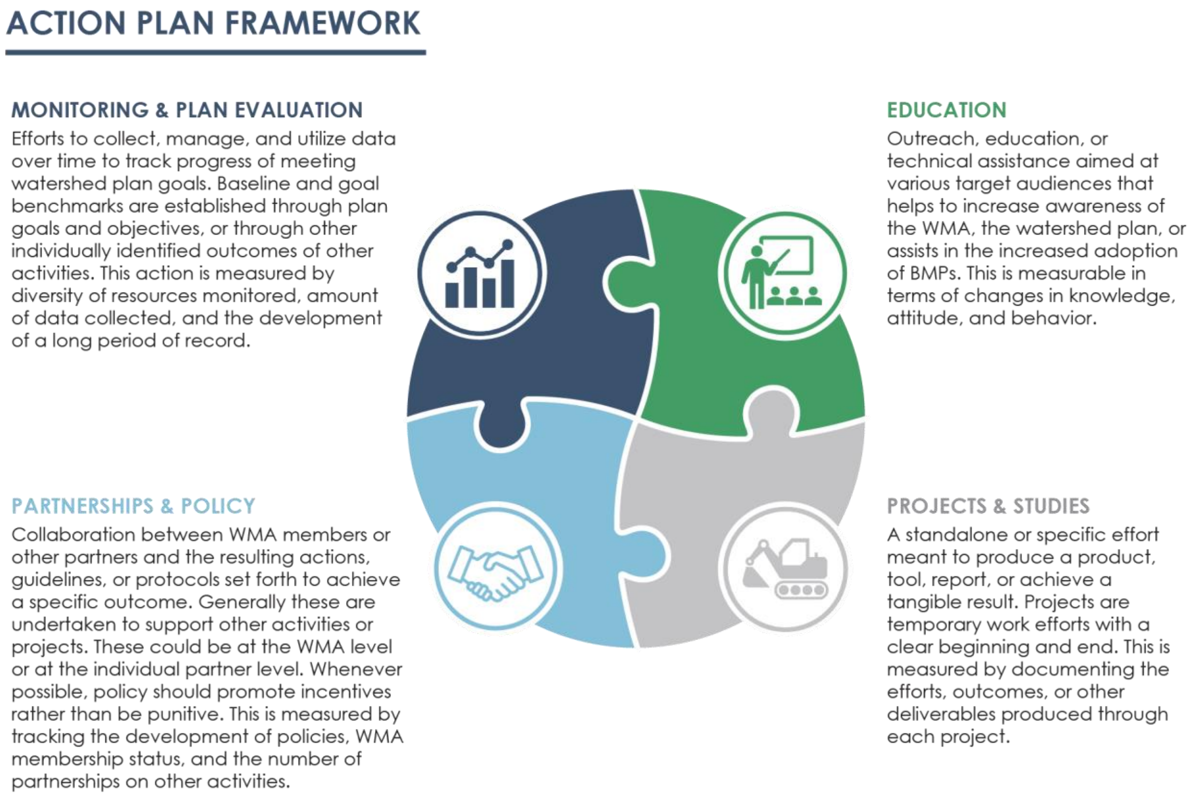
The action plan was developed concurrently with the plan's goals and objectives over the course multiple WMA meetings:

- June 4, 2020: Participants identified and discussed the issues and potential solutions that were important to both themselves and the broader watershed.
- August 20, 2020: Participants were broken into several small discussion groups, to ensure all potential activities were identified, start to prioritize them, and begin to identify partners that might lead certain activities.
- May 20, 2021: The full list of all action items was presented to the WMA. Participants were divided into small discussion groups to review each category of the draft action plan for completeness. Additionally, the small groups also prioritized the top action items for each category. Following the meeting, an updated and prioritized list of action items was emailed to the WMA for additional feedback.
- August 19, 2021: The fully drafted action plan was presented to the WMA and reviewed line-by-line with participants. Following the meeting, the updated draft action plan was emailed to the WMA for additional feedback. The updated action plan was incorporated in the full draft watershed plan for final reviews.

7.02 FRAMEWORK

The action plan has been developed around a framework of four categories of activities, illustrated in Figure 78, which include Education, Projects and Studies, Partnerships and Policy, and Monitoring and Plan Evaluation.

Figure 78: Action Plan Framework and Categories



Additionally, each activity in the action plan includes the following information:

- **Description** – a description of the activity or action to be taken.
- **Goals Addressed** – which goals of this plan the activity seeks to advance.
- **Timeline/Milestones** – an estimate of when, or at what interval, the activity should be completed.
- **Primary Activity Lead** – who is responsible for leading or facilitating the activity.
- **Potential Partners** – a list of agencies or organizations that may directly partner with the primary activity lead to complete the action.
- **Primary Technical & Funding Resources** – a list of the most likely resources that could aid in completion of the activity.

It is important to note that the action plan has been developed to help realize the goals and objectives identified within this plan. Should those change, the action items should also be reevaluated. At a minimum, they should be reviewed annually and updated every five years during plan updates in accordance with the EPA's nine elements (EPA, 2008).

7.03 PARTNER ROLES

While the Boone River WMA is the sponsor of this plan, it has no authority to implement actions or other recommendations on its own. The success of this plan is reliant on the voluntary coordination and cooperation of numerous private and public stakeholders at all levels. Individual WMA members and stakeholders will ultimately be needed to lead implementation.

Each stakeholder or agency is unique in its capabilities and priorities, and the following list summarizes the responsibilities, roles, and expectations each primary planning partner may play in implementation. It should be noted that this list is not exhaustive, and it is a goal of the plan to expand the number and diversity of partners working to implement this plan.

- **Boone River Watershed Management Authority (WMA)** – The WMA will act as the lead facilitator and coordinator for projects throughout the BRW. It will help to connect funding opportunities with local project sponsors and serve as a regional source of information exchange. The BRWMA can serve as a host for a watershed coordinator position to assist with execution of the plan.
- **Counties** – County governments can serve as local sponsors (through the Board of Supervisors, county emergency managers, county engineers, drainage districts, conservation boards, etc.) for leading the implementation of projects. They can promote or encourage policies to protect floodplains and reduce runoff. They can leverage their local funds against other grant programs.
- **Cities** – City governments can serve as local sponsors for implementing projects within or near their communities. They can promote or encourage policies to protect floodplains and reduce runoff. They can leverage their local funds against other grant programs.
- **Soil and Water Conservation Districts (SWCD)** – Each county's SWCD can provide funding and technical expertise for the implementation of BMPs.
- **Iowa DNR** (IDNR) – Through multiple programs, including the Section 319 program, IDNR can provide technical expertise and funding through education and grant programs to assist with implementation of BMPs. Additionally, IDNR will continue to provide data through the water quality sampling program and can provide assistance in evaluation of the data. IDNR can also provide expertise towards river restoration, floodplain management, and water trails.
- **IDALS** – Through the Iowa Water Quality Initiative (WQI), IDALS is already working to improve water quality within the Boone River Watershed. IDALS can provide funding and technical expertise through the WQI or other programs for staffing, monitoring, and implementation of both urban and agricultural BMPs.

- **NRCS –** Local NRCS can be a leader in implementing agricultural BMPs through technical support and targeted funding. Additionally, the BRWMA may also work with Iowa NRCS to access other funding programs such as the Regional Conservation Partnership Program (RCPP) or the Watershed and Flood Prevention Operations (WFPO or PL-566) program.
- **Iowa Flood Center (IFC)** – IFC will continue to provide technical assistance and support to the WMA in helping them reach the goals identified in this plan.
- **The Nature Conservancy (TNC)** – Currently, TNC hosts a webpage dedicated to the Boone River. Additionally, TNC is leading implementation of oxbow restoration BMPs and associated education and outreach. TNC will continue to serve in a technical advisory capacity in support of the WMA.
- **US Fish and Wildlife Service (USFWS)** – The USFWS will continue to serve in a technical advisory capacity in support of the WMA. The USFWS can also help to implement projects through the following programs: Partners for Fish and Wildlife Program, Fishers & Farmers Partnership for the Upper Mississippi River Basin, and Fish and Aquatic Conservation program. These programs have various methods of technical and financial support for permitting, fish passage assessment, fish surveys, and technical assistance and cost-share incentives directly to private landowners to restore fish and wildlife habitat.
- **Iowa State University (ISU) Extension** – ISU Extension will continue to serve in a technical advisory capacity in support of the WMA. Extension can provide leadership for outreach and education efforts, especially those directed at producers and landowners, to help boost adoption of BMPs.
- **Iowa Homeland and Emergency Management Division (IHSEMD)** – IHSEMD will continue to serve in a technical advisory capacity in support of the WMA, particularly on projects or practices that most directly evaluate flood risks or improve flood mitigation.
- **Iowa Soybean Association (ISA) / Agricultural Clean Water Alliance (ACWA)** – The ISA and ACWA currently maintain a stream monitoring network within the watershed and can provide valuable water quality data. ISA also has close ties with many area producers and may be able to partner on BMP implementation efforts.

7.04 CATALYST FOR ACTION

The Boone River WMA has taken the lead on the organizational and planning elements for the Boone River Watershed. As such, the WMA serves as a central hub for communities, counties, SWCDs, and other stakeholders to come together. While the WMA has no formal authority or jurisdiction to implement actions, it does provide a mechanism for its members to leverage their existing authorities or capabilities and act in a unified direction.

This leadership and coordination role would be most effectively manifested through the employment of a watershed coordinator staff position. Employing a watershed coordinator ensures that there is someone to do the day-to-day work of engaging communities, producers, and other project partners, as well as work to bring in outside resources (such as funding and technical assistance). A watershed coordinator would serve as a catalyst for action.

7.05 ACTION PLAN

The action plan consists of *Table 48* through *Table 51*

Table 48: Action Plan for Education Activities

EDUCATION								
#	Action Item and Description	Goals Addressed			Timeline/ Milestones	Primary Activity Lead(s)	Potential Partner(s)	Primary Technical or Funding Resources
		1	2	3				
1	Install BMP outreach signage that highlights the good practices landowners or producers are utilizing.	X	X	X	By the end of 2023	SWCD	IDALS, NRCS, TNC	ISU Extension, IDNR, IDALS, ISA
2	Enhance signage at river access points for visibility and to provide information on watershed issues.			X	By the end of 2023	CCB	IDNR	IDNR
3	Install watershed boundary signs to raise awareness at 12 key locations where major roads enter into the watershed. Additional signage may be considered at major stream crossings.			X	By the end of 2023	SWCDs	IDOT, County Engineers	IDNR
4	Promote partner efforts and leverage information. Encourage story sharing of projects happening in the watershed and getting them published/shared through existing outlets.			X	Beginning in 2022	TNC	ISU Extension, IDALS, NRCS, CCBs	ISU Extension, IDALS, NRCS, CCBs
5	Create an onboarding document that would help get new members up to speed on WMA, goals, and other updates.			X	By the end of 2022	WMA Chairperson	IDNR	n/a

Table 49: Action Plan for Projects and Studies

PROJECTs & STUDIES								
#	Action Item and Description	Goals Addressed			Timeline/ Milestones	Primary Activity Lead(s)	Potential Partner(s)	Primary Technical or Funding Resources
		1	2	3				
1	Apply for grant funding to implement BMPs, education and outreach, or other activities within a priority subwatershed.	X	X	X	By the end of 2022	WMA	IDNR, IFC, IDALS, TNC	IDNR, IDALS, USFWS
2	Complete a hydrologic assessment of the watershed to understand the hydrology, historic floods, future hydrologic trends, and evaluate structural and nature-based flood mitigation strategies at the watershed level.		X		By the end of 2023	WMA	Engineering Consultant	IFC
3	Develop a unified water quality model for the BRW that addresses nutrients, sediment, and bacteria. The existing Des Moines River SWAT model could possibly be used as a baseline.	X			Begin in 2024	WMA	Engineering Consultant	IDNR
4	Complete a detailed evaluation and mapping of drainage district infrastructure. A first step is to catalog which counties have this and to what extent, as some data may already exist.	X	X	X	By the end of 2026	County drainage districts	Engineering Consultant	Counties
5	Gauge BMP retention levels with randomized yearly follow-ups with operators who implement practices. This information can be used for	X	X	X	Beginning in 2022	WMA	ISU Extension	CCBs

#	Action Item and Description	Goals Addressed			Timeline/ Milestones	Primary Activity Lead(s)	Potential Partner(s)	Primary Technical or Funding Resources
		1	2	3				
	monitoring progress and improving outreach efforts or BMP designs.							
6	Develop a BMP demonstration farm that can be used for education, outreach, and research at the local level. One possible location is the existing County Farm owned by Wright County.	X	X	X	Begin initial process in 2022	Wright County	IDALS, ISU, IDNR, TNC	IDALS, ISU, IDNR, TNC,

Table 50: Action Plan for Partnerships and Policy Activities

PARTNERSHIPS & POLICY								
#	Action Item and Description	Goals Addressed			Timeline/ Milestones	Primary Activity Lead(s)	Potential Partner(s)	Primary Technical or Funding Resources
		1	2	3				
1	Hire and/or maintain a local watershed coordinator position using funds from grants and/or partner contributions.			X	Begin process in 2022	WMA	WMA Members	WMA Members
2	Create and distribute an annual report of WMA activities and finances to partners and the public.			X	Begin in 2021	WMA	IDALS	IDNR
3	Current WMA members and partners attend board meeting of potential members on a regular basis to educate and provide updates on the WMA, with the goal of recruiting them to joining the WMA.			X	Begin in 2021	WMA	WMA	n/a
4	Keep a standing invite for WMA meetings to all potential members or partners.			X	Ongoing, beginning in 2021	WMA Chairperson	IDNR	n/a
5	Bring projects or proposals to county supervisor meetings and give them ideas of projects where we could partner together.			X	Annually beginning in 2022	WMA	Varies based on proposal	Varies based on proposal

Table 51: Action Plan for Monitoring and Plan Evaluation Activities

MONITORING & PLAN EVALUATION								
#	Action Item and Description	Goals Addressed			Timeline/ Milestones	Primary Activity Lead(s)	Potential Partner(s)	Primary Technical or Funding Resources
		1	2	3				
1	Track river use though metrics such as: length of designated river trail, number of access points, river user counts, and number of in-stream BMP projects completed.			X	Complete initial database by the end of 2022. Update yearly.	Hamilton CCB	IDNR, Webster City	IDNR
2	Develop a database to track locations, types, and costs of BMPs implemented. For reporting purposes, aggregate practice adoption rates to the watershed scale to protect personal identifiable information.	X			Complete initial database by the end of 2022. Update yearly.	WMA	SWCD, IDALS, USFWS, TNC, IDNR	IDNR
3	Continue to operate the existing water quality monitoring and sampling efforts, provided by IDNR, IIHR (Iowa Flood Center), and the Iowa Soybean Association (Agriculture's Clean Water Alliance).	X	X		Invite each entity to winter WMA meeting to get report on previous year's data and update on upcoming monitoring year	WMA Chairperson	IDNR, IIHR-IFC, ISA/ACWA	n/a

CHAPTER 8. FUNDING AND TECHNICAL RESOURCES

8.01 INTRODUCTION

The power to implement this plan lies with each city, county, and Soil and Water Conservation District (SWCD) that is a member of the Boone River Watershed Management Authority (WMA). The primary role of the WMA is to champion the plan, coordinate member actions within the watershed, and help to leverage resources and partnerships. These resources include both financial and technical assistance. Individual members of the WMA are taxing authorities and may be able to contribute a local match (cash or in-kind funds); however, the WMA does not have this authority or any funds of its own. Therefore, it is important to identify a variety of outside funds to leverage against local sources with limited availability. The intent of this chapter is to identify resources that may be available to support implementation.

All available monetary and technical resources will need to be explored and leveraged to achieve the plan goals. This includes partnering with Federal, state, local governments; academia; nonprofits; businesses; and other local entities (Figure 79). The discussion in this chapter focuses on those programs or agencies that can provide significant or critical funding for projects, BMPs, or other actions items. However, a full listing of organizations and their primary type of assistance they can provide is found in the *Grant Funding Roadmap* in Appendix E. This summary specifies the primary type of assistance (financial and/or technical), along with the primary activities each address (as correlated to the action plan) for each agency or program.

It should be noted that during the implementation process, other resources or partners may be identified and should be considered at that time.

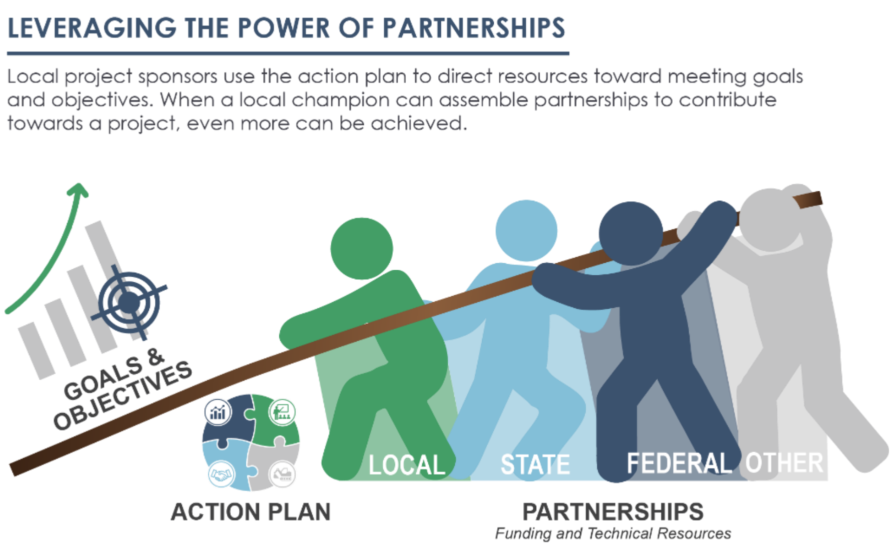


Figure 79: Partners from all levels will be necessary for successful plan implementation.

8.02 WATER QUALITY FUNDING

While there are many options to fund the implementation of water quality BMPs, the WMA should start by looking at the most readily available programs (Table 52). Each funding program has their own requirements to meet prior to accessing the funding, and many programs typically only fund certain types of practices. However, piecing these programs together for landowners is critical. By providing landowners with multiple funding options and helping them navigate the administrative hurdles, more BMPs will be implemented, and a better leveraging of local match sources will be achieved. It should be noted that while the programs and BMPs identified in Table 52 primarily benefit water quality, many of them have secondary benefits for flood risk reduction, mitigation, or resiliency.

Table 52: Matrix of Primary Funding Sources for Water Quality BMPs

	Watershed Program (319 Program)	State Revolving Fund (SRF) Sponsored Projects	Iowa Water Quality Initiative (WQI)	Financial Incentives Program	Urban Conservation Program	Conservation Reserve Enhancement Program (CREP)	Conservation Reserve Program (CRP)	Environmental Quality Incentives Program (EQIP)	Agriculture Conservation Easement Program (ACEP)	Conservation Stewardship Program (CSP)	Regional Conservation Partnership Program (RCPP)	Nonprofit Conservation Organizations (PF, DU, NWTF, TNC)	USFWS - various programs
Practice Type (examples) / Funding Agency	DNR		IDALS				FSA	NRCS			Partners		
Nutrient Management Sidedress N, agronomic rate application, 4Rs, etc.	X		X					X		X	X		
Tillage No-till, strip till	X		X	X				X		X	X		
Cover Crops Rye, oat, clover, radish, etc.	X		X	X				X		X	X		X
Edge-of-Field Erosion Control Grassed waterways, terraces, WASCOBS, ponds, etc.	X	X		X				X		X	X		X
Edge-of-Field Practices Wetlands, saturated buffers, bioreactors, etc.	X	X	X			*wetlands only*		X		X	X	X	X
Land Use Changes / Alternative Crops Pasture conversion, buffers, prairie STRIPS, land retirement, rotation, wetlands, etc.	X	X		X	X		X	X	X	X	X	X	X
Livestock/Small Open Feedlots Waste systems, clean water diversion, vegetative treatment, open lot runoff management, manure management plans, heavy use area protection, etc.	X	X						X		X	X		
Grazing Lands Management Exclusion fencing, alternative water sources, grazing management plans, stream crossings, etc.	X							X	X	X	X	X	X
Riparian Area Management Buffers, stream stabilization, grade control, floodplain restoration, oxbow restoration, fish passage, etc.	X	X			X		X	X			X	X	X
Urban Stormwater BMPs Bioretention, bioswales, rain gardens, permeable pavers, soil restoration, septic systems, etc.	X	X			X								

8.03 FLOOD RESILIENCY FUNDING

Improving flood risk reduction, mitigation, or resiliency involves implementing projects, practices, and programmatic changes throughout a community and watershed. There are multiple options to help pay for many of these initiatives; however, the WMA should start by looking at the most readily available programs (Table 53). Each funding program has their own requirements they must meet prior to accessing the funding, and many programs typically only fund certain activities. However, piecing these programs together is necessary to address the many aspects of flood resiliency. By working with multiple programs, the WMA will better leverage local match sources. It should be noted that while the activities identified in Table 53 primarily address flood risk reduction, mitigation, or resiliency, many of them have secondary benefits for water quality.

Table 53: Matrix of Primary Funding Sources for Flood Resiliency Projects and Programs

	Building Resilient Infrastructure and Communities (BRIC)	Flood Mitigation Assistance (FMA)	Hazard Mitigation Grant Program (HMGP)	Public Assistance Section 406	Community Development Block Grants	Water Waste Disposal Loan & Grant Program	Flood Plain Management Program	Watershed and Flood Prevention Operations (WFPO or PL-566)	Emergency Watershed Protection Program (Recovery and Floodplain Easements)	Agricultural Conservation Easement Program
Action Type (examples) / Funding Agency	**FEMA / HSEMD**				**HUD**	**USDA**	**DNR**	**NRCS**		
Acquisition / Demolition / Relocation	X	X	X						X	X
Structure Elevation	X	X	X							
Floodproofing Structures	X	X	X							
Local Flood Risk Reduction Projects bridge/culvert replacement, storm system upgrades, detention cells	X	X	X	X	X	X		X	X	X
Green Infrastructure (Urban Drainage) green space, rain gardens, infiltration basins, bioswales			X		X	X			X	
Non-localized Flood Risk Reduction Projects bridges, dams, levees, detention cells, channel widening, diversion channels	X		X	X	X	X		X	X	
Structural Retrofits dam and detention cell rehabilitation	X	X	X	X	X	X		X		
Administrative Actions building code and floodplain management ordinance updates and enforcements	X		X				X			
Social Vulnerability flood awareness and education programs, community rating system (CRS), warning systems		X			X					
Floodplain Mapping Improved mapping products, Risk MAP		X	X					X		
Mitigation Planning Parcel-leve planning, flood mitigation plan, drainage studies, watershed plan, GIS inventory					x					

8.04 KEY STATE AND FEDERAL RESOURCES

There are several key agencies and programs that will be important to explore, utilize, or partner with for funding and/or technical assistance. Each one of these agencies or programs will bring a unique set of opportunities and individual priorities that must be aligned with those of the WMA members and/or stakeholders. The WMA should lead an initial and ongoing dialog with entities and their key programs. The intent is to identify possible partnership opportunities and to be best positioned for when funding becomes available. Below are highlights of primary programs that may be of interest or of use to the WMA at this time. Note that Appendix E includes a much longer list of additional programs and agencies that should be reviewed. It should be noted that collaboration with any of these entities will depend on the alignment of mutually beneficial goals between the WMA, stakeholders, and the outside program.

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

FEMA funding is administered via Iowa Homeland Security & Emergency Management (HSEMD). Local communities should work with FEMA and the Iowa Department of Natural Resources (IDNR) on floodplain management issues. Many flood mitigation-type projects are specifically eligible and of high priority for FEMA under existing funding programs. County emergency managers and their communities should work with HSEMD on obtaining project funding through the hazard mitigation assistance (HMA) program under one of the following programs:

- **Hazard Mitigation Grant Program (HMGP)**
- **Building Resilient Infrastructure and Communities (BRIC) Program**
- **Flood Mitigation Assistance (FMA)**

US ARMY CORPS OF ENGINEERS (USACE) – ROCK ISLAND DISTRICT

USACE has multiple programs that can be utilized to obtain assistance for both planning and implementation type projects. USACE should be contacted by the WMA about the following programs:

- **Section 14 – Emergency Streambank and Shoreline Protection**
- **Section 22 – Planning Assistance to States**
- **Section 206 – Aquatic Ecosystem Restoration**

UNITED STATES DEPARTMENT OF AGRICULTURE (USDA)

The USDA has two primary programs that the WMA should consider:

- **The Water and Waste Disposal Loan & Grant program.** This program provides low interest loans or grants to finance drinking water, storm water drainage, and waste disposal systems for rural communities with 10,000 or fewer residents. In 2018, the USDA awarded $256 million to 81 projects in 35 states through this program.

- The **Conservation Reserve Program (CRP)** is a long-standing conservation program that is used to fund the establishment of permanent vegetation such as crop conversions and buffers.

US FISH AND WILDLIFE SERVICE (USFWS)

The USFWS currently is partnering in the watershed to help implement projects through the Partners for Fish and Wildlife Program, which provides technical assistance and cost-share incentives directly to private landowners to restore fish and wildlife habitat. There are also opportunities for technical and financial assistance through the Fishers & Farmers Partnership for the Upper Mississippi River Basin and Fish and Aquatic Conservation program. Additionally, the Iowa WMD also works with partners and landowners to acquire, restore, and provide public access to wetland and permanent cover (native prairie) in perpetuity through the creation of Waterfowl Production Areas. The WMA and its partners should continue to work with USFWS to expand or enhance these efforts.

NATURAL RESOURCES CONSERVATION SERVICE (NRCS)

NRCS has long standing relationships with almost every producer in the watershed. Through both the state and local offices NRCS provides conservation assistance (financial and technical) through various programs. There are many NRCS programs, and thus the WMA should work to form a partnership with each local NRCS office to learn about each program, and how they can be promoted and utilized to achieve common goals between the NRCS and the WMA.
Programs include:

- Environmental Quality Incentives Program (EQIP)
- Conservation Stewardship Program (CSP)
- Regional Conservation Partnership Program (RCPP)
- Watershed and Flood Prevention Operations (WFPO or PL-566)

IOWA DEPARTMENT OF NATURAL RESOURCES (IDNR)

The IDNR has multiple primary programs that the WMA should consider:

- The **Resource Enhancement and Protection (REAP) Program** can provide funding for conservation education as well as on-the-ground BMPs. Counties, cities, and nonprofits can apply for this grant.
- The **Private Lands Program** provides technical assistance and can help secure funding to private landowners interested in installing BMPs. The WMA can work with local IDNR biologists to identify landowners and to assist in conservation efforts.
- IDNR administers the **Flood Plain Management and Dam Safety Programs** which can be consulted to assist in various flood mitigation projects and local floodplain ordinance development.

- The **Lake and River Restoration Program**, as well as the **Watershed (Section 319) Program** all have funding and technical assistance available to help implement projects and BMPs within priority watersheds or waterbodies.
- The **IDNR Water Trails Program** provides technical assistance and grant funding to study, create, and develop water trails across Iowa.
- The **State Revolving Fund (SRF) Sponsored Projects** program can fund a wide variety of water quality projects through low-interest loans. For communities already utilizing SRF funding for water infrastructure projects (drinking or wastewater), a portion of the interest paid can be redirected towards water quality improvement projects. This lets the overall interest rate to be reduced and allows the community to finance two projects for the cost of one.
- The **Water Quality Financing Program** is a relatively new low interest rate program established through SF512 in 2018. The program is administered by the Iowa Finance Authority in partnership with the IDNR and IDALS. It is focused on helping project sponsors implement BMPs from the Iowa Nutrient Reduction Strategy.

IOWA DEPARTMENT OF AGRICULTURE AND LAND STEWARDSHIP (IDALS)

IDALS has numerous programs available that would greatly enhance the WMA's efforts towards plan implementation. Many of these are funneled through a local SWCD, which can take the lead in contacting regional coordinators or urban conservationists to assist in accessing these programs. Given the IDALS well established state funding and existing contacts with producers, the WMA should establish a strong working relationship with IDALS to achieve common goals utilizing one or more the following programs:

- Conservation Reserve Enhancement Program (CREP)
- Iowa Financial Incentives Program (IFIP)
- Urban Conservation Program
- Water Quality Initiative (WQI)
- Low interest loans available for drainage district improvements

8.05 LOCAL RESOURCES

PUBLIC FUNDS

While outside funding from grants, loans, or other sources will be needed to fully implement this plan, there is also a need for local match (cash or in-kind). This may be required for matching funds to grants, to leverage against other funds, to pay staff that can coordinate and apply for other funding sources, or to simply pay for projects directly. Each WMA member and stakeholder is unique in its financial resources available and taxing structure; therefore, the following options are meant to be flexible and to inspire the WMA members to develop something that fits them best. These options should be used to help generate ideas that work for each entity. The WMA should consider discussing these options or hosting a guest speaker at each WMA meeting from each entity or each funding source/mechanism presented in this chapter.

The following entities may be able to provide additional information:

- Iowa Stormwater Education Partnership
- County Auditor
- Iowa League of Cities
- Iowa State Association of Counties
- Watershed Management Authorities of Iowa
- City or County Attorney
- Other communities that have successfully utilized these options
- Drainage District Attorney or Auditor
- Iowa Drainage District Association
- Center for Rural Affairs

IN-KIND SERVICES

Many grant programs allow all or a portion of the "local match" to be made up of in-kind services instead of a cash match. In-kind contributions typically include the work of local government or partner staff or materials towards a specific project. This might be coordination, landowner outreach, public education, or completing technical work they are qualified to do. Communities need a consistent and defendable way to document, track, and report in-kind services in order for them to count towards match on grant funded projects.

GENERAL FUND DOLLARS

A portion of a community or county's general funds could be budgeted towards the implementation of this plan. This could be for specific projects, programs, or administrative costs of the WMA. The WMA should consider establishing a general fund to which each member contributes. A common use of this fund among other WMAs is to hire a watershed coordinator. By having a paid watershed coordinator, the WMA would be able to pursue other grant funds, essentially leveraging local funding to bring outside funding into the community for project implementation.

CAPITAL IMPROVEMENT FUND

A city may establish a reserve fund for capital improvement projects. This fund is built using tax revenue on a yearly basis, which is levied for the fund to accumulate money for the financing of specified capital improvements or to carry out a specific capital improvement plan. While it does take several years to build up a fund capable of making major improvements, this fund allows a city to save for specific projects without the need for issuing debt (bonds). When the city bonds for a project or to make a larger purchase, the city pays interest on those bonds.

PERMIT, FEES, AND DEVELOPER CONTRIBUTIONS

Communities can establish new fees, earmark a portion of existing permit and fee structures, and/or establish requirements for developer contributions for new development in flood prone areas or areas that may contribute to water quality problems. The proceeds can be accumulated into a separate fund that is tied to specific project types. One kind of these fees is known as a stormwater utility fee, which is discussed below.

STORMWATER UTILITY FEE

A stormwater utility is a stand-alone city utility that is used to pay for capital improvements, operations, maintenance, and meeting federal/state permit obligations. Rates are typically based on the quantity of hard surface (or impervious area) on a property. This funding option can be used to help pay for urban stormwater improvements or flood mitigation projects.

GENERAL OBLIGATION BONDS

General obligation bonds are backed by property taxes and are issued by a city or county for a wide array of community betterment projects. These are typically best suited for infrastructure projects.

LOCAL OPTION SALES TAX (LOST)

LOST is a special-purpose tax implemented and levied at the city or county level. A local option sales tax is often used as a means of raising funds for specific local area projects. Jurisdictions that don't already exercise a LOST, or those that already do, could consider targeting LOST funds towards projects identified in this plan.

SPECIAL ASSESSMENT DISTRICTS

Certain improvements can be financed by special assessments. This method of financing is a tax upon a property owner for a portion of the costs incurred by the city for a particular improvement. This could be considered for a variety of projects, especially urban stormwater improvements or flood mitigation projects.

TAX INCREMENT FINANCING (TIF)

Tax Increment Financing (TIF) is a tool that encourages private development in areas experiencing blight and disinvestments, typically areas in or near downtown. A TIF program provides a method for financing public costs (roads, sewer, infrastructure, etc.) associated with a private development project by using the projected increase in property tax revenue, which would be a result of the new development bringing increased value to the property. This could be considered for a variety of projects, especially urban stormwater improvements or flood mitigation projects.

LEASE PURCHASE PROGRAM

A lease-purchase agreement allows a city to purchase and use an item while making payments on the item. These items include pieces of equipment, such as fire trucks, or real estate, such as land or buildings. These agreements are similar to private “rent-to-own” agreements. It is very important that cities consult with their bond attorney to ensure the agreement is worded in such a manner to benefit the city.

UTILITY FRANCHISE FEE

In 2009, Iowa authorized cities to charge up to 5% in franchise fees on gas and electric bills. All revenues collected must be deposited in a separate account from the city’s general fund. These funds can only be used for authorized purposes, which includes the repair, remediation, restoration, cleanup, replacement, and improvement of existing public improvements and other publicly owned property, buildings, and facilities, projects designed to prevent or mitigate future disasters, and the establishment, construction, reconstruction, repair, equipping, remodeling, and extension of public works, public utilities, and public transportation systems. These purposes could include projects or portions of a project that are intended to improve water quality or flood resiliency.

8.06 PRIVATE FUNDS

While outside financial assistance is important to help implement BMPs, existing programs rarely cover 100% of all project or BMP costs. It is also important that willing landowners, citizens, farm operators, and others have a “stake in the game”. Many BMPs and practices require long term maintenance or behavior changes. Ensuring individuals are invested in the success of a particular BMP will help ensure they continue the maintenance or behavioral change into the future. These costs will vary by practice type and by the extent of funding received from other sources. Financial assistance through incentives is necessary for many conservation measures, particularly for smaller producers that may not be able to afford to install more costly measures.

8.07 NONPROFIT ORGANIZATIONS

Successfully implementing this plan will require creative approaches to project funding. A broader range of funding resources will create opportunities for additional implementation options. Alternative funding sources can sometimes be found at the regional or local level through partnerships with private sector businesses, private foundations, and other nonprofit organizations. Creativity is often needed in fitting various funding sources together to ensure project objectives are met, while also meeting the purposes of each funding source.

This may lead to finding project benefits through secondary effects, or piggy backing projects together. For example, a “trail project” may provide an opportunity to improve an area’s hydrology, install educational signs, or implement streambank stabilization structures. Another example can be found through the wildlife habitat programs hosted by IDNR or various conservation nonprofits. Many of these program activities, such as wetland restoration or other habitat improvements, provide secondary benefits to water quality or flood resiliency.

The following options for partnerships (Table 54) have been identified due to the possibilities for working together on financial and/or technical resources, and because they have been shown to be successful in other communities. Forming successful partnerships is not as clear-cut as applying for grants. A great example is The Nature Conservancy (TNC), which is currently working with partners in the watershed to provide cost-share towards the implementation of various BMPs, with a special emphasis on oxbow restorations.

Successful partnerships involve engaging a broad spectrum of stakeholders, each with diverse programs and interests, and employing combinations of resources (both directly and indirectly) towards solving what are formidable issues. The reality is that significant increases in government funding to address flooding or water quality issues are not apparent on the immediate horizon and the WMA will need to be creative, cooperative, and proactive to realize implementation on a meaningful level. Table 54 should not be considered all-inclusive, as other options may be identified during the implementation process and should be considered at that time.

Table 54: Options for Local Partnerships

Nonprofits	
Iowa Land Improvement Contractors Association (LICA)	
Iowa Stormwater Education Partnership	
Citizens groups (Rotary, etc.)	
Iowa State University	Leopold Center for Sustainable Agriculture
	Iowa Learning Farms
	Prairie STRIPS
	Extension
Conservation Organizations	Groundwater Foundation
	The Nature Conservancy (TNC)
	Izaak Walton League
	Pheasants Forever (PF) – both state level and local chapters
	Ducks Unlimited (DU)
	National Wild Turkey Federation (NWTF)
	Iowa Natural Heritage Foundation
Agriculture Associations	Iowa Soybean Association (ISA)
	Iowa Corn Growers Association
	Iowa Cattlemen's Association
	Iowa Pork Producers Associations
	Soil Health Partnership
	Women, Land, and Legacy Program
Corporate Foundations, Grants, or Giving (types of entities to consider)	
Co-Ops and other agricultural businesses (implement, sales, and equipment dealers)	
Feedlots or other larger farming operations	
Wineries or other similar types of agritourism businesses	
Local businesses	
Corporate businesses (Wal-Mart, John Deere, etc.)	
Fund Raising Campaigns	
Crowdfunding (GoFundMe, Kickstarter, etc.)	
Traditional fund raisers (raffles, sales, etc.)	

8.08 ALTERNATIVE FUNDING OPTIONS

PAY FOR SUCCESS

A Pay-for-Success (PFS) program is a financing structure which leverages private investment to achieve outcomes with a public benefit (Figure 80). PFS projects are designed to attract private capital to conservation, broadening the funding base available for programs and infrastructure improvements. This structure benefits communities by getting projects and BMPs on the ground which have direct benefits to their community, while significantly reducing financial risk.

Essentially, the investors and service providers take on the risk of a project (flood project, BMPs, etc.), anticipating that successful outcomes will bring returns that make shouldering the costs worthwhile. These returns can be financial, but they also include social or environmental outcomes (flood risk reduction, water quality, etc.). The local government pays for outcomes, not practices or interventions, lowering risk and ensuring that public funds go towards effective and proven solutions. Conservation Innovation Grants (CIG), a program from the NRCS, may be a great starting point for the WMA to begin a pilot PFS program.

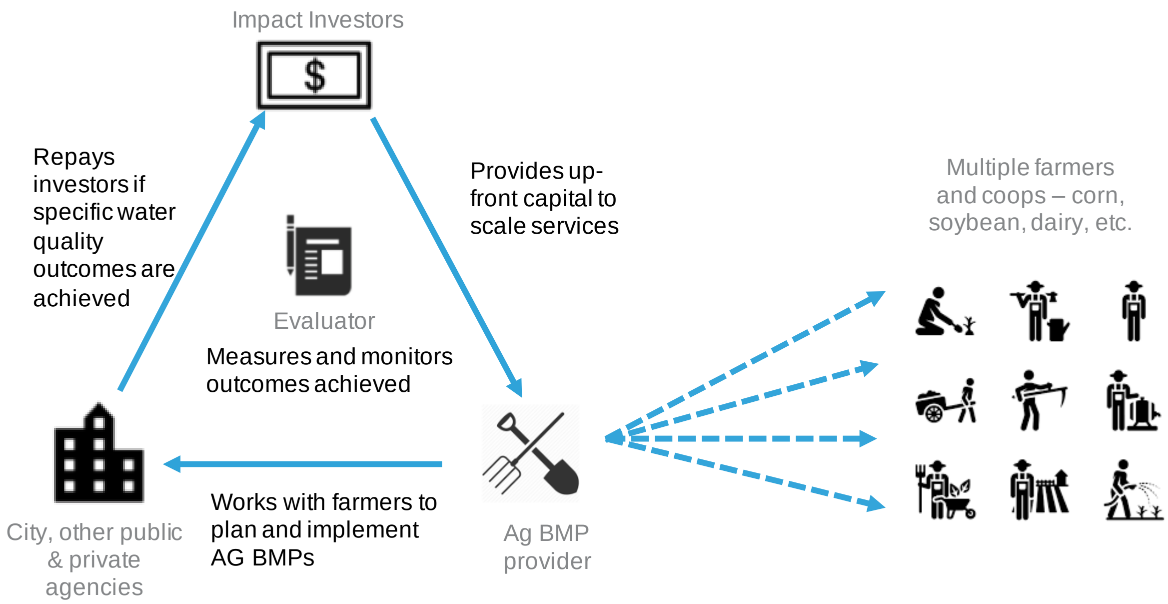


Figure 80: Pay for Success Financing Model

WETLAND BANKING INSTRUMENT

A mitigation bank is a wetland, stream, or other aquatic resource area that has been restored, established, enhanced, or preserved for the purpose of providing compensation for unavoidable impacts to aquatic resources as permitted under Section 404 (of the U.S. Clean Water Act) or a similar state or local wetland regulation. A mitigation bank may be created when a government agency, corporation, nonprofit organization, or other entity undertakes these activities under a formal agreement with a regulatory agency.

In a mitigation bank, a government agency or a firm acquires a large tract of land and restores or creates wetlands. Based on the extent and type of wetlands restored, “credits” are earned which can then be sold to those who need them to satisfy their mitigation requirements. If the WMA or one of its members were to establish a mitigation bank, not only would the available credits assist in permitting some flood resiliency or water quality projects, but the income generated could be used to help pay for those projects.

IN-LIEU FEE MITIGATION PROGRAM

An In-Lieu Fee (ILF) is one method of compensatory mitigation for damages to the environment. It is used to compensate for impacts or unavoidable losses to wetlands and streams due to development, road-construction, or other projects. With ILFs, mitigation occurs when a permittee provides funds to an in-lieu-fee sponsor (e.g., a public agency or non-profit organization). In most cases, the sponsor collects funds from multiple permittees to pool the financial resources necessary to plan for, build, and maintain a mitigation site. Like mitigation banking, in-lieu fee mitigation is often “off-site.” Unlike mitigation banking, it typically occurs after the permitted impacts.

The Iowa DNR has investigated the feasibility of an in-lieu fee compensatory mitigation program (ILF program) to serve the needs of stream mitigation work for USACE permittees in Iowa. This process was initiated in response to conversations with various constituent groups and complements Iowa DNR’s work on other river restoration initiatives, including the River Restoration Best Management Practices Toolbox and Iowa Stream Mitigation Method. Work to date has culminated in the document titled “In-Lieu Fee Market Assessment and Alternatives Analysis,” (Bentley and others, 2017). Analysis has shown that an Iowa DNR-sponsored ILF program could be financially sustainable. The WMA should continue to monitor the development of the ILF program as it could be a valuable source of project funding in the future.

WATER QUALITY TRADING

Water quality trading programs are used in various places throughout the United States to make water quality permit compliance easier, raise funds for projects, and ultimately improve the water quality of streams and lakes. This type of program focuses on incentives instead of penalties to achieve goals. A trading program can be operated on various scales, but the larger the better.

Currently the Iowa Nutrient Reduction Exchange (NRE) is in early stages of framework development and pilot projects. However, once fully operational this may be a source of funds for potential projects. The WMA should work with state and regional agencies, such as IDNR, other WMAs, the Iowa League of Cities, and others to develop the NRE, which focuses on nutrients and flood mitigation.

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