Raccoon River Watershed Water Quality Master Plan

November 2011

A tool to inform and guide watershed residents and stakeholders as they seek to cooperatively improve water quality in Iowa's Raccoon River Watershed.

Thank you to the many stakeholders, experts, and diverse interests who contributed to development of the recommendations and ideas expressed in this document. Without your time, your assistance, and your honest opinions, development of the Master Plan would not have been possible. Special thanks to Drs. Phil Gassman and Manoj Jha, Center for Agriculture and Rural Development, for your leadership and work on water quality modeling.

Prepared on behalf of the M&M Divide Resource Conservation & Development

By Agren, Inc.
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Preface

The Iowa Department of Natural Resources (DNR) awarded a grant to the Missouri & Mississippi (M&M) Divide RC&D, with a subcontract to Agren, Inc. to develop a Water Quality Master Plan for the Raccoon River Watershed in January 2010. Funding for the grant agreement was provided through Section 319 of the Environmental Protection Agency, as well as Section 604(b) of the American Recovery and Reinvestment Act of 2009.

The initiative to create a comprehensive plan for the 3,625 square mile Raccoon River Watershed grew from concerns of the river's impairments for both nitrate and bacteria. Additional information on water quality in the river can be found later in this report, as well as the Water Quality Improvement Plan developed by the Iowa DNR (Schilling and Wolter 2008).

This Master Plan is, by design, broad in scope and intended audience. It is not meant to direct the activities of one specific agency or organization. Rather, it has been developed as a tool to inform and guide watershed

What is a watershed?

The term watershed refers to an area of land that all drains to a common waterway. The watershed area includes both the streams and rivers that convey water, as well as the land surfaces from which the water drains. Other terms that mean the same thing as watershed are drainage basin, river basin, or catchment.

residents and stakeholders as they seek to improve the environmental conditions of the watershed while maintaining the economic vigor of the region rooted in production agriculture. The Plan does not define specific outcome targets for water quality, nor does it prescribe a specific vision of what constitutes an environmentally and economically prosperous Raccoon River basin. Rather, the Plan focuses on common needs that have been identified by, and are broadly supported by, multi-disciplinary experts and watershed stakeholders.

Priorities identified within the Master Plan are organized into nine recommendations that have been identified by stakeholder and expert contributors as being important steps to restoring water quality. Many of these recommendations are immediately actionable. In addition to the recommendations set forth in the Master Plan, this document also provides an overview of existing water quality, land use, and demographic data and forecasts possible water quality outcomes based on varying implementation levels of agricultural best management practices (BMPs).

Executive Summary

The Iowa Department of Natural Resources (DNR) awarded a grant to the Missouri & Mississippi (M&M) Divide RC&D, with a subcontract to Agren, Inc., to develop a Water Quality Master Plan for the Raccoon River Watershed. The 3,625 square mile Raccoon River Watershed in central Iowa is identified as having water quality impairments for nitrate and bacteria.

The resulting Master Plan is broad in scope and intended audience and focuses on common needs that have been identified by multi-disciplinary experts and watershed stakeholders. The Master Plan document provides an overview of existing water quality, land use, and demographic data. Supplementary water quality modeling efforts by the Center for Agriculture and Rural Development identify high priority subwatersheds within the Raccoon River Watershed and forecast possible water quality outcomes based on varying implementation levels of agricultural best management practices. Priorities identified within the Master Plan are organized into nine recommendations:

1) Develop a regional planning organization to guide implementation of the Raccoon River Watershed Water Quality Master Plan.
2) Conduct public education to improve awareness of water quality and instill a personal commitment to water quality improvement among all watershed residents
3) Focus outreach and education efforts to farm operators and agricultural landowners on nutrient and drainage management strategies.
4) Aggressively pursue opportunities to facilitate private-sector conservation planning services.
5) Take full advantage of emerging technologies and LiDAR elevation data to identify areas of concern and target practices based on landscape characteristics at the field level.
6) Target implementation of agricultural best management practices to priority subwatersheds and priority impairments.
7) Enhance effectiveness of nutrient control and removal practices by encouraging a "stacked" approach to nutrient management such as reduce, trap, and treat.
8) Monitor water quality at the subwatershed scale to characterize existing conditions and evaluate effectiveness of watershed projects and conservation practices.
9) Continue to assess long-term water quality status and trends in the Raccoon River and enhance these efforts as resources allow.

Due to the altered hydrology and land use of the watershed, there is no simple or single solution to markedly improving water quality in the Raccoon River. Water quality modeling results indicate that even with 100 percent acceptance and use of any single best management practice, attaining the water quality reductions identified by the Iowa Department of Natural Resources for nitrate and pathogen loading is unlikely. Clearly, new strategies and technologies for drainage and nutrient management are needed. Significant progress toward water quality improvement will come only from strong private sector leadership, cooperation among all partners, and a genuine commitment to a new conservation delivery system.

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Methodology

Information and recommendations for the Master Plan were collected using a participatory approach. The process was designed to allow stakeholders to inform decision-making along with scientists and policy-makers. The approach is often beneficial when the problem at hand involves diverse stakeholders with different interests and information, which often makes it difficult for a single stakeholder to develop an informed and practical solution.

Four formal expert panel events and four stakeholder receptions were held to collect information for the Master Plan. A list of these events is included here as Table 1. A list of meeting participants is included in Appendix 1. Additionally, input was collected through an electronic survey, emails, phone calls, and individual and small group meetings throughout the 18-month planning process. Audio recordings of expert panel events, presentation copies, and background information provided to panelists can be accessed from the Iowa Department of Natural Resources Records Center.

Table 1. Master Plan meeting events

Meeting Event	Date	Location
Agriculture BMP Expert Panel	June 6-10, 2010	Various watershed locations (Storm Lake, Rockwell City, Carroll, Perry)
Stakeholder Reception- Watershed farmers and landowners	June 6, 2010	Swan Lake Education Center, rural Carroll
Stakeholder Reception- Agricultural groups	June 7, 2010	Grant Park, rural Auburn
Stakeholder Reception- Environmental groups	June 8,2010	Larry Greving Farm, rural Carroll
Stakeholder Reception- Raccoon River Watershed Association	June 9, 2010	Whiterock Conservancy, rural Coon Rapids
Non-agriculture BMP Expert Panel	October 18 & 19, 2011	Walnut Woods State Park Lodge, West Des Moines,
Expert Panel Modeling Review	December 9, 2010	Iowa State University, Ames
Implementation Expert Panel	March 17 & 18, 2011	Hotel Pattee, Perry

Current Watershed Conditions

The Raccoon River drains 3,625 square miles, or 2.3 million acres, in west-central Iowa. It is a tributary of the Mississippi River Basin, draining to the Gulf of Mexico. The Raccoon River receives water from portions of 17 Iowa counties including Clay, Palo Alto, Buena Vista, Pocahontas, Sac, Calhoun, Webster, Carroll, Greene, Boone, Audubon, Guthrie, Dallas, Polk, Adair, Madison, and Warren counties (Figure 1). It flows approximately 186 miles from its origin in Buena Vista County to its mouth in Des Moines (Schilling and Wolter 2008).

The Raccoon River flows for much of its length as three streams: North, Middle and South Raccoon rivers. The North Raccoon River is, by far, the longest of the three. It originates in northeastern Buena Vista County, flows south into Sac County, then runs southeastward for the remainder of its course through Calhoun, Carroll, Greene and Dallas Counties. The Middle Raccoon River begins in northwestern Carroll County and flows generally southeastwardly through Guthrie and Dallas Counties. The Middle Raccoon River flows into the South Raccoon River just south of Redfield. The South Raccoon River rises in northeastern Audubon County and flows generally southeastwardly through Guthrie and Dallas Counties, past the town of Guthrie Center. The north and south forks join in Dallas County just west of Van Meter, and the Raccoon River flows generally eastwardly into Polk County. The Raccoon River joins the Des Moines River just south of downtown Des Moines (Iowa Department of Natural Resources n.d.).

The Raccoon River

Drainage area: 2.3 million acres

Length: 186 miles

Major tributaries: North, Middle, and South Raccoon Rivers

Outlet: Joins Des Moines River, south of Des Moines

Water uses: Drinking water, recreation

Water uses

Surface water from the Raccoon River is used by Des Moines Water Works and the City of Panora for drinking water. In addition, 23 central Iowa utilities receive treated drinking water from Des Moines Water Works. The river also is considered to be a recreational water, typically used for activities like swimming, canoeing, and fishing. The Iowa Department of Natural Resources considers the uses of a water body in order to determine if it is impaired for these uses by a contaminant.

Water quality

The Raccoon River stream system has been impacted by elevated levels of nitrogen, phosphorus, sediment, and bacteria pollutants during recent decades, primarily from nonpoint source pollution (Hatfield, McMullen and Jones 2009, Schilling and Wolter 2008, Jha, et al. 2010). Unlike point source pollution from industrial and sewage treatment plants, nonpoint source pollution comes from many diffuse sources. It occurs when rainfall or snowmelt runs over land or through the ground, picks up pollutants, and deposits them into rivers, lakes or ground water.

Portions of the Raccoon River have officially been identified as impaired by nitrate-nitrogen (nitrate) (Appendix 2). This is because the river is a drinking water source, and water quality assessment has found levels of nitrate that exceed the maximum contaminant level for drinking water (10 mg/l). High levels of nutrients in the water also can lead to too much algae and too many aquatic plants. This is a problem known as nutrient enrichment, which results in a number of water quality problems (Libra, Wolter and Langel 2004). The Total Maximum Daily Load (TMDL) target for nitrate in the Raccoon River was established at 9.5 mg/l. This standard requires that stream nitrate concentrations do not exceed the target level for the entire range of stream flow. It is estimated that about a 48 percent reduction in nitrate loads is needed to comply with the Total Maximum Daily Load target (Schilling and Wolter 2008).

The Iowa Department of Natural Resources also classifies several river segments as impaired by the pathogens indicator Escherichia coli (*E. coli*) bacteria. This is because the river is designated to support recreational uses. It is estimated that about a 99 percent reduction in pathogen loads is needed for compliance with the Total Maximum Daily Load target for *E. coli*.

Figure 1. Raccoon River Watershed

A corresponding list of subwatershed names is included as Appendix 3.

Additional information on Iowa's water quality standards and stream classification system can be found on the Iowa Department of Natural Resources website (http://www.iowadnr.gov/water/standards/faq.html) and in the Water Quality Improvement Plan for the Raccoon River (Schilling and Wolter 2008).

"The most critical conservation concern in the region is loss of nitrogen through leaching."

USDA Natural Resources Conservation Service

Nitrate-nitrogen export from the Raccoon River Watershed is among the highest in the United States and contributes to impairment of downstream water quality (D. Goolsby, et al. 2001).Generally, rivers with higher concentrations of nitrate are often encompassed by watershed basins with similar general characteristics: 1) humid/high rainfall conditions; 2) soils high in organic matter; 3) poorly drained, fine-textured soils needing artificial subsurface drainage for optimum crop production; and 4) domination by intensive corn and soybean agricultural systems (Gyles W. Randall 2010). All of these conditions are present in the Raccoon River Watershed.

Annual export of nitrate from Iowa surface waters comprise about 25 percent of the nitrate that the Mississippi River delivers to the Gulf of Mexico, despite Iowa occupying less than 5 percent of its drainage area (Manoj K. Jha 2006). Looking beyond Iowa's borders, Iowa and Illinois together contribute about 35 percent of the total nitrate load to the Mississippi River Basin, contributing to hypoxia in the Gulf of Mexico (D. A. Goolsby, et al. 2000). Recent findings of the USDA Conservation Effects Assessment Project for the Upper Mississippi River Basin echo these findings. The report states, "The most critical conservation concern in the region is loss of nitrogen through leaching (USDA Natural Resources Conservation Service 2010)."

Land uses

The Raccoon River Watershed spans some of the most fertile farmland on earth. As shown in Figure 2, row crop production is the principal land use in the watershed. Corn and soybeans are the most commonly grown crops, contributing to nearly 73 percent of the overall land cover. In the North Raccoon River Watershed, row crop production accounts for 85 percent of the land area, where as 61 percent of the land area in the South Raccoon is in row crop production (Schilling and Wolter 2008). A detailed land cover map is included as Appendix 4.

The greater Raccoon River Watershed contains 685 Confined Animal Feeding Operations and 171 permitted feedlots. In addition, there are a number of non-agricultural permitted facilities within the watershed (Iowa Department of Natural Resources 2011). Other environmentally regulated facilities in the watershed handle wastewater, storm water, and drinking water, among other things (Appendix 5).

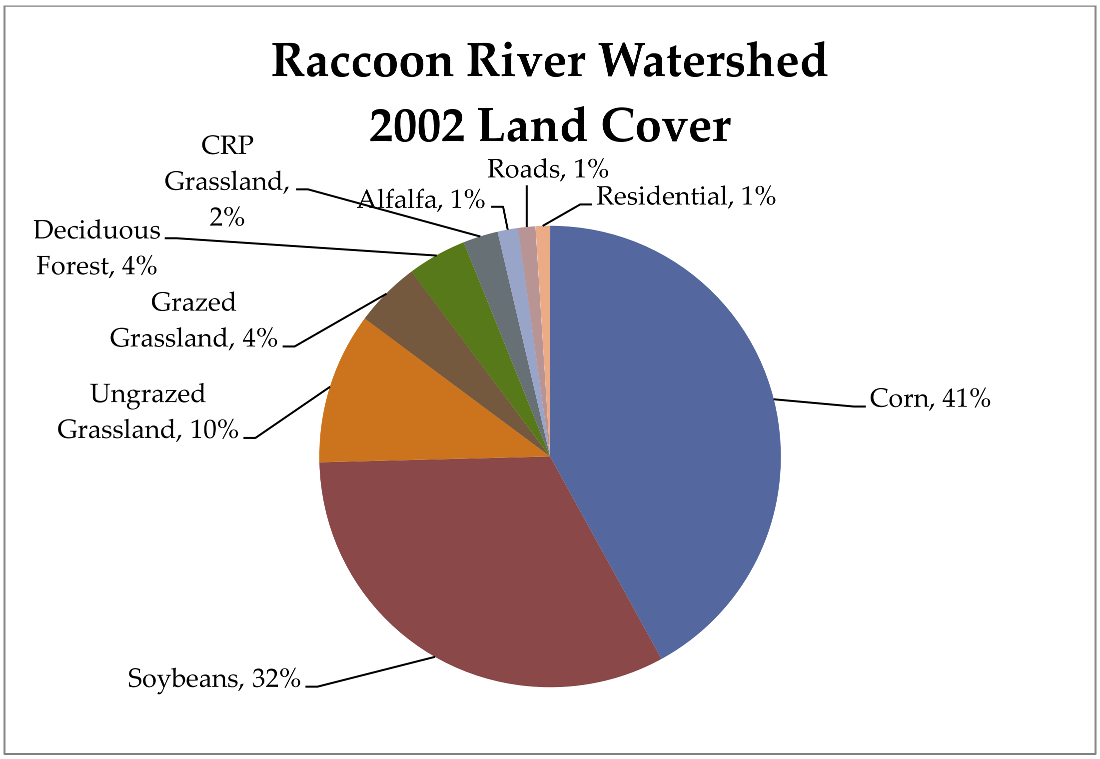

Figure 2. Raccoon River Watershed land cover (Iowa Department of Natural Resources 2010)

Geology and soils

The watershed includes land in two distinct land form regions (Figure 3). The North and Middle Raccoon Rivers flow primarily through the Des Moines Lobe. The Des Moines Lobe is dominated by flat land and poor surface drainage. In contrast, the South Raccoon River drains the Southern Iowa Drift Plain. The South Raccoon is characterized by higher slopes, steeply rolling hills and well-developed drainage (Oschwalkd, et al. 1977) . The Clarion-Nicollet-Webster soil association, found in the Des Moines Lobe region, is the most extensive soil association in Iowa. Clarion soils, formed from calcareous loam till under prairie vegetation, are well drained and occupy the higher portions of the upland on gently sloping areas, typically on slopes of 2 to 5 percent, ranging up to 30 percent. Nicollet soils are found between the well-drained Clarion soils and the poorly drained Webster soils of low-lying areas. The Nicollet soils were developed from glacial till under prairie vegetation and occur on slopes of 1 to 5 percent. Webster soils occur on nearly level (0-2 percent slopes) low-lying areas below the Clarion and Nicollet soils. The Webster soils were developed from glacial till or glacial outwash over glacial till under wet prairie grass vegetation. Canisteo soils, an important minor soil in the Clarion-Nicollet-Webster soil association, are nearly level, poorly drained, and have a higher lime (higher pH) content than other soils in the association. They are found on broad upland flats characterized by many scattered potholes (Oschwalkd, et al. 1977).

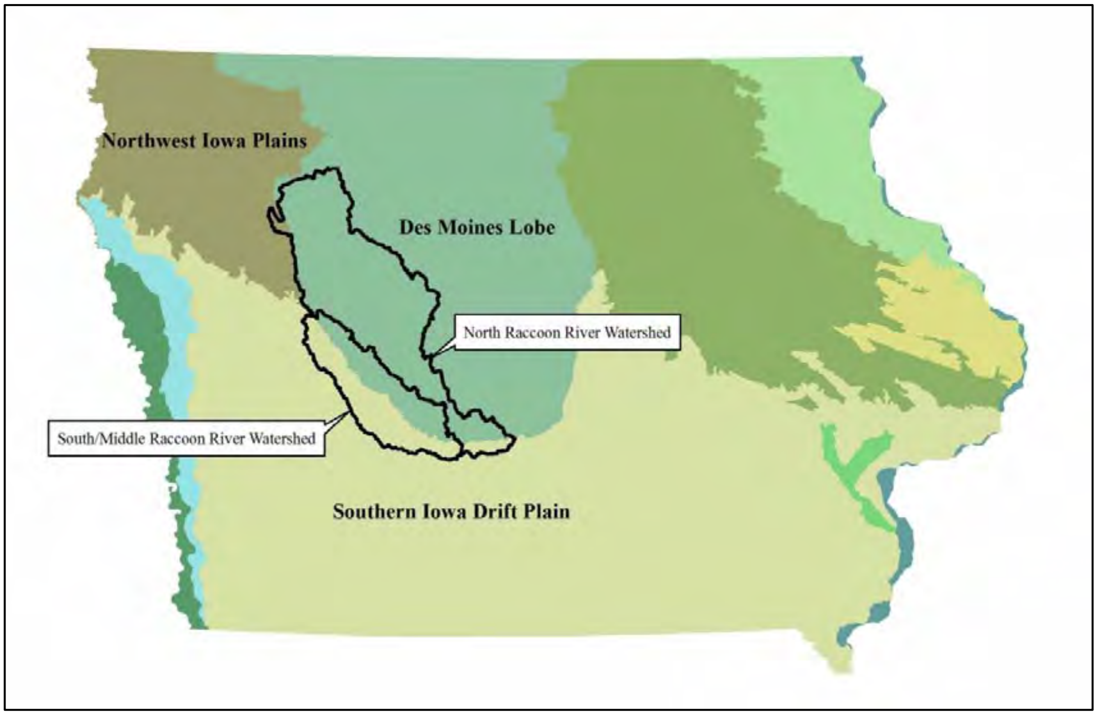

Figure 3. Iowa landform regions

Sharpsburg soils, the dominant soil type found in the Southern Iowa Drift Plain region of the Raccoon River Watershed are formed from loess under the influence of prairie vegetation. In Dallas and Guthrie counties, they predominately occupy the area south and west of the Middle Raccoon River (Iowa Agriculture and Home Economics Experiment Station; USDA Soil Conservation Service 1974). Sharpsburg soils can be found on a variety of sites, including nearly level uplands, side slopes, and loess-covered high stream benches. Sharpsburg soils are moderately well-drained and moderately slowly-permeable soils (Oschwalkd, et al. 1977).

Hydrology

Conversion of land use from what was once prairie to what is now farmland has dramatically altered the hydrology of the watershed. Hydrologic modifications include the loss of wetlands and perennial vegetation, the straightening of streams, and the installation of subsurface tile drainage and surface drainage ditches. This evolution of water management has increased crop productivity, reduced risk, and improved economic returns for crop producers. However, it also has impacted water quality.

Based on soil characteristics, an estimated 49 percent of the agricultural land within the greater Raccoon River Watershed has subsurface drainage. Tile-drained soil types mostly span the Des Moines Lobe region of the North and Middle portions of the watershed (see Appendix 6). In the North Raccoon portion of the watershed, estimates of tile drainage are as high as 77.5 percent of the land area (Schilling and Wolter 2008).

The prevalence of tile drainage on cropland, particularly in the North and Middle Raccoon River Watersheds, has led to significant water quality problems. Whenever water moves over or through the soil, nutrient losses from a field can occur. Although subsurface tile decreases runoff from the surface of a field, subsurface flow and leaching losses of nitrate are increased. This is due mostly to an increase in flow volume and the "short-circuiting" of subsurface flow, but also in part to the increased mineralization and formation of nitrate in the soil profile (Randall, Goss, and Fausey 2010). Subsurface tile drainage provides a direct channel from farm fields into adjacent surface water streams.

Demographics

The majority of the land in the watershed lies in rural areas that typically have declining and aging populations (U.S. Census Bureau 2009). Most rural Iowa counties have suffered double-digit percentage losses of population since 1980, and many have seen declines of more than 20 percent (Arbuckle, Lasley, et al. 2010). Over 60 percent of farmland owners in the watershed are 65 and older. Across Iowa, landowners age 75 and older increased more than 15 percent from 1982 to 2007 to nearly 30 percent of landowners (Duffy 2011). Compared to the rest of Iowa, farmland owners in the Raccoon River Watershed are older, and there is more of a tendency for the land to be owned by an older, single female. (Duffy 2010).

Land tenure in the watershed is also changing. In 11 of the 17 counties in the watershed, over 60 percent of the farmland is rented, and in several counties in the watershed leased farmland is approaching 70 percent. This figure is slightly higher than the statewide average of 60 percent. An increasing number of non-operator owners live outside of Iowa. From 1982 to 2007, out-of-state landownership increased by nearly 15 percent to over 20 percent of landowners living outside of the state of Iowa (Duffy 2011). A majority of Raccoon River Watershed landowners indicate current income is a driving force behind their continued land ownership (Duffy 2010).

Non-operator landowners (also called absentee landowners) leave a high percentage of decisions to the operator. A recent survey shows 90 percent of tillage practices, 85 percent of crop inputs, 48 percent of conservation practices, and 36 percent of tile drainage decisions are left to the operator (Arbuckle, Landowners and Operators Care About the Land: Iowa Farmland Owner and Operator Survey 2010). Moreover, non-operator landowners typically implement conservation practices at a lower rate than traditional owner/operators and seek different incentives for conservation practice adoption (Nickerson 2011).

Climate

The watershed, like most of the Midwest, has a humid continental climate with extremes of both heat and cold (City-Data 2010). In winter, the average temperature is around 32 degrees Fahrenheit. In summer, the average temperature is just above 80 degrees Fahrenheit (Schilling and Wolter 2008).

Year-to-year variations in precipitation appear to be the norm rather than the exception. Average annual precipitation from 1980 to 2005 was 33.08 inches. However, annual precipitation over the 25-year period ranged from 21.8 in 1980 to 44.2 inches in 1986. In 17 of the 25 years reported, precipitation was outside the range of normal. Seasonally, precipitation falling in the months of March through July account for 70 percent of total annual stream flow and 68 percent of total annual base flow in the Raccoon. Highest monthly precipitation totals typically occurred in May and June when average precipitation exceeded 4.3 inches and occasionally exceeded five inches (Schilling and Wolter 2008).

Recommendations

Priorities identified within the Master Plan are organized into nine recommendations that have been identified by stakeholder and expert contributors as being important steps to restoring water quality. The recommendations presented here are meant to guide watershed residents and stakeholders as they seek to cooperatively maintain and improve both the environmental and economic conditions of Iowa's Raccoon River Watershed. The recommendations focus on a response to common needs that have been identified by and are broadly supported by multi-disciplinary experts and watershed stakeholders.

> *Recommendations are meant to guide watershed residents and stakeholders as they seek to cooperatively maintain and improve both the environmental and economic conditions of Iowa's Raccoon River Watershed.*

Recommendation #1: Develop a regional planning organization to guide implementation of the Raccoon River Watershed Water Quality Master Plan.

The concept of coordinated planning of water resources throughout a river basin dates back to the late nineteenth century, when John Wesley Powell recommended using major river basins as administrative units. The Tennessee Valley Authority provided a prototype model for river basin planning around the world. President Theodore Roosevelt was an early proponent of the concept, stating that "each river system, from its headwaters in the forest to its mouth on the coast, is a unit and should be treated as such." From the 1940's to early 1980, several river committees were established at the federal level, but all failed to provide the planning flexibility and success of the Tennessee Valley Authority to effectively promote integrated, basin-wide programs (Jacobs n.d.).

> *"Each river system, from its headwaters in the forest to its mouth on the coast, is a unit and should be treated as such."*
>
> *President Theodore Roosevelt*

Current efforts

A watershed management organization (also referred to as a river basin commission, authority, committee, council, or board) can assume a variety of forms and functions. These groups have been organized under different sponsorship and for different purposes. All approach watershed planning and management issues differently. Their powers range from serving as consulting bodies to making decisions on all phases of water-related development. Watershed management organizations constitute a significant and valuable regional planning resource for advancing coordinated approaches to watershed issues and for building public awareness and responsibility for water quality.

Today, several states, for example Minnesota and Washington, rely extensively on watershed management organizations as a mechanism for developing and carrying out local water management plans at a more local level (Municipal Research and Service Center of Washington 2010) (Nobles 2007) . This approach has not been formally implemented in Iowa, although the Lake Rathbun Association provides an example within Iowa of a long-standing, locally-led organization that is actively targeting technical and financial assistance to achieve specified objectives in their watershed management plan (Agren, Inc. 2011).

In April of 2010, a legislative bill (HF2459) outlining the process for establishing formal Watershed Management Authorities was signed into Iowa law. The bill calls on watershed stakeholders to sign 28E joint intergovernmental agreements to reduce flood risk and improve water quality, monitor federal flood risk planning and activities, and educate residents of the watershed regarding flood risks and water quality (Rebuild Iowa Office 2010).

Potential opportunities

A key objective of the master planning process was to consider mechanisms to promote implementation of best management practices (BMPs) cited in the Plan, as well as implementation of the Master Plan itself. For the Implementation Expert Panel Meeting, panelists focused discussion on the potential for developing a regional planning organization that would guide implementation of all or parts of the Raccoon River Water Quality Master Plan. Panelists concurred that some form of a watershed management organization can work to solve many, but not all, of the identified water quality management issues in a watershed. A full account of the panel's discussion, as well as meeting conclusions, can be found in the final summary report of that meeting (Agren, Inc. 2011). Included here is a summary of recommendations made by the expert panelists, with respect to the form and function of a watershed management organization for the Raccoon River Watershed.

As part of the discussion, panelists were asked to consider several different "scenarios" for what a watershed management organization might look like and do. Each panelist was asked to provide specific comment on their likes and dislikes about each scenario, as well as what they would change about the specific scenario. At the conclusion of this session, the group worked to combine the most desirable features of each scenario as a vision for the type of organization that could best serve the needs of the Raccoon River Watershed. The following bullets outline the group's vision.

- Watershed area: An organization should be formed to carry out a defined and strategic mission across the entire Raccoon River Watershed. However, it was recognized that to be effective, smaller geographic areas would need to be prioritized and targeted for different projects.

- Mission: Establishing a critical mission and strategic plan will help the organization to maintain focus. The watershed organization should try to know and understand all the issues in the watershed; however they should decide on which specific issues to focus. The priority focus of the organization should be pathogen and nitrate reduction for water quality, which should influence all activities of the organization. Education and outreach should be an important part of the organization's mission, (outlined in Recommendations #2 and #3 in this document). Furthermore, panelists noted that monitoring and continued evaluation will be an important component.
- Leadership: Leadership and organizational support could be provided by the Region XII Council of Governments (COG), with support from the Resource Conservation and Development offices (RC&D) within the watershed. The group felt this type of leadership would provide institutional stability, which is imperative to the long-term sustainability of the organization. It also was noted that the Council of Government and Resource Conservation and Development leadership is appropriate because preservation of water quality in the Raccoon River is more than just a natural resources conservation issue. It is an important economic development and tourism issue as well.
- Board and constituency: A watershed board or council should govern the organization and meet on a monthly basis. The board should be tiered, with a core voting board and a larger advisory board. Membership on the voting board should be limited in number and include only members living within the watershed. Emphasis should be placed on forming a local, passionate board. Farmers and non-governmental organizations, including Des Moines Water Works and/or any organization lending financial support should be represented on the voting board. At-large appointments also could prove valuable. The organization should carefully weigh the advantages and disadvantages of "appointed designees" from county Boards of Supervisors, as these individuals may lack commitment. The advisory board should include one SWCD commissioner or an SWCD appointee from each county.
- Legal authority or basis: The organization should either be set-up as a nonprofit organization (501c3) or as a joint intergovernmental agreement (Iowa Code Chapter 28E). Panelists did not come to a clear consensus on the legal structure of the organization, and there was not an overwhelming bias toward either option by any of the panelists.
- Funding: The organization should not rely on government grant funding to survive. A minimum of 50 percent of the organization's operating budget should come from money within the watershed, and participating organizations should contribute to

funding the organization. For example, on-going financial support could come from a combination of participating Soil and Water Conservation Districts, county governments, city governments, and non-governmental organizations such as Des Moines Water Works and Agriculture's Clean Water Alliance. Office space and equipment could be provided in-kind by an organization within the watershed, such as the Council of Governments. Grant funding should be sought to support special projects and technical staff. Local contributions at the levels discussed would provide excellent opportunity for leveraging state and federal grant dollars for water quality projects.

- Staff: The organization should have a full-time staff. Organizations with full-time staff have clear track records for having the most success. The organization should have at least one full-time staff person, and more as specific projects allow. Staff members with a personal interest or stake in the watershed are often more effective. The staff office should be housed within the watershed. Some group members felt the organization could still exist and provide value without a full-time staff if funding was not available. However, other members disagreed and felt the organization could not function effectively without at least one full-time, committed staff person.

Initiating organization of a watershed management organization is recommended as a first step to implementing the Master Plan. Moving quickly will allow leadership to capitalize on momentum and interest created through the planning process, establish clear implementation priorities, and progress more quickly to action. Figure 4 provides a suggested timeline for establishing a watershed management organization.

Challenges and barriers

Potential barriers to developing an effective and sustainable watershed management organization are mostly similar to the challenges experienced by any organization with a diverse membership. Some of the potential concerns cited by expert panelists include maintaining focus of the organization, diffusing "turf issues", and maintaining accountability among board members. Several of these issues could be positively influenced by a talented and dedicated staff person and committed, passionate board members. Funding will provide an ongoing challenge to the organization, especially if the majority of financial support comes through state and federal grant sources.

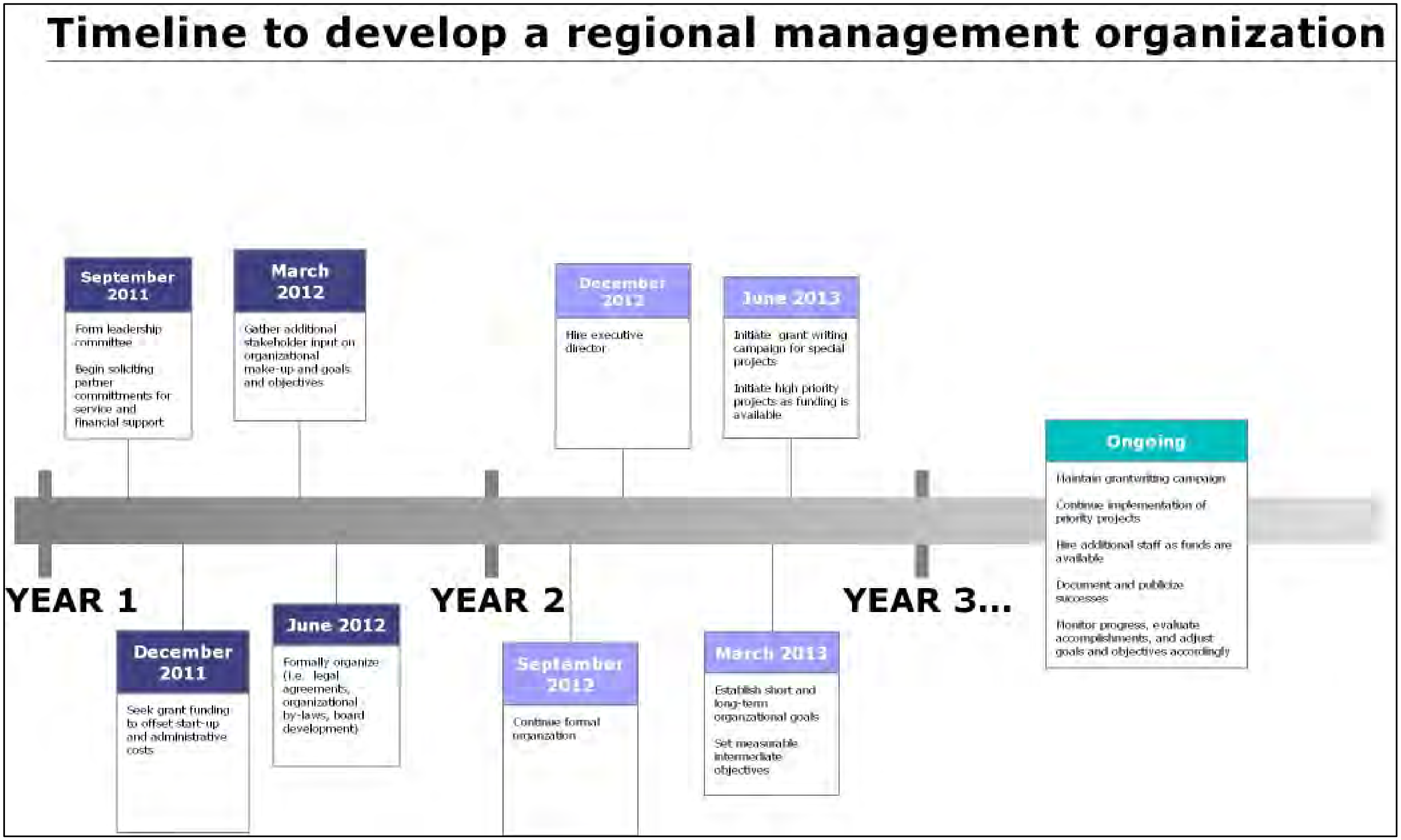

Figure 4. Timeline to establish a regional management organization

Recommendation #2: Conduct public education to improve awareness of water quality and instill a personal commitment to water quality improvement among all watershed residents.

A significant first step towards water quality improvement must be increasing awareness of the general public about water quality within the Raccoon River Watershed. Without this, neither public officials nor watershed residents can be expected to support water quality improvement efforts. Water quality should be positioned as a concern and responsibility of all residents.

Water quality should be positioned as a concern and responsibility of all residents.

In an on-line survey conducted in support of the Master Plan, Raccoon River Watershed residents were asked if they were "*aware the Raccoon River has the highest average nitrate concentration of any of the 42 largest tributaries in the Mississippi River Basin*" (D. Goolsby, et al. 2001). Fourteen percent of respondents indicated they were unaware of water quality issues in the Raccoon River. Forty-two percent indicated they were generally aware, but not of this specific finding. It should be noted that over 65 percent of respondents to the same survey also specified they *actively support water quality improvement efforts in Iowa*, indicating the sample of respondents may be more active, and therefore more aware of water quality issues, than the general public (Agren, Inc. 2010).

The call for public education on water resources, water quality, water supply, wastewater, and storm water management was a key finding of the Non-agricultural Best Management Practice Expert Panel meeting held in support of Master Plan development. The panel identified a lack of public education as being a significant barrier to many of the water-related challenges faced by communities within the watershed, especially smaller rural communities. The group asserted that most watershed residents take for granted that their water is clean and safe to drink and that their wastewater is adequately treated. The group concluded that even though a small portion of contaminants in the Raccoon River come from non-agricultural sources, everyone in the watershed needed to take responsibility for water quality and work to be "part of the solution" (Agren, Inc. 2010).

Furthermore, these same panelists identified a need for public education on agriculture. The panel recognized that the majority of watershed stakeholders live in the relatively small, urban and suburban portion of the watershed nearer to Des Moines and are very removed from agriculture (Agren, Inc. 2010).

Outside of Raccoon River Water Quality Master Plan activities, the need to educate the general public on water resources issues has been identified by several other planning efforts. The Iowa Watershed Quality Planning Task Force, Governor's Water Quality Summit, and the Iowa Watershed Task Force have all recommended media campaigns to educate Iowans on water quality and related issues (Watershed Quality Planning Task Force 2007, Iowa Department of Natural Resources 2003, Iowa Department of Agriculture and Land Stewardship 2001).

Current efforts

In spite of several calls for a public information campaign, this has not been implemented on a statewide basis, or in the Raccoon River Watershed. Some form of public education is usually integrated into locally-led, subwatershed projects. However, these efforts generally lack the scale, scope, and intensity of what is recommended here.

Potential opportunities

Increasing the general awareness of water quality within the Raccoon River Watershed can be accomplished through a well thought-out, structured education and marketing campaign. The campaign should be organized and implemented by one single organization, on behalf of many supporting public and private partner organizations, and delivered across the entire Raccoon River Watershed. A watershed management organization, similar to that described here as Recommendation #1, would be an ideal organization to lead this public education effort.

First, a marketing campaign and brand strategy should be developed. A consistent, recognizable brand creates awareness of an entity, and eventually, establishes credibility. All of the marketing and outreach in the watershed must work in tandem with the brand to establish a consistent, cohesive public image. This means that all partnering organizations must be willing to work through a single

All partnering organizations must be willing to work through a single organization to present their outreach messages in the watershed.

organization to present their outreach messages in the watershed. In lieu of this unified approach, sporadic outreach messages from different entities essentially compete against each other, often confusing the general public and lessening the impact of each individual effort.

A marketing campaign should be delivered over an extended period of time. Establishing a credible brand will take time, it cannot be accomplished through a short-term project. Staying the course and being consistent will eventually lead to having a recognized, reliable brand known for delivering accurate and important information.

The campaign should be delivered through various medium, including direct mail, local newspapers, radio stations, social media, and field day events. Field day events can be used to demonstrate the form and function of different agricultural and non-agricultural best management practices and to help intermingle the farm and non-farm audiences.

Audiences for the public information campaign will vary widely, from elected officials to both rural and urban watershed residents. For each audience, the tailored message should focus on the value of water resources and how watershed residents can work together to support and improve water quality in the Raccoon River. Messages should start with basic messages to establish awareness of the watershed and water quality, and then progress to more targeted, specialized messages to high priority audiences on high priority issues. An under-utilized resource identified for educating communities on the issue of storm water management and low impact development is the Iowa Stormwater Management Manual.

Challenges and barriers

With professional marketing and branding assistance, the logistics of developing and delivering a wide-reaching public information and marketing campaign in the Raccoon River Watershed should not be technically difficult; these types of campaigns are developed and implemented by businesses and other private sector groups all of the time. However, the importance of developing messages that resonate shared responsibility among all watershed residents, rather than finger-pointing and defensive reactions, cannot be over-emphasized and will require strategy, market research, and likely some trial and error.

Another challenge is the difficulty in funding a public information initiative through state or federal grant sources. Although it is widely accepted that awareness is a necessary step to behavior change, a funding prerequisite for most water quality-related projects is the outcome of direct and measurable impacts on water quality. Changes in public perception are difficult to measure, especially over a time-period of just a few years. Dedicated, long-term funding will be necessary to effectively implement this recommendation. Private sector involvement will be imperative to the ability of an organization to sustain funding for this type of effort.

Recommendation #3: Focus outreach and education efforts to farm operators and agricultural landowners on nutrient and drainage management strategies.

If significant progress is to be made towards meeting water quality standards in the Raccoon River Watershed, farmers and agricultural landowners must fully understand and accept the impact of subsurface tile drainage on nitrate loading and the need for system-based or "stacked" approaches to nutrient management. Managing for soil conservation is fundamentally different than managing for nutrient conservation. As stated by one expert panelist in reference to his interactions with Raccoon River farmers, "Most farmers think they are doing a good job with conservation, and in most cases, I'd agree, but now we're looking for something beyond that."

"Most farmers think they are doing a good job with conservation, and in most cases, I'd agree, but now we're looking for something beyond that."

Ag BMP Expert Panelist

A recent survey by Conservation Districts of Iowa and Iowa State University also point to lack of awareness and acceptance among agricultural landowners and farm operators regarding the impacts of row crop production in tile drained landscapes. The survey found that only about 29 percent of farm operators in the Middle Raccoon Watershed agreed with the statement, *Farming activities are causing water quality problems*. And, 92 percent of these same farm operators either disagreed or were uncertain about the statement, *Tile drainage is causing water quality problems.* For non-operator landowners, the percentage who agreed with the statement, *Farming activities are causing water quality problems,* was higher, with 38 percent agreeing. However, 81 percent of non-operator landowners either disagreed or were uncertain about the statement, *Tile drainage is causing water quality problems* (Arbuckle, Landowners and Operators Care About the Land: Iowa Farmland Owner and Operator Survey 2010).

Current efforts

At present, outreach on water quality best management practices and conservation programs is provided by Iowa State University Extension, the Iowa Department of Natural Resources, Iowa Department of Agriculture and Land Stewardship, the USDA

Natural Resources Conservation Service, 100 Soil and Water Conservation Districts, and various non-governmental organizations.

State-wide educational and governmental organizations develop fact sheets, news releases, and other outreach materials. These materials (brochures, posters, fact sheets, etc.) are produced and posted on-line or printed and set out in local USDA Service Centers or other offices. The information is most often made available to people actively seeking information on a topic and as handouts for use by conservation planners and water quality specialists. Local Soil and Water Conservation Districts and watershed projects sometimes distribute relevant materials in their local areas, based on local priorities or program availability.

Local organizations may augment these materials from state or federal organizations with their own outreach pieces, such as radio programs, newspaper articles, newsletters, letters, or emails. However, in general, outreach materials are not delivered to a specific audience using a targeted or consistent approach. Moreover, there is generally little coordination between these entities on development of information. Finally, mailing lists are often incomplete and only include those farmers and landowners who have been previous cooperators. Because outreach materials mailed from field offices are generally sent via bulk mail, undeliverable addresses are not returned to the sender, preventing mailing addresses to be updated or landowner names to be removed from the list.

The current method is a logical approach to education in that it allows for technical experts to develop technically sound materials. Local planners and watershed specialists can access professionally developed materials and do not need to "reinvent the wheel." The approach allows local entities to select and distribute messages consistent with their local priorities. However, education alone will not lead to significant change. This method of outreach lacks several features that are central to marketing campaigns designed to motivate action; for example:

- Marketing plan/strategy
- Targeted audience
- Consistent branding
- Consistent messaging
- Strong offer/ call to action
- Repetition and follow-up

Potential opportunities

This "new kind of conservation" that farm operators and landowners must begin to understand and embrace calls for a new kind of conservation outreach. First, similar to the process outlined in Recommendation #2, a marketing campaign and brand strategy should be developed and delivered watershed-wide. The marketing plan should coincide with and build on the public awareness campaign (Recommendation #2), and include a series of well thought-out, repetitive, branded messages. This message should be delivered in multiple ways, over an extended period of time. Furthermore, campaigns must be designed to intentionally bring each audience from a level of awareness, through interest, desire, and finally to action (practice implementation). For example, on-going awareness messages may be delivered throughout all or large portions of the watershed, followed with more action-oriented, resource-intensive outreach activities in high-priority watersheds.

Secondly, specific and unique campaigns should be developed and delivered to both the farm operator and absentee landowner audiences. It is imperative that the growing number of absentee landowners in the watershed become aware of water quality in the watershed and understand their potential role in supporting their operator in improving nutrient and drainage management.

Also similar to Recommendation #2, this type of campaign should be organized, implemented, and branded by one organization, on behalf of both public and private partner organizations. A likely entity to lead this campaign is a watershed management organization, similar to the organization outlined here as Recommendation #1. Furthermore, this provides an excellent opportunity to partner with agricultural retailers and other agri-business groups to develop co-branded messages. Co-branding is a marketing term used to describe the association of a single message with more than one brand. This concept combines the different perceived properties associated with each individual brand to emphasize a single message.

Finally, the organization that originates the marketing should work cooperatively with Soil and Water Conservation Districts and local watershed staff to be sure outreach messages are relevant and timely. However, the emphasis of these local offices should be timely follow-up and in-person contacts with farm operators and landowners, rather than developing or distributing outreach materials.

Challenges and barriers

With professional marketing and branding assistance, the logistics of developing and delivering this type of campaign to farmers and landowners in the Raccoon River Watershed should not be particularly difficult. However, there are some inherent challenges that must be considered.

First, messaging must be developed that clearly states the source of the priority problem (nitrates and pathogens) and need for action (combinations of best management practices). The message must be stated in a way that is not preachy or threatening and does not alienate the farming community.

Another challenge will be successfully engaging the absentee landowner audience. While survey results indicate this group has a relatively high degree of interest in conservation (Arbuckle 2010), work by Agren, Inc. and others indicates there are a number of barriers that prevent this audience from participating in conservation practices in the same way as owner-operators. Some of these barriers include: sibling relationships, fear of jeopardizing relationships with tenants, lack of understanding of basic agriculture practices, communication with local field offices, influence from the operator, inability to contact field offices during regular business hours, and planting, installation and maintenance of practices. Furthermore, Agren's work in several different geographic areas has determined it is "challenging at best" for field offices to provide adequate customer service and follow-up to absentee landowners (Ridgely 2009).

A successful marketing campaign to absentee/non-operator landowners will likely need to involve specialized resources for customer service and technical assistance for absentee landowners. A current effort led by Conservation Districts of Iowa in Sac, Calhoun, and Carroll counties involves employing a "landowner advisor" to work as a liaison between absentee landowners and conservation organizations. The purpose of the landowner advisor is to build relationships with interested landowners and access resources for technical and financial assistance. The demonstration project is in an early pilot phase, and it is too early to gauge whether or not the advisor will be successful in overcoming the many barriers identified by this audience.

Finally, this method of outreach and marketing is significantly different than today's approach. This may lead to some reluctance from local Soil and Water Conservation Districts and locally-led watershed project coordinators who prefer the autonomy of developing and distributing their own outreach messages. Conversely, other local offices may appreciate the extra time to focus on conservation planning and relationship building with landowners.

Recommendation #4: Aggressively pursue opportunities to facilitate private-sector conservation planning services.

Perhaps the most limiting factor to getting adequate application of conservation practices in the watershed is a lack of conservation planning services.

A key finding of the Ag BMP Expert Panel was the recognition that perhaps the most limiting factor to getting adequate application of conservation practices in the watershed is a lack of conservation planning services (Agren, Inc. 2010). Without adequate technical assistance for conservation planning, public funding for both state and federal financial assistance programs cannot be appropriately targeted to the practices and locations where the monies will provide the most significant benefit to natural resources. Specifically, the group identified a need to work with private service providers to reach pivotal implementation levels of 1) process-oriented practices, such as adaptive nutrient management planning; and 2) general resource management planning using assessment tools such as the Soil Conditioning Index, Phosphorus Index, and RUSLE2 erosion model.

Current efforts

The vast majority of conservation technical assistance in Iowa is provided by the federal government, through the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS), and through the State of Iowa, through the Iowa Department of Agriculture and Land Stewardship's Division of Soil Conservation (IDALS). As both of these agencies continue to face staffing cuts, an opportunity is created for the private sector to fill this gap.

The Natural Resources Conservation Service Technical Service Provider Assistance program, first authorized in the 2002 Farm Bill, provides a basic framework for a public-private conservation planning partnership. The initiative encouraged the Department of Agriculture to use technical service providers to increase the technical assistance available to help landowners meet their conservation goals. Individuals, private businesses, nonprofit organizations, and public agencies can become part of a cadre of certified professionals that are approved by the Natural Resources Conservation Service to provide different types of technical assistance. Iowa maintains an active technical service provider program. For example, certified technical service providers are frequently contracted to develop comprehensive nutrient management plans in Iowa. However, the current application of the program focuses mostly on comprehensive nutrient management plans and does not provide the full range of planning services necessary to significantly enhance practice implementation in the Raccoon River Watershed.

Also worth noting, Pheasants Forever provides an example of a natural resources advocacy organization that is striving to meet their mission of enhanced wildlife habitat by directly employing natural resource practitioners. Their recent Reload Iowa initiative aims to raise local dollars to support a biologist that will work one-on-one with landowners to restore wildlife in a one to two county area. The Iowa Department of Natural Resources Private Lands Program also employs regional biologists to work with private landowners. While these organizations focus their programming on wildlife habitat, their objectives often overlap with water quality programming.

Potential opportunities

The Raccoon River Watershed provides an excellent opportunity to pursue public-private partnerships that can accelerate the application of conservation practices by making conservation technical assistance more accessible and valuable to farmers and landowners. Several non-governmental entities within the watershed are well-positioned to expand the services they currently provide to include some form of conservation planning assistance.

Agriculture’s Clean Water Alliance is an association of agricultural product retailers in west-central Iowa. The organization was first formed in response to water quality concerns in the Raccoon River. Member ag retailers united in an agreement to internalize and implement a dual mission of blending optimal crop yield and profitability with the best environmental performance possible. To date, Agriculture’s Clean Water Alliance has focused their resources on developing an extensive water quality monitoring network, with over 40 water sampling sites in the river basin (Agriculture's Clean Water Alliance 2010).

A public-private conservation planning partnership with member ag retailers could capitalize on the trust and long-standing relationships farmers already have with their retailers, both as suppliers and as consultants. In many cases, ag retailer agronomists know nearly as much about the landscape, soils, and productivity of a customer's individual fields as the farmer himself knows. Often, retail agronomists have tremendous influence over a farmer's decisions. Retail agronomists develop these relationships and knowledge as a means to secure product sales. Many already provide tremendous value to farmers through their consulting services. It is plausible to consider that conservation planning could be facilitated by retail agronomists as they conduct their regular business with farmers.

Independent crop consultants are another group of agronomists who rely on farmer relationships and knowledge of their customer's fields to support their businesses. Independent crop consultants differentiate themselves from retail agronomists in that they do not sell product. Rather, their business model is supported by income generated solely by providing agronomic services and recommendations.

The prospect of engaging independent crop consultants in a public-private partnership for conservation planning eliminates the possible bias towards product sales inherent to the retail agronomist partnership. However, there are far fewer independent crop consultants actively working in the watershed compared to ag retailer agronomists. In either case, a desirable partnership would be one that builds on farmer relationships and individual field knowledge of the agronomist to 1) deliver planning assistance for process-oriented practices such as adaptive nutrient management planning; or 2) conduct field level resource management planning using existing environmental assessment tools.

One possible scenario may be equipping field agronomists with the skills and tools to provide basic conservation planning services, identify areas of concern, and engage farmers in considering possible practice alternatives. Then, once a farmer has established an interest, the farmer would be encouraged to pursue technical and financial assistance for implementation with their local field office. The advantage of this arrangement is that rather than only the most motivated producers asking for assistance, service providers are approaching farmers who manage land that is in need of practices. And, they already have both a rapport with the farmer and an intimate knowledge of the landscape.

This approach could be adaptable to many approaches to targeting limited resources to high priority sites. For example, a special initiative could be developed in high priority watersheds where agronomists would be trained to identify potential practice sites and recommend a few high priority practices to farmers. Alternately, a regional organization could use geographic information systems and remotely sensed data to site conservation practices in the most beneficial landscape areas, develop a basic plan and layout of the practice, and provide it to the field agronomist to review with the farmer. Or, agribusinesses could utilize advanced geographic system technologies to site and layout conservation practices on their own, and provide this information to farmers as an added service. In all cases, trained field office staff could maintain the roles of practice design and administering financial assistance programs.

Challenges and barriers

Creating a credible and effective public-private partnership for conservation planning in the Raccoon River Watershed will not come without challenges. The basic infrastructure is provided through the Natural Resources Conservation Service Technical Service Provider program. This program could provide the quality assurance framework needed to ensure conservation planning services delivered through the private sector continue to be technically sound. However, for the program to be successful, there are many other considerations.

Creating an effective payment or incentive program to engage agronomists will be of paramount importance. For many independent crop consultants, conservation planning will fit easily into the portfolio of services they provide to their clients. However, in the minds of retail agronomists, conservation planning will need to be advanced to a level similar in importance as fertilizer, seed, and pesticide sales. It is likely unrealistic that the financial rewards received by retail agronomists for conservation planning services can be elevated to match those of ag product sales. Therefore, participating cooperatives will need to genuinely support the need for conservation planning in the watershed and understand their unique position and ability to provide conservation planning as a valuable and added service to their customers. And, they'll need to be prepared to carry this message to their agronomy sales force. Strong leadership from Agriculture's Clean Water Alliance will be important to institutionalize delivery of conservation planning as a consulting service offered by retail agronomists in the watershed.

Financial support at some level will likely be necessary for ag retailers to provide the infrastructure and incentive needed to engage their agronomists. Large agribusiness companies could be approached as sponsors for conservation excellence programs for both farmers and agronomists. The programs could function much the same way as these companies provide incentive programs for product sales. Another potential option could involve agricultural retailers voluntarily adding a small fee onto the cost of ag products that could be used to partially fund infrastructure and incentives for third-party conservation planning services. A watershed management organization could also consider subsidizing or rewarding technical service providers or the farmers they work with directly.

Training also will be an important component of a successful private sector conservation planning initiative. The educational opportunities available to the private sector to gain knowledge and skills for natural resources assessment and conservation planning are limited. Training programs will need to be developed and delivered to prepare agronomists to utilize their existing agronomic skills and experience for conservation planning; for example to extend their knowledge of fertilizer rates and timing to the process and application of adaptive nutrient management. Furthermore, agronomists will need training to use environmental assessment tools to identify critical areas for conservation best management practices. They will need a sound understanding of local, state, and federal financial assistance programs so they can comfortably communicate basic information to their farmer clients. Iowa's Certified Crop Advisor program provides a mechanism for certified agronomists to receive accredited soil and water training. However, the training required (as well as what is typically offered) for the accreditation program is not sufficient at this time to meet the needs of a private sector conservation planning initiative in the Raccoon River Watershed. Additional training could be provided directly by the Natural Resources Conservation Service or by a third-party with previous experience training conservation planners.

Appropriate conservation planning tools and technologies must be accessible to private technical service providers. These tools must be easy to use and understand. Alternately, as new conservation planning tools and technologies are developed by the public sector, they should have outputs appropriate for use by third-party service providers as they work with farmers. The concept of using emerging technologies to efficiently site and plan conservation practices is discussed in further detail below as Recommendation #5.

Finally, the notion of a public/private sector conservation planning partnership will need to be embraced by both sides of the partnership, at a local level. Technical service providers will need to engage other specialists, such as public sector conservationists and engineers, to assist with delivering services for which they are not adequately trained or equipped. Likewise, governmental field offices will need to engage their private sector counterparts in providing the tasks for which the private sector can provide most efficiently. Understanding the nuances of the relationship among local partners will take both time and trial, as is the case in any effective partnership.

Recommendation #5: Take full advantage of emerging technologies and LiDAR elevation data to identify areas of concern and target practices based on landscape characteristics at the field level.

Throughout the Raccoon River Watershed, entire farms and fields are managed mostly uniformly to simplify farming operations. However, land conditions such as soil type and topography vary substantially at smaller scales. This in-field variability impacts the need for and effectiveness of conservation best management practices. Therefore, in order to significantly improve water quality, it is imperative that conservation best management practices be applied specifically to these critical areas on the landscape.

Defining critical areas is a challenge. However, new technologies such as high-resolution elevation data and advanced geographic information systems can provide resource management professionals with effective decision tools (Birr 2011). Today, targeting critical resource areas is possible not only at a watershed scale (as presented in Recommendation #6), but also at a farm and field scale.

The concept of applying conservation practices in the right place, at the right time, and at the right scale has been called "precision conservation."

The concept of applying conservation practices in the right place, at the right time, and at the right scale has been called "precision conservation" (Cox 2010). More technically, precision conservation is defined as the use of one or more technologies to implement conservation management practices that integrate variations in space and time across natural and agricultural systems (Delgado and Berry 2008). The purpose of precision conservation is to maintain the increases in crop productivity made possible through precision agriculture, while reducing unnecessary inputs and losses of sediment, nutrients, and other chemicals to the environment (Delgado, Berry and Khosla 2008).

In many cases, the greater cost of precision conservation can be offset partly by greater water-quality benefits. Some of the field-level applications explored by researchers include use of precision conservation to:

- Increase nutrient use efficiencies
- Increase carbon sequestration
- Reduce soil erosion
- Reduce off-site transport of soil, nutrients, or pesticides
- Treat or trap soil, nutrients, or pesticides.

Current efforts

The Iowa Department of Natural Resource currently maintains an extensive geographic information systems (GIS) database that can be used in different ways to identify critical resource areas on the landscape. For example, the Iowa Department of Natural Resources has developed models to estimate sediment and phosphorus delivery across a watershed. And, in cooperation with the Iowa Department of Agriculture, they have developed a model that calculates sediment and phosphorus reduction potential at a specific site for a variety of practices. Other examples of technology being used to target conservation include the Revised Universal Soil Loss Equation 2 (RUSLE2) soil loss model, Iowa's Phosphorus Index, and the Soil and Water Assessment Tool (SWAT).

A relatively new development in Iowa is the acquisition of a very high-resolution elevation data set, derived from LiDAR. Iowa was one of the first states in the nation to have full state-wide coverage of LiDAR data. An acronym for **li**ght **d**etection and **r**anging, the term LiDAR is used to describe how location and elevation data is collected using laser beams. A small aircraft sends out thousands of light beams to define the surface of the earth and the heights of above ground features. Processing of the data points results in a highly accurate digital elevation model - essentially a plaster relief of the land made from light.

Iowa's old 10-foot contour topographic data (often displayed as maps) was accurate within 5 feet. With LiDAR, Iowa now has publically-available 2-foot contour data that is accurate within 8-inches (Iowa Department of Natural Resources 2011). The availability of LiDAR in Iowa greatly increases the opportunity for applying precision conservation.

Iowans are coming up with new uses for LiDAR data all of the time. Some of the conservation-related uses for LiDAR within the state include flood plain mapping, watershed modeling, runoff modeling, wetland restoration, forestry management, and mapping recreational trails (Iowa Department of Natural Resources 2011). When combined with software packages designed for conservation planning, the LiDAR data can be even more powerful. Approximately one-half of Iowa's Soil and Water Conservation Districts have licensed a suite of conservation planning tools designed to increase the efficiency and accuracy of conservation planning using LiDAR. These tools lower the knowledgebase needed to plan structural conservation practices and also can be used to quickly and easily quantify environmental benefits.

Potential opportunities

There are a number of new technologies on the horizon that could substantially increase the efficiency of targeting conservation practices to locations within a field where they are most effective. Better targeting of conservation practices alone will not solve water quality problems in the Raccoon River. However, as budget concerns mount in the public sector, it is more important than ever to implement technology to make the most efficient use of local conservation agency staff and available financial assistance programs.

Iowa researchers are experimenting with using existing conservation best management practices in new ways. For example, variable width conservation buffers, designed based on sediment loading, have been shown to be more effective than those designed with uniform width. Additionally, trials at Iowa's Neal Smith National Wildlife Refuge are finding that strategically-placed strips of perennial vegetation can be placed into cropland fields to provide conservation benefits that are disproportionately greater than the land area occupied by the perennial vegetation (Helmers 2011).

In Minnesota, the Minnesota Department of Agriculture is implementing a special initiative to train local conservation professionals. A similar initiative will be necessary in Iowa if local Soil and Water Conservation Districts become responsible for using LiDAR data to target conservation practices.

The Iowa Department of Agriculture and Land Stewardship, Division of Soil Conservation, is currently working with the USDA National Laboratory for Agriculture and the Environment and a private vendor to develop a geographic information system (GIS)-based soil loss model. This tool will allow conservation planners to evaluate soil loss variably across a field, on a 3 by 3 meter grid, using the popular RUSLE2 sheet and rill erosion model. Additionally, it will also allow planners and farmers to evaluate different combinations and placement of conservation practices based on effectiveness for erosion control.

Where it was once only practical for a local Soil and Water Conservation District field office to work with landowners to voluntarily site conservation practices at the field level, the technologies mentioned above make it possible for a more regional organization to assume the task of locating practices in landscape positions with the most benefit. Centralizing this role will reduce the burden of technology transfer to field offices and allow for a uniform approach to evaluating fields and targeting conservation practices. One possible scenario would be for a regional organization to work throughout a high-priority sub-watershed to site best management practices on the most highly susceptible areas on the landscape. Then, the local field office, locally-led watershed project staff, or a private technical service provider could solicit and work with landowners of targeted fields on voluntary implementation of the appropriate best management practice.

Challenges and barriers

Precision conservation offers the opportunity for significant gains in efficiency, both from the standpoint of staffing and reaping the greatest benefit from limited financial assistance programs. However, the approach requires a significant departure from the way conservation practices are currently sited and implemented by Soil and Water Conservation District field offices in the watershed.

Precision conservation will require a fundamental shift in the way conservation programming is administered. Although there is some level of targeting and prioritization occurring in field offices and locally-led watershed projects today, technical and financial assistance programs are largely equally available to all landowners and across all agricultural land. In general, a program is made available, broadly advertised across a geographic area, interested owners and/or operators request technical assistance for planning the practice, and then apply for financial assistance. Moreover, incentive payments are mostly the same, regardless of the performance of the practice and the landscape position in which it is placed. In contrast, precision conservation technologies will allow for an entity to site conservation practices across an entire watershed landscape. Planners will determine which practices are likely to provide the greatest natural resource protection, and then work with local field offices or the private sector to seek out and assist the owners and managers of these high-priority sites.

Convenience is another challenge to precision conservation. In some cases, even though the technology and data is available to site the right conservation practices to the right place and at the right time, it may not yet be convenient to employ these technologies at a scale beyond demonstration. For example, the process to design variable width conservation buffers takes many tools, because a single, specialized software tool hasn't yet been developed (Dosskey, Eisenhauer and Helmers 2005). It is likely impractical for a field office to be trained in each of the computer tools necessary to assess the landscape and design the buffers. Field offices are short staffed, and most of the remaining staff are more "generalists" than "specialists". However, as researchers continue to prove the efficacy of precision conservation practices, and technology continues to evolve, this barrier should be overcome fairly rapidly (assuming sufficient capital investment is made in these technologies). Moreover, transferring the responsibility for locating practices to a regional entity with specialized staff would alleviate this concern.

Recommendation #6: Target implementation of agricultural best management practices to priority subwatersheds and priority impairments.

A significant focus of the master planning process was evaluating agricultural best management practices for increased implementation in the watershed. This task was a primary goal of the Ag BMP Expert Panel Meeting. A full discussion of the prioritization process and results, in addition to detailed information on each best management practice evaluated, can be found in the final summary report of that meeting (Agren, Inc. 2010).

The Ag BMP Expert Panel provided an opportunity for in-depth analysis of several best management practices identified as having the most promise for restoring water quality in the Raccoon River Watershed (see Table 2 for a list of best management practices evaluated, listed in no particular order). The meeting did not result in specific recommendations for which best management practices held the most promise for restoring and maintaining the environmental and economic conditions in the river basin. Rather, panelists felt strongly that because certain practices are more beneficial to specific resource concerns than others, it is inappropriate to prioritize practices at the Raccoon River full-watershed scale without site-specific planning (both at 12-digit HUC and field levels). Identifying priority practices across the watershed may lead to a "cookie cutter" or "one-size fits all" approach of implementing conservation practices in the watershed, which is undesirable to stakeholders and an inefficient use of limited financial resources. Therefore, Recommendation #6 addresses 1) the need for increased application of select agricultural best management practices across the watershed; and 2) the need to target these practices to locations where they are most needed within the Raccoon River Watershed.

A "one-size fits all" approach to implementing conservation is undesirable to stakeholders and an inefficient use of limited financial resources.

Table 2. List of BMPs evaluated by Ag BMP Expert Panel

Ag BMPs Evaluated
Site specific livestock runoff control
Nitrate removal wetlands
Farm ponds
Addition of perennial vegetation in rotation
Adaptive nutrient management with verification
Covered manure storage
Grazing mgmt, including fencing cattle from streams
Cover crops
No/reduced till
Strategically placed perennial vegetation
Streamside buffers
Nutrient Management Plan (NRCS 590)
Bioreactors

Computer-aided water quality modeling, conducted in support of the planning process by the Center for Agriculture and Rural Development at Iowa State University, indicates that different parts of the Raccoon River Watershed contribute contaminants disproportionately (a full report of modeling results, along with a discussion of appropriate use of modeling results, is included as Appendix 7). Therefore, different best management practices are needed to address the highest priority resource concern. The most appropriate best management practices are different across different subwatersheds. Watershed residents and conservation planners should gain a good amount of knowledge about their watershed before adopting and incentivizing specific control strategies.

The most appropriate best management practices are different across different subwatersheds. Watershed residents and conservation planners should gain a good amount of knowledge about their watershed before adopting and incentivizing specific control strategies.

In the sections that follow,

resource concerns- including nitrates, pathogens, phosphorus, sediment, and wildlife habitat- are addressed independently of one another and in no particular order of importance. An assessment of stream flow also was conducted as part of the modeling study and can be found in Appendix 7. Stream flow is not addressed here, as it was not a significant focus of expert panel discussion.

In the section that follows, information is provided on the source of each contaminant, subwatersheds are identified where the contaminant is of paramount concern, and best management practices for control of the resource concern are prioritized. However, it should be noted that expert panelists strongly supported the need to target limited financial resources toward two priority resource concerns in the Raccoon River Watershed - nitrate and pathogen reduction- in the subwatersheds where these have been identified as a priority impairments.

Expert panelists strongly supported targeting limited financial resources toward two priority resource concerns in the Raccoon River Watershed - nitrate and pathogen reduction- in the subwatersheds where these have been identified as a priority impairments.

Nitrates

Nitrate sources in the Raccoon River include municipal and industrial wastewater, storm water, animal feeding operations, fertilizer, soil mineralization, legume fixation, manure, septic systems, turf grass fertilizer, and wildlife. Soil mineralization and fertilizer are the two largest sources, contributing a combined 48 to 60 percent of the total nitrogen input. Greater contribution from these two sources is found in the North Raccoon than the South Raccoon Watershed, which is consistent with a greater proportion of land used for crop production. Legume fixation and animal manure also contribute significantly. Figure 5 illustrates non-point sources of nitrate at the Van Meter monitoring station, as a percentage of the total load. Nitrogen loading was evaluated using data and procedures developed for the state wide nutrient budget (Libra, Wolter and Langel 2004) (Schilling and Wolter 2008).

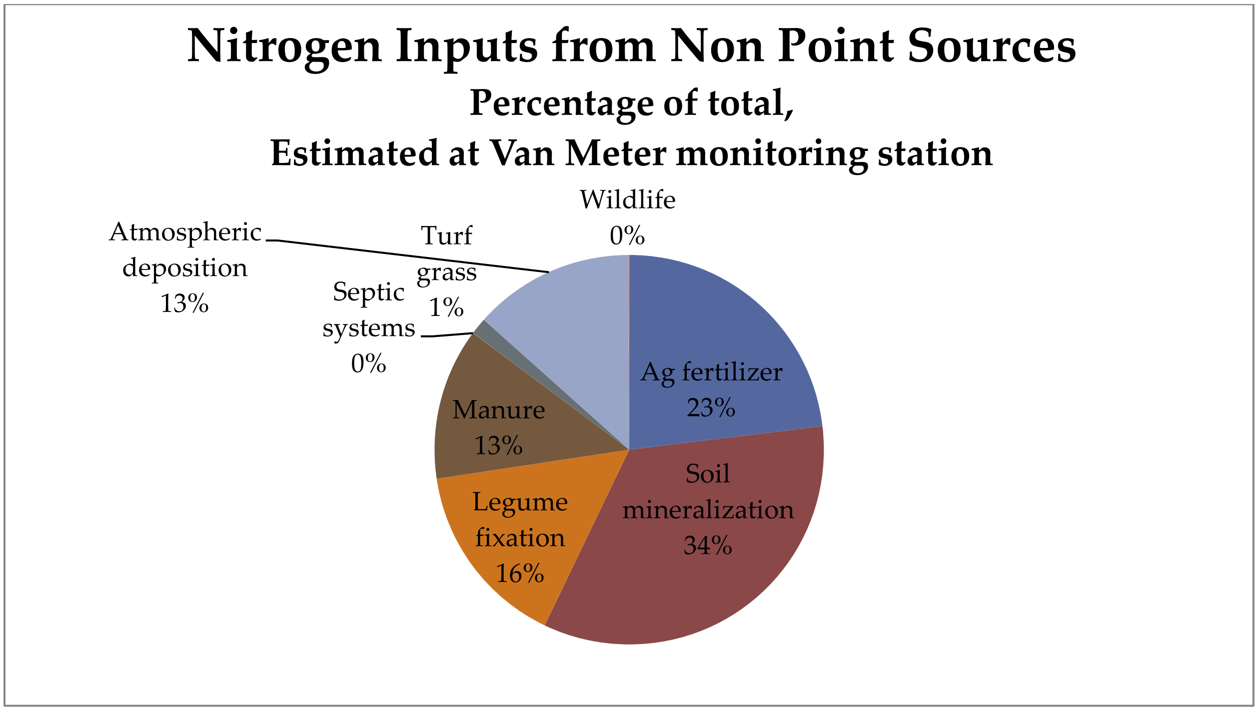

Figure 5. Nitrogen inputs from nonpoint sources

Priority geographic areas for nitrate reduction

Computer modeling was used to evaluate which subwatersheds within the Raccoon River Watershed are the most significant sources of nitrate. Figure 6 depicts each subwatershed by level of priority for implementation of nitrate reduction best management practices. Figure 7 illustrates the nitrate load contributed by each of the 112 subwatersheds. The top 20 subwatersheds for nitrate reduction best management practices are ordered consecutively below, with the highest priority subwatershed listed as number 1 (subwatershed numbers can be referenced to the maps included as Figures 6 or 7):

1) Subwatershed 20
2) Subwatershed 17
3) Subwatershed 19
4) Subwatershed 25
5) Subwatershed 26
6) Subwatershed 86
7) Subwatershed 7
8) Subwatershed 3
9) Subwatershed 8
10) Subwatershed 34
11) Subwatershed 2
12) Subwatershed 105
13) Subwatershed 16
14) Subwatershed 103
15) Subwatershed 9
16) Subwatershed 102
17) Subwatershed 30
18) Subwatershed 1
19) Subwatershed 14
20) Subwatershed 100

For additional information on the modeling methodology used, refer to the Appendix 7. *Application of the Soil and Water Assessment Tool (SWAT) Model for the Raccoon River Watershed Master Plan* (Gassman and Jha 2011).

Priority best management practices for nitrate reduction

Best management practices for both crop production and livestock production were evaluated for the Master Plan. As shown in Table 3, practices identified as having the most potential for nitrate reduction in the Raccoon River include cover crops, addition of perennial vegetation in the crop rotation, bioreactors, nitrate removal wetlands, and adaptive nutrient management with verification. Manure and runoff control structures for livestock production also are identified as high priority in subwatersheds with high livestock concentrations. The most appropriate best management practices for manure and runoff control practices will be highly dependent on site characteristics.

Table 3. Priority BMPs for nitrate reduction

High Priority BMPs	Moderate Priority BMPs	Livestock Priorities
Cover crops	Farm ponds	Site specific livestock control
Addition of perennial vegetation in rotation		
Bioreactors		
Nitrate removal wetlands		
Adaptive nutrient management with verification		

As discussed in Recommendation #7, conservation practices for nutrient management should be planned using a multi-tiered approach, sometimes referred to as “stacking practices” (Agren, Inc. 2010). Implementing a suite of practices from each of three functional categories (source reduction, nutrient trapping, and nutrient treatment) will be important for achieving measurable impacts on water quality.

Several priority best management practices were modeled for impact on nitrate loading using the Soil and Water Assessment Tool (SWAT) water quality model. Scenarios depicting various levels of implementation for cover crops, addition of perennial vegetation to crop rotations, and adaptive nutrient management (variations in form, rate, and timing) were modeled independently and in combination with one another.

For information on results and the modeling methodology used, refer to Appendix 7. *Application of the Soil and Water Assessment Tool (SWAT) Model for the Raccoon River Watershed Master Plan* (Gassman and Jha 2011).

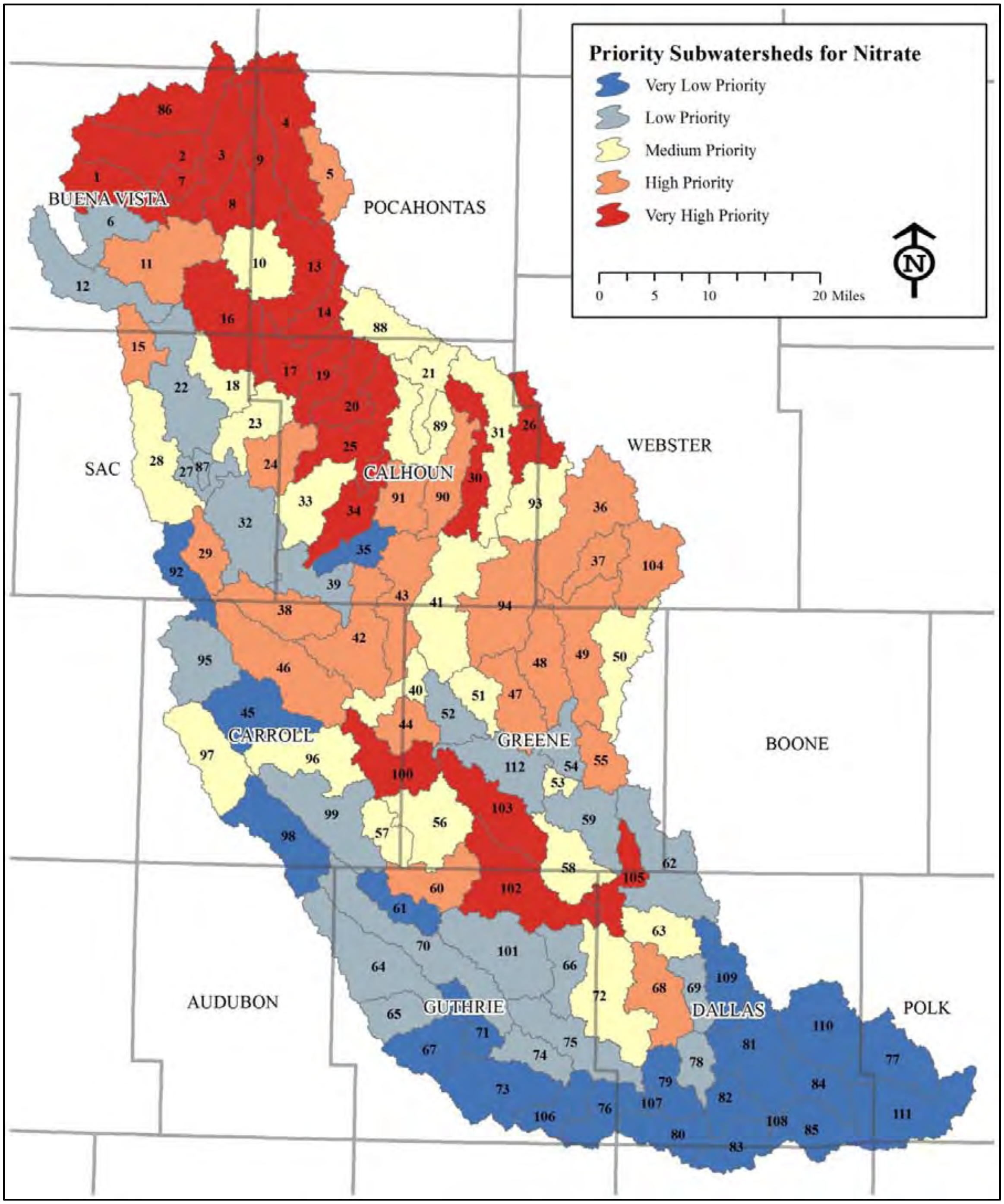

Figure 6. Priority subwatersheds for nitrate reduction

Note: Subwatershed boundaries DO NOT exactly follow HUC12 watershed designations. Rather, they are based on Hydrologic Response Units in the SWAT model, which for most subwatersheds closely follow HIC12 watershed boundaries.

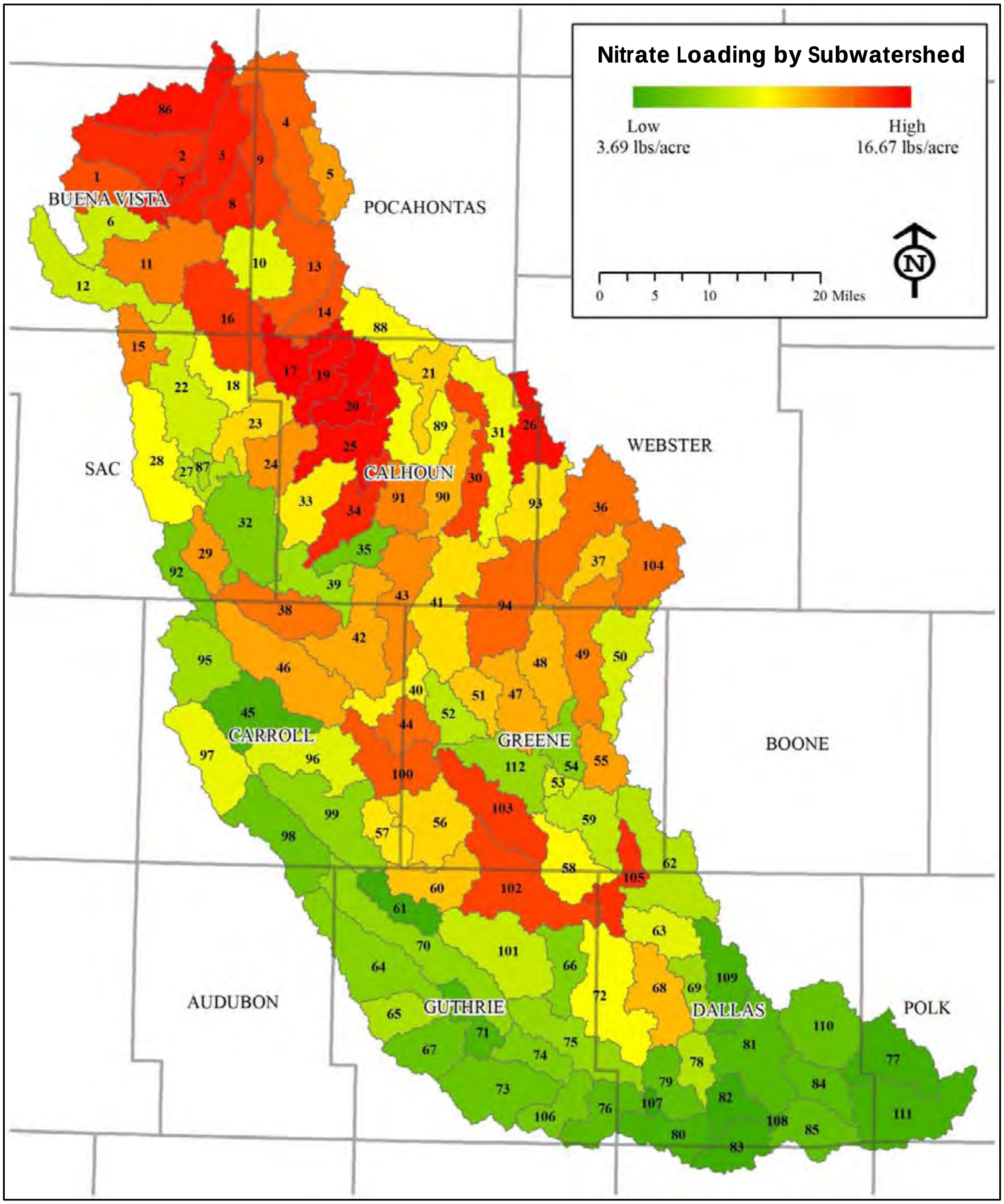

Figure 7. Nitrate loading by subwatershed

Note: Subwatershed boundaries DO NOT exactly follow HUC12 watershed designations. Rather, they are based on Hydrologic Response Units in the SWAT model, which for most subwatersheds closely follow HIC12 watershed boundaries.

Pathogens

Sources of *E. coli* bacteria (the pathogen indicator) include municipal and industrial wastewater treatment plants, storm water runoff, animal manure, septic systems, and wildlife. Waste water treatment plants and other point sources of bacteria are required to disinfect wastewater before it is discharged. Manure from hogs and cattle are by far the two largest sources of bacteria. Cattle manure contributes about 66 percent of the bacteria in the South Raccoon Watershed, and hog manure contributes about 63 percent of the bacteria load in the North Raccoon Watershed. Rural septic systems are also a concern, with 70 to 90 percent in the watershed estimated as inadequate or failing. The overall contribution of pathogens by septic systems is estimated at less than 1 percent of the total bacteria load (Schilling and Wolter 2008).

Priority geographic areas for pathogen reduction

Computer modeling has been used to evaluate which subwatersheds within the Raccoon River Watershed are the most significant sources of pathogens. The data presented here is based on the 2008 watershed assessment conducted in conjunction with development of the original Water Quality Improvement Plan for the Raccoon River watershed (Schilling and Wolter 2008). Unfortunately, due to the difficult nature of bacteria fate and transport, it was not possible to update the model for pathogen loading, nor was it possible to predict pathogen load reductions based on projected levels BMP implementation.

Figure 8 depicts each subwatershed by level of priority for implementation of pathogen reduction best management practices. Figure 9 illustrates the pathogen loading contributed by each of the 112 subwatersheds. The top 20 subwatersheds for installation of pathogen reduction best management practices are ordered consecutively below, with the highest priority subwatershed listed as number 1 (subwatershed numbers can be referenced to the maps included as Figures 8 or 9):

1. Subwatershed 99
2. Subwatershed 96
3. Subwatershed 46
4. Subwatershed 38
5. Subwatershed 97
6. Subwatershed 15
7. Subwatershed 86
8. Subwatershed 98
9. Subwatershed 95
10. Subwatershed 2
11. Subwatershed 64
12. Subwatershed 32
13. Subwatershed 3
14. Subwatershed 16
15. Subwatershed 39
16. Subwatershed 39
17. Subwatershed 57
18. Subwatershed 23
19. Subwatershed 71
20. Subwatershed 7

Priority best management practices for pathogen reduction

Best management practices for crop production and livestock production were both evaluated for pathogen reduction by expert panelists for the Master Plan. As shown in Table 4, practices identified as having the most potential for pathogen reduction in the Raccoon River are livestock manure management practices, including manure and runoff control, covered manure storage, and grazing management, including fencing cattle from streams. The most appropriate best management practices for pathogen control will be highly dependent on site characteristics (for example, soil type of slope steepness site).

Table 4. Priority BMPs for pathogen reduction

High Priority BMPs	Moderate Priority BMPs
Site specific livestock control	Nitrate removal wetlands
Covered manure storage	Farm ponds
Grazing management	Streamside buffers
	Addition of perennial vegetation to rotation
	Cover crops

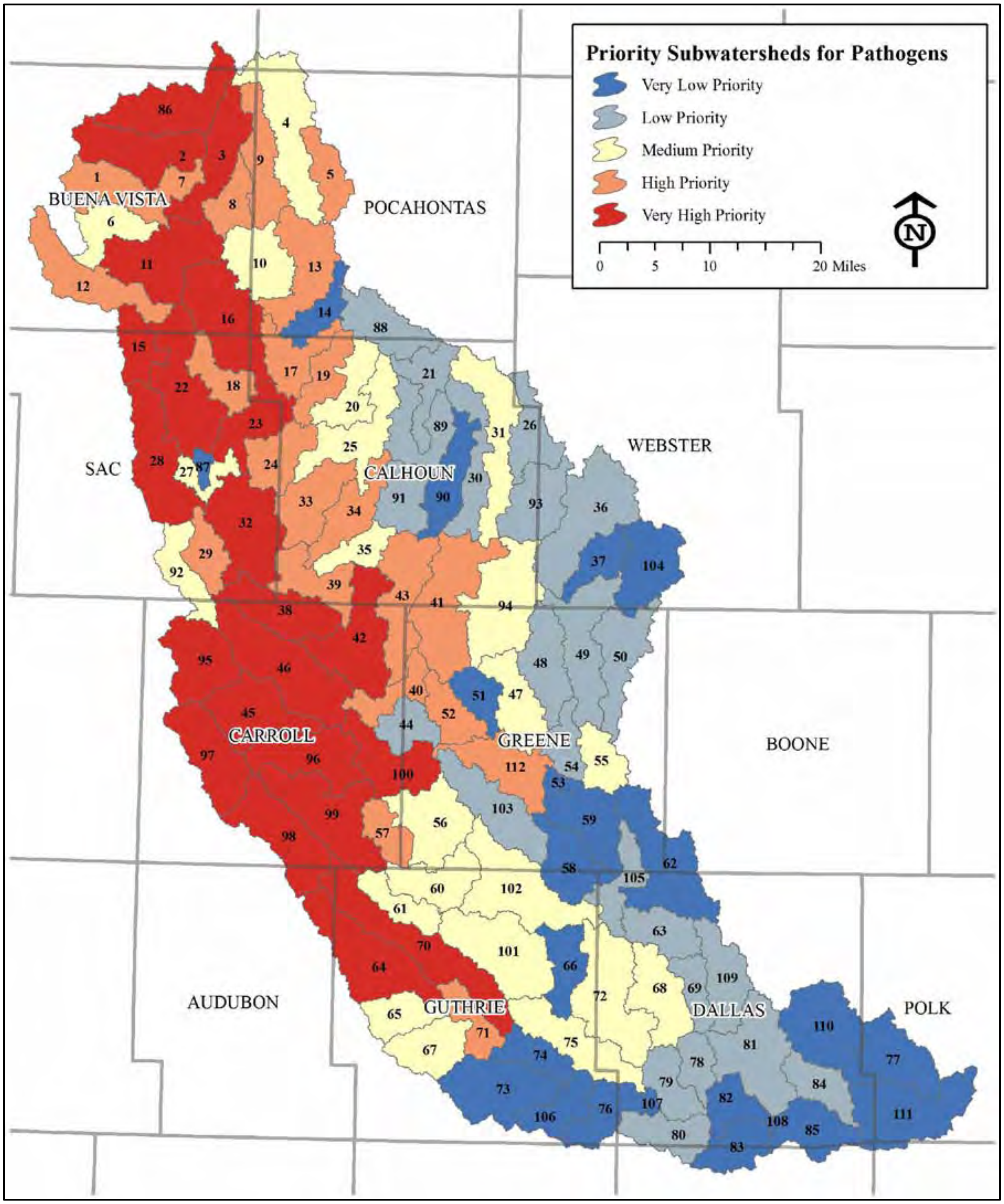

Figure 8. Priority subwatersheds for pathogen reduction

Note: Subwatershed boundaries DO NOT exactly follow HUC12 watershed designations. Rather, they are based on Hydrologic Response Units in the SWAT model, which for most subwatersheds closely follow HIC12 watershed boundaries.

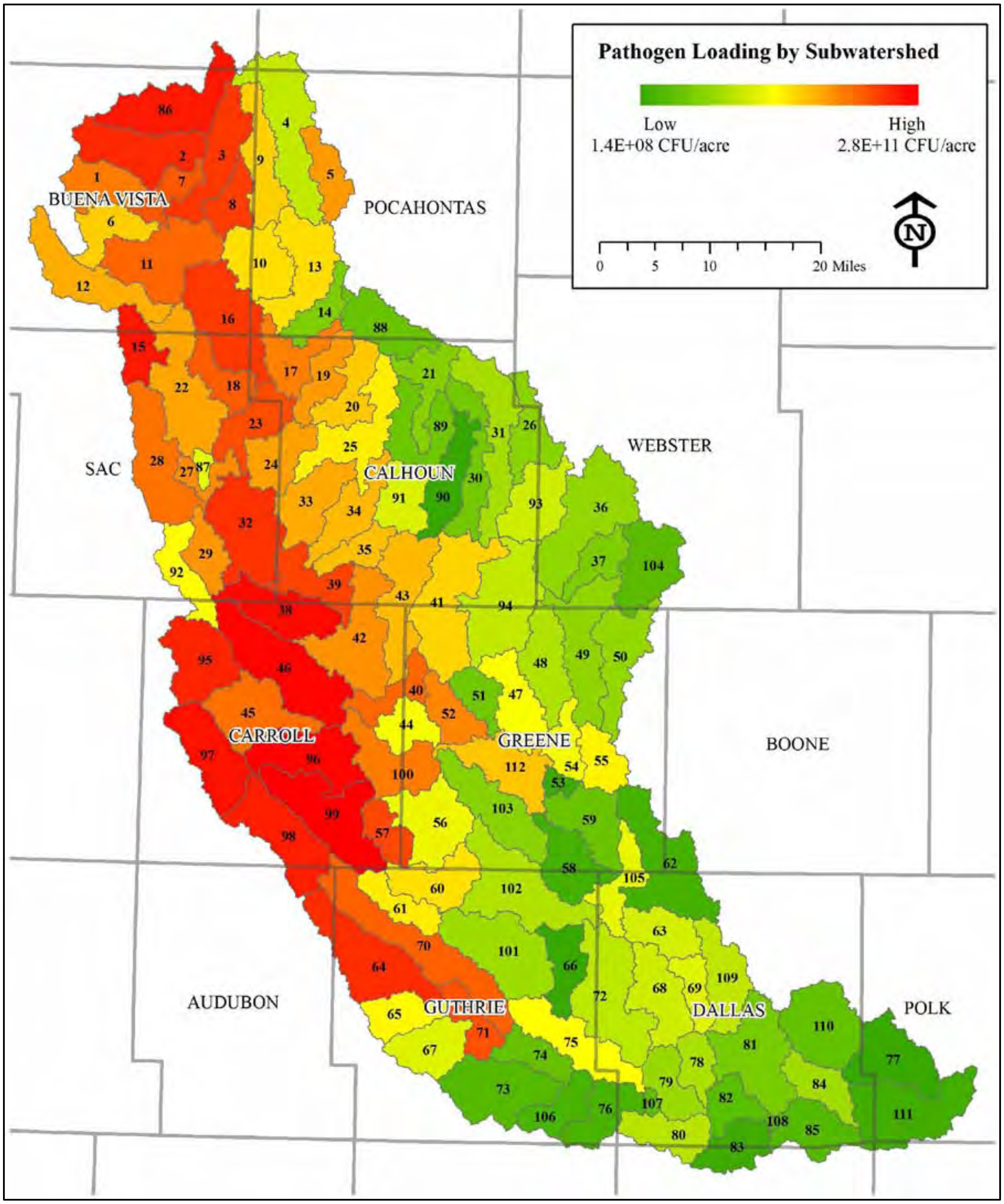

Figure 9. Pathogen loading by subwatershed

Note: Subwatershed boundaries DO NOT exactly follow HUC12 watershed designations. Rather, they are based on Hydrologic Response Units in the SWAT model, which for most subwatersheds closely follow HIC12 watershed boundaries.

Phosphorus and sediment

In Iowa, most of the phosphorus that makes its way to surface water comes from manure, commercial fertilizer, and from what occurs naturally in soils. Human and industrial inputs account for less than one percent of the phosphorus in water bodies (Libra, Wolter and Langel 2004). Sediment in the Raccoon River and its tributaries comes from water erosion of sloping or unprotected cropland, pastures, and construction sites. Significant levels of sediment and phosphorus also erode from stream banks.

Priority geographic areas for phosphorus reduction

A combination of water monitoring and computer modeling has been used to evaluate which subwatersheds within the Raccoon River Watershed are the most significant sources of phosphorus. Figure 10 depicts each subwatershed by level of priority for implementation of phosphorus reducing best management practices. Figure 11 illustrates the phosphorus loading contributed by each of the 112 subwatersheds. The top 20 subwatersheds for phosphorus reduction best management practices are ordered consecutively below, with the highest priority subwatershed listed as number 1 (subwatershed numbers can be referenced to the maps included as Figures 10 or 11).

1) Subwatershed 99
2) Subwatershed 97
3) Subwatershed 96
4) Subwatershed 95
5) Subwatershed 64
6) Subwatershed 67
7) Subwatershed 98
8) Subwatershed 71
9) Subwatershed 73
10) Subwatershed 65
11) Subwatershed 70
12) Subwatershed 75
13) Subwatershed 61
14) Subwatershed 45
15) Subwatershed 101
16) Subwatershed 76
17) Subwatershed 74
18) Subwatershed 85
19) Subwatershed 107
20) Subwatershed 111

For additional information on the modeling methodology used, refer to Appendix 7, *Application of the Soil and Water Assessment Tool (SWAT) Model for the Raccoon River Watershed Master Plan* (Gassman and Jha 2011).

Priority geographic areas for sediment reduction

A combination of water monitoring and computer modeling has been used to evaluate which subwatersheds within the Raccoon River Watershed are the most significant sources of sediment. Figure 12 depicts each subwatershed by level of priority for implementation of soil erosion reduction best management practices. Figure 13 illustrates the sediment loading contributed by each of the 112 subwatersheds. The top 20 subwatersheds for sediment reduction best management practices are ordered consecutively below, with the highest priority subwatershed listed as number 1 (subwatershed numbers can be referenced to the maps included as Figures 12 or 13).

1) Subwatershed 73
2) Subwatershed 67
3) Subwatershed 95
4) Subwatershed 64
5) Subwatershed 98
6) Subwatershed 97
7) Subwatershed 99
8) Subwatershed 61
9) Subwatershed 65
10) Subwatershed 75
11) Subwatershed 70
12) Subwatershed 96
13) Subwatershed 74
14) Subwatershed 76
15) Subwatershed 71
16) Subwatershed 111
17) Subwatershed 106
18) Subwatershed 45
19) Subwatershed 85
20) Subwatershed 101

For additional information on the modeling methodology used, refer to Appendix 7, *Water Quality Modeling*, or the report *Application of the Soil and Water Assessment Tool (SWAT) Model for the Raccoon River Watershed Master Plan* (Gassman and Jha 2011).

Priority best management practices for phosphorus and sediment reduction

Best management practices for phosphorus reduction and soil erosion (sediment) were evaluated together by expert panelists. Generally, practices that are effective in controlling soil erosion and/or trapping sediment also are effective in reducing particulate phosphorus transport to water bodies. Due to the nature of the water quality impairments of the Raccoon River, the practices evaluated by expert panelists for the Master Plan are necessarily focused on removal of pathogens and nitrogen from the watershed (Table 2). The best management practices identified and prioritized here (Table 5) should be considered a subset of BMPs important for reducing nutrients and pathogens in the Raccoon River, that also have a significant positive impact on sediment and phosphorus contributions. Thus, the practices evaluated for the Raccoon River Watershed Master Plan that have the most potential to positively affect sediment and phosphorus transport are no/reduced tillage, cover crops, farm ponds, addition of perennial vegetation in crop rotation, and strategically-placed vegetation including streamside buffers. However, there are additional strategies (i.e. terraces, grassed waterways, sediment and water control basins, grade stabilization structures) that are proven to significantly impact sediment and phosphorus delivery. These, too, should be considered in subwatersheds where sediment and phosphorus resources are identified as priority concerns.

Table 5. Priority BMPs for phosphorus and sediment reduction

High Priority BMPs	Moderate Priority BMPs
No/reduced tillage	
Cover crops	
Farm ponds	
Addition of perennial vegetation to rotation	
Strategically-placed vegetation (including streamside buffers)	

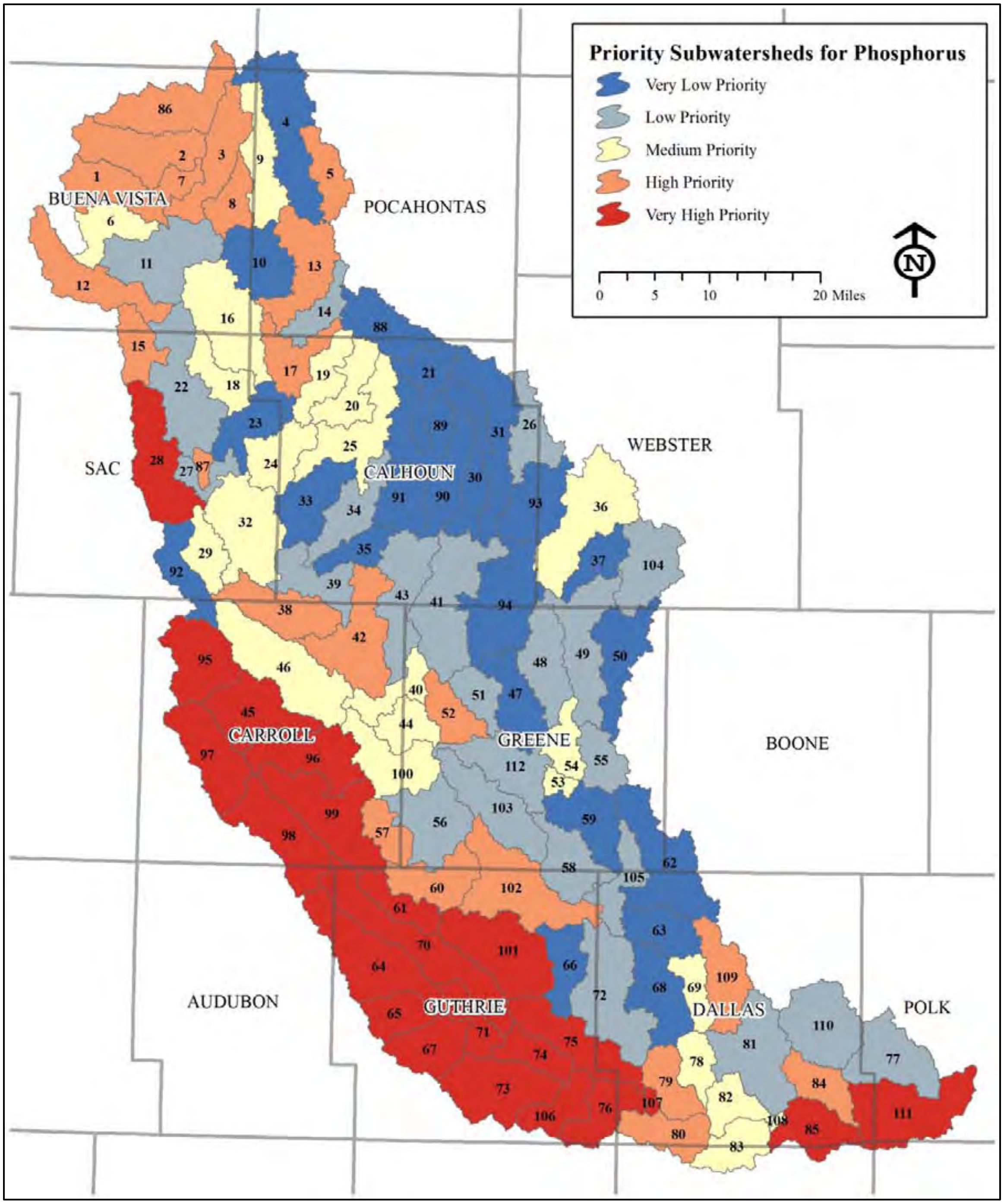

Figure 10. Priority subwatersheds for phosphorus reduction

Note: Subwatershed boundaries DO NOT exactly follow HUC12 watershed designations. Rather, they are based on Hydrologic Response Units in the SWAT model, which for most subwatersheds closely follow HIC12 watershed boundaries.

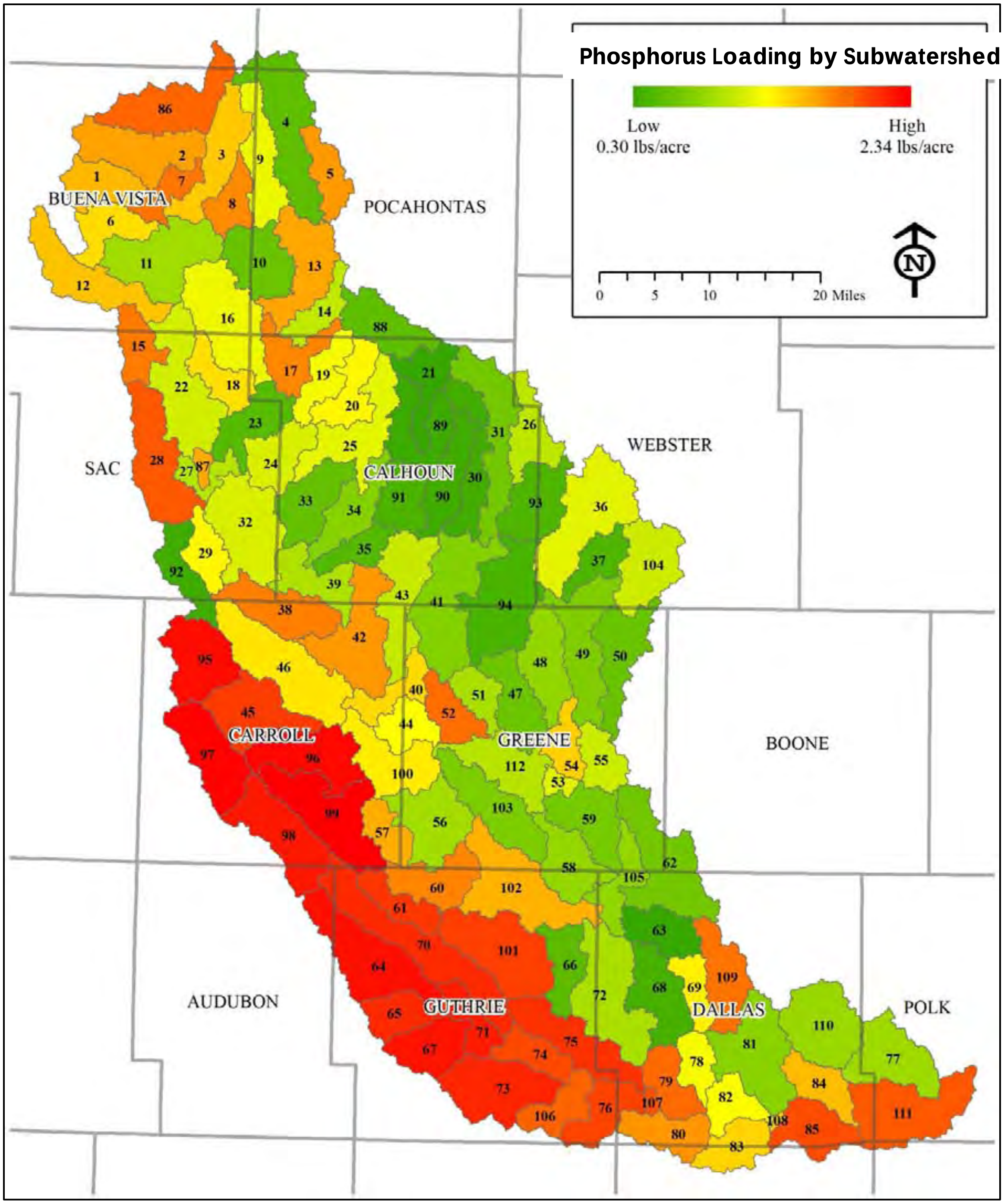

Figure 11. Phosphorus loading by subwatershed

Note: Subwatershed boundaries DO NOT exactly follow HUC12 watershed designations. Rather, they are based on Hydrologic Response Units in the SWAT model, which for most subwatersheds closely follow HIC12 watershed boundaries.

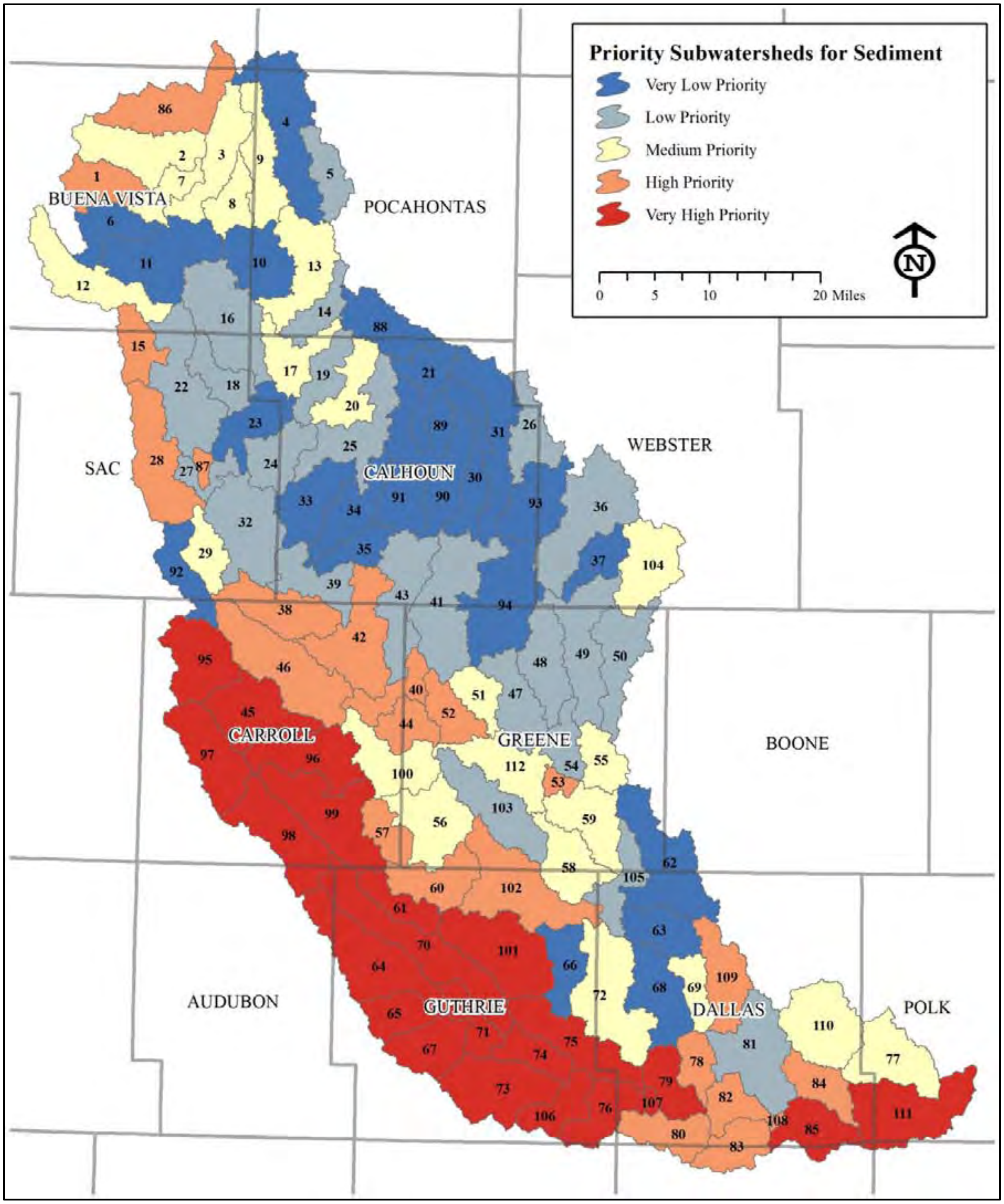

Figure 12. Priority subwatersheds for sediment reduction

Note: Subwatershed boundaries DO NOT exactly follow HUC12 watershed designations. Rather, they are based on Hydrologic Response Units in the SWAT model, which for most subwatersheds closely follow HIC12 watershed boundaries.

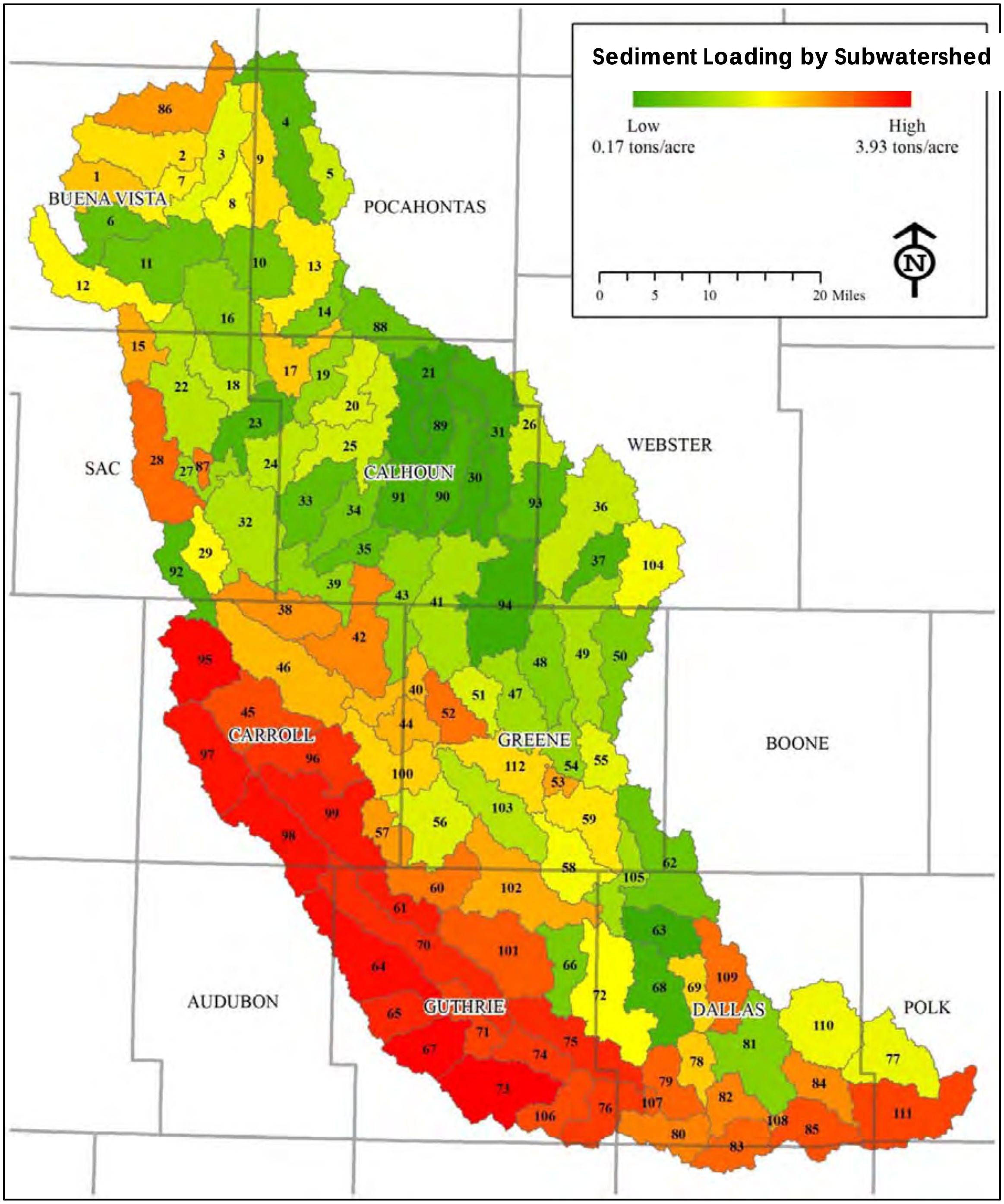

Figure 13. Sediment loading by subwatershed

Note: Subwatershed boundaries DO NOT exactly follow HUC12 watershed designations. Rather, they are based on Hydrologic Response Units in the SWAT model, which for most subwatersheds closely follow HIC12 watershed boundaries.

Habitat

Priority Geographic Areas for Habitat

Priority geographic areas for habitat restoration in the Raccoon River Watershed (Figure 14) are adapted from a scoring system developed for the *Iowa Wildlife Action Plan* to identify high priority areas for cooperative conservation actions (Zohrer 2006). These priority areas are determined by overlaying more than 20 map layers depicting the priorities of important conservation partners and programs. Examples of map layers used to determine priority areas include:

- Prairie Pothole Joint Venture Priority Wetland Complexes identified in the North American Waterfowl Management Plan
- Priority Areas for Biodiversity Conservation as defined by The Nature Conservancy,
- Important Bird Areas identified by the Audubon Society
- Critical Habitat for the Topeka Shiner identified by the U.S. Fish and Wildlife Service
- Special project areas identified by the Iowa Department of Natural Resources.

Where these map layers overlap, the "importance score" for the location increases. Geographic areas with the highest score indicate locations where there is the most potential to work with like-minded partners to leverage conservation dollars for habitat restoration.

As depicted in Figure 14, the higher priority areas indicate locations where more conservation partners have overlapping priorities. Therefore, these subwatersheds are likely to have the most significant potential for habitat restoration as well as the greatest potential to maximize the impact of funding resources.

Priority Practices for Habitat

Both aquatic and terrestrial wildlife habitat were considered together for the sake of prioritizing practices for the Raccoon River Watershed Master Plan. In general, best management practices that restore ecosystem functionality and slow the movement of water through the watershed are beneficial for both aquatic and terrestrial wildlife.

Table 6. Priority BMPs for wildlife habitat

High Priority BMPs	Moderate Priority BMPs
Farm ponds	Addition of perennial vegetation to rotation
Nitrate-removal wetlands	Cover crops
Strategically-placed perennial vegetation (including streamside buffers)	Grazing management

Due to the nature of the water quality impairments of the Raccoon River, the practices evaluated by expert panelists for the Master Plan are necessarily focused on removal of pathogens and nitrogen from the watershed (Table 2). The best management practices identified and prioritized here (Table 6) should be considered a subset of BMPs important for reducing nutrients and pathogens in the Raccoon River. These same BMPs also are expected to have a positive impact on aquatic and wildlife habitat. Thus, the practices evaluated for the Raccoon River Watershed Master Plan that have the most wildlife potential to positively affect wildlife are farm ponds, nitrate-removal wetlands, and streamside buffers. The addition of perennial vegetation to crop rotations, cover crops, and grazing management, also will have a positive impact on wildlife habitat in the watershed.

However, there are additional strategies that can significantly benefit wildlife in the Raccoon River Watershed. These should not be overlooked in subwatersheds where habitat restoration is identified as a key priority. For example, restoration and creation of shallow-water wetlands and grasslands throughout the watershed will create more wildlife benefits than treating larger amounts of water towards the bottom of a watershed. When wetlands are designed to be shallower and are placed higher in the watershed, they tend to be less turbid, support more aquatic vegetation, and host a greater diversity of wildlife. *The Iowa Wildlife Action Plan: Securing a Future for Fish and Wildlife* (Zohrer 2006) provides an excellent resource for subwatersheds within the Raccoon River Watershed that identify habitat as a key priority. Specifically, Chapter 6 of the plan outlines a vision for Iowa's wildlife by the year 2030 and provides conservation actions to achieve each vision element.

Topeka shiner

Under the Endangered Species Act, the Topeka shiner (*Notropis topeka*) was listed as "endangered" in 1998. Additionally, the U.S. Fish and Wildlife Service designates portions of the watershed as critical habitat. The Topeka shiner is the only federally listed endangered animal species found in the watershed and the only species with federally designated critical habitat in Iowa. Therefore, Topeka shiner is the only animal species highlighted in the Master Plan.

Off-channel and side channel pools of the North Raccoon River, ten North Raccoon tributaries, and associated floodplain habitats are designated by the U.S. Fish and Wildlife Service as critical habitat for the Topeka shiner (see Table 7.).If land management actions in these areas result in the harm or harassment to the Topeka shiner, and if the actions result in adverse modification to the Critical Habitat, there may be regulatory consequences (Coffey 2011) (U.S. Fish & Wildlife Service 2011).

Table 7. Counties with designated critical habitat for Topeka shiner

County	Stream Segments	Total Stream Miles
Calhoun	8	68
Carroll	2	7
Dallas	3	3
Greene	8	87
Sac	4	12
Webster	1	9

The Topeka shiner is a small, silvery minnow, 3 inches or less in length. It is found in small to mid-size prairie streams with relatively high water quality and cool-to-moderate temperatures. Iowa is the easternmost and only Mississippi River drainage population of the Topeka shiner. While the Topeka shiner can sometimes live in streams with degraded habitat conditions, its long-term survival in these streams is at risk.

Historically, the Topeka shiner has been found in 36 Iowa counties. However, recent studies have found the minnow in only 13 counties, 6 of which are located in the Raccoon River Watershed (U.S. Fish & Wildlife Service 2011). A current study at Iowa State University is finding the highest Topeka shiner populations in the North Raccoon and Boone River basins (Bakevich 2011).

Although the exact reason for the decline of the Topeka shiner is not known, there are many likely causes. Possible causes include habitat loss and fragmentation due to channelization and draining of oxbows, increased sedimentation, impaired water quality, and the introduction of predator fish that are not native to small stream habitat. Reconstruction, restoration, and reconnection of oxbows are encouraged as best practices for increasing Topeka shiner numbers (Tomer 2011).

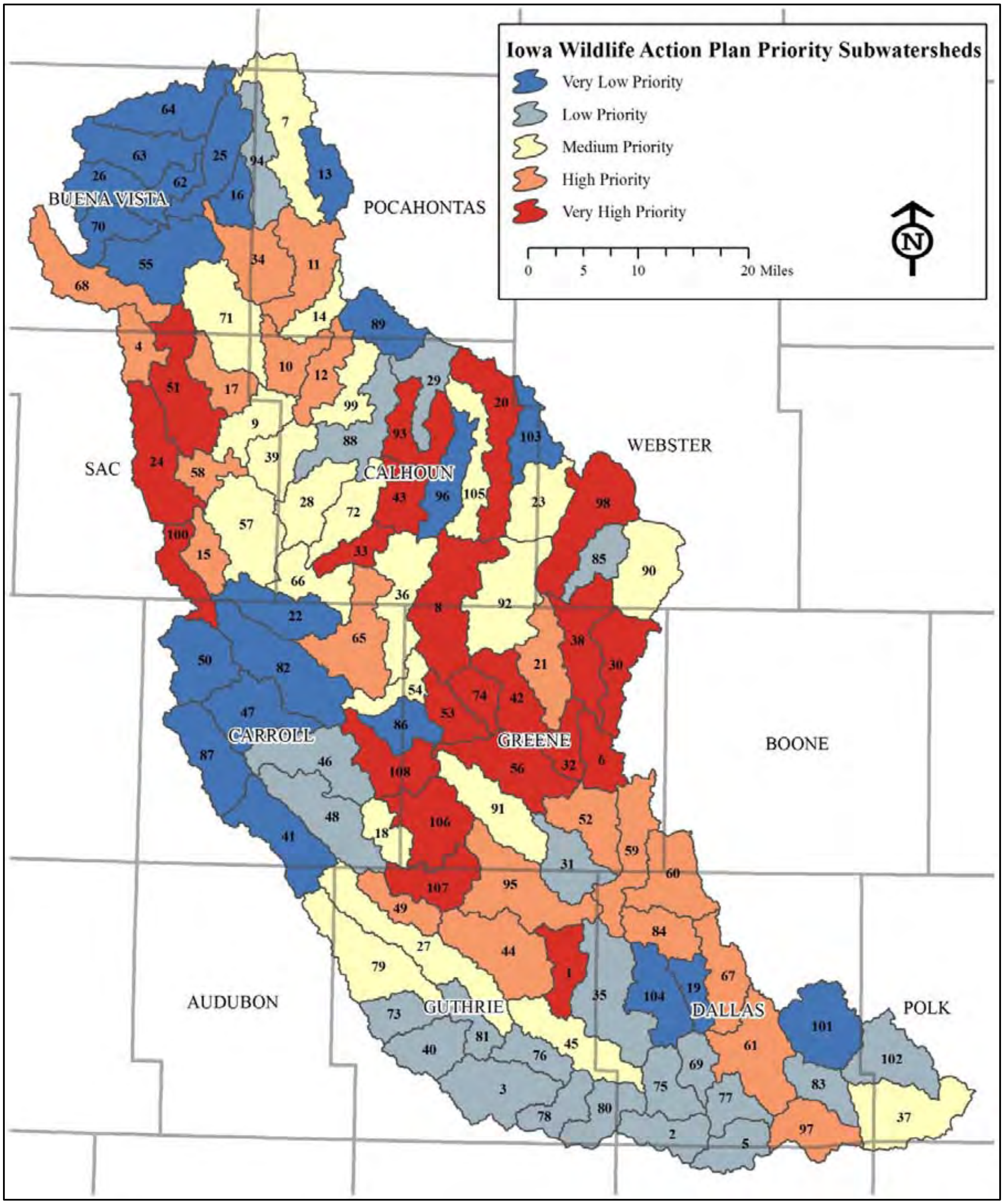

Figure 14. Priority areas for wildlife BMPs

See Appendix 3 for a listing of subwatershed names by corresponding number. Note: Figure 14 watershed boundaries follow HUC12 boundaries and DO NOT match the subwatershed boundaries of the preceding map figures.

Recommendation #7: Enhance effectiveness of nutrient control and removal practices by encouraging a "stacked" approach to nutrient management such as reduce, trap, and treat.

A key conclusion of the Ag BMP Expert Panel was the recommendation that conservation practices for nutrient management should be planned using a multi-tiered approach, sometimes referred to as "stacking practices" (Agren, Inc. 2010). In other words, conservation planners and landowners/farm operators should work towards implementing a suite of nutrient control practices, made up of one or more practices from each of three functional categories:

- Source reduction
- Nutrient trapping
- Nutrient treatment

This strategy is consistent with the three-tiered strategy used as part of the Mississippi River Basin Initiative (USDA Natural Resources Conservation Service 2011). Table 8 lists the practices evaluated as part of the master planning process, categorized by their core functions of source reduction, trapping, and treatment.

Combining practices from these three categories also is well supported by water quality modeling work conducted in support of the Master Plan by the Center for Agriculture and Rural Development. Based on water quality modeling results (Appendix 7), it is clear that even with 100 percent acceptance and use of any single best management practice, attaining the water quality standard for nitrate of 9.5 mg/l of nitrate is unlikely. Modeling results indicate that improvement of infield management of nutrients in the watershed, for example adjusting the rate, form, or timing of nitrogen application to cropland, will have only limited impact on nutrient delivery to the watercourse. Therefore, it will be necessary to move towards implementation of combinations of nutrient management practices that include both if-field nutrient management and off-site nutrient trapping and/or treatment to have a cumulative impact on water quality (Gassman and Jha 2011).

Table 8. Nutrient BMPs, categorized by core function

Function	Des Moines Lobe (Drained)	Southern IA Drift Plain (Non-Drained Rolling)	Riparian Corridor (flood plain, steep slopes)
Source reduction	Livestock runoff control	Livestock runoff control	Grazing mgmt (riparian pastures)
	Adaptive nutrient mgmt	Adaptive nutrient mgmt	No-till/Strip-till
	Cover crops	Cover crops	
Trapping	Streamside buffers	Streamside buffers	Strategic perennials
	Strategic perennials	Strategic perennials	Riparian wetlands
	Covered manure storage	Covered manure storage	Cover crops
	Perennial veg in rotation	Perennial veg in rotation	Streamside buffers
	No-till/Strip-till	No-till/Strip-till	
Treatment	Nitrate removal wetlands	Strategically placed ponds	
	Bioreactors (hotspots)	Bioreactors (hotspots)	

Due to the altered hydrology and land use of the watershed, especially in subwatersheds identified as high contributors of nitrate (Figures 6 and 7), adequate control of nutrients will require a combination of best management practices that 1) reduce the source of nutrients; 2) trap nutrients before they enter water sources; and 3) treat tile drainage water or surface runoff to reduce nutrients.

Adequate control of nutrients will require a combination of best management practices that 1) reduce the source of nutrients; 2) trap nutrients before they enter water sources; and 3) treat tile drainage water or surface runoff to reduce nutrients.

Current efforts

The Natural Resources Conservation Service refers to combinations of practices as a conservation system and has promoted a systems approach for years. Farms that incorporate systems (stacked practices) for soil conservation tend to fair far better in high rainfall events than those farms with only one practice.

The concept of applying a systems or stacked approach to nutrient management in the Raccoon watershed is fairly novel. Only in the last decade have practices such as cover crops, nitrate removal wetlands, and bioreactors been recommended for their ability to trap and treat nutrients.

Potential opportunities

Recent research and advances in treatment practices creates significant potential for using combinations of nutrient best management practices to achieve significant reductions in nitrate loading. Adding management practices with the ability to trap and treat nutrients in effect provides farmers insurance against nutrient losses from cropland. Often, nutrient loss is unavoidable due to weather and precipitation events.

Moreover, the message of "stacked" conservation practices is one that could be effectively carried by the private sector. For example a retail agronomist or Certified Crop Advisor is already consulting with their farmer clientele on nutrient application decisions. It makes logical sense that these service providers also be the messenger of information on full systems for nutrient management, including nutrient trapping and treatment practices. Additional discussion of private sector conservation planning opportunities is included within this document as Recommendation #4.

Challenges and barriers

The greatest challenges and barriers inhibiting implementation of a stacked or systems-based approach to nutrient management may simply stem from the need for a farmer to consider, plan, and implement more than a single practice to achieve a desired outcome. Each practice in the system provides a different functionality that must be explained, understood, implemented, and maintained. This will require a significant outreach and education effort, as well site-specific conservation planning and appropriate decision support technologies. Each of these topics is identified as a recommendation for improvement elsewhere in the Master Plan.

Recommendation #8: Monitor water quality at the subwatershed scale to characterize existing conditions and evaluate effectiveness of watershed projects and conservation practices.

Water quality monitoring at the subwatershed scale was identified as a high priority by both BMP expert panelists and a modeling subcommittee assembled by Iowa DNR. Notes from the January 2011 modeling sub-committee meeting highlight several priorities, including the importance of subwatershed monitoring programs. These monitoring programs not only characterize the existing conditions in small tributaries to the Raccoon, but also provide data to assess the effectiveness of watershed projects and conservation practices (Kiel 2011).

Current efforts

Currently, Agriculture's Clean Water Alliance, an organization of agricultural retailers in the Raccoon and Des Moines River watershed areas, is coordinating subwatershed monitoring at over 40 sites in the Raccoon River (Appendix 8) Since 1999, the organization has been monitoring for forms of nitrogen on a bi-weekly basis, from April to October. At some sites, samples also are evaluated for bacteria, chloride, phosphorus, and/or sulfate. Data collected by Agriculture's Clean Water Alliance has been used by researchers to characterize water quality conditions in various subwatersheds. The organization is now focusing more on using their monitoring data to measure effectiveness of locally-led watershed projects and conservation practices. Monitoring reports are available on the organization's website (http://www.acwaraccoonriverwatersheds.org). Further discussion of existing water monitoring efforts can be found in the Raccoon River TMDL report (Schilling and Wolter 2008).

Additionally, the IOWATER program, Iowa's volunteer water quality monitoring program, is active in the Raccoon River Watershed. The first pilot IOWATER workshop was actually held in the Raccoon River Watershed in 1999. Since, the organization has grown to train approximately 138 active volunteers in the basin. There is some limitation on how data collected by volunteers can be used from a regulatory standpoint. However, data collected by volunteers is being used to identify areas in need of more in-depth, professional monitoring, to inform land-use decisions, and to determine where implementation of best management practices could improve water quality.

Potential opportunities

In addition to these efforts, local watershed groups should implement a monitoring plan as part of their restoration efforts. Water quality monitoring provides an excellent opportunity for the conservation partnership to work directly with private landowners and operators. Where possible, tile-line monitoring, edge-of-field monitoring, or sampling of other contributing areas should be considered as part of local watershed planning efforts. Advanced technologies available for monitoring at the field-level are currently limited and often costly and may only be practical on research and demonstration sites. However, simple test strips are inexpensive and can be used to gather preliminary information.

Preparation of a guidance document for subwatershed monitoring by locally-led watershed projects in the Raccoon River Watershed would significantly improve the ability of these smaller organizations to develop efficient and effective monitoring programs.

Recommendation #9: Continue to assess long-term water quality status and trends in the Raccoon River and enhance these efforts as resources allow.

Continuation of ambient surface water monitoring in the Raccoon River also was well supported by both BMP expert panelists and a modeling subcommittee assembled by Iowa DNR (Kiel 2011). The purpose of an ambient monitoring program is to assess long-term status and provide a broad overview of water quality trends in the river.

Current efforts

Currently, the Iowa DNR monitors three sites in the Raccoon River Watershed on a monthly basis: South Raccoon near Redfield; North Raccoon near Jefferson; and the North Raccoon near Sac City. These sites have been sampled on a monthly basis since the 1980's. Additionally, the U.S. Geological Survey monitors for nitrates at four sites in the watershed and stream flow at thirteen sites. Funding for this monitoring comes from a variety of sources including the U.S. Geological Survey, the Iowa DNR, the Iowa Department of Transportation, Des Moines Water Works, Agriculture's Clean Water Alliance, and others. Des Moines Water Works collects daily samples at its Fleur Drive location and monitors for nitrate, coliform bacteria, turbidity, hardness, alkalinity, pH, and organic carbon. On a limited basis, Iowa DNR also monitors fish and benthic (bottom dwelling) macro invertebrates at 29 sites in the watershed with the goal of monitoring the status and trends of the biological community. Appendix 8 provides a map of current monitoring sites in the watershed. Additional discussion of existing water monitoring efforts can be found in the Raccoon River TMDL report (Schilling and Wolter 2008).

Potential opportunities

Where possible and as funding allows, Raccoon River Watershed monitoring programs should be expanded to:

- Further characterize the health of the in-stream biological community
- Assess the condition and contribution of lakes and wetlands within the watershed
- Increase surface water flow monitoring
- Improve the understanding of in-river processes to determine water quality impacts

Facilitation of an annual watershed-wide modeling meeting would help researchers to better coordinate monitoring efforts, prioritize monitoring needs, and identify and coordinate funding sources.

Conclusion

Due to the altered hydrology and land use of the watershed, there is no simple or single solution to markedly improving water quality in the Raccoon River. Water quality modeling results indicate that even with 100 percent acceptance and use of any single best management practice, attaining the water quality reductions identified by the Iowa Department of Natural Resources for nitrate and pathogen loading is unlikely. Clearly, new strategies and technologies for drainage and nutrient management are needed.

However, the nine recommendations outlined within this document provide a strong foundation for measurable water quality improvement. Significant progress will come only from strong private sector leadership and cooperation among all partners. The challenge of restoring water quality in the Raccoon River calls for a genuine commitment to a new conservation delivery system, including the use of new technologies to efficiently and effectively target combinations of best management practices to the highest contributing areas, as well as the development of strong and ongoing outreach and education campaigns to support this effort . Formation of a watershed-wide management organization to shepherd these actions will be an important step towards this end and can provide the organizational structure necessary to lead institutional change.

All citizens of the Raccoon River Watershed have a responsibility to do what they can do to preserve and improve the water resources their own actions impact. It should not be overlooked that several elements of this Master Plan are immediately actionable and do not require the corroboration of a regional management organization. Watershed stakeholders are encouraged to take action towards improving water quality on their own property, educating their peers, and advocating for water quality improvement throughout the Raccoon River Watershed.

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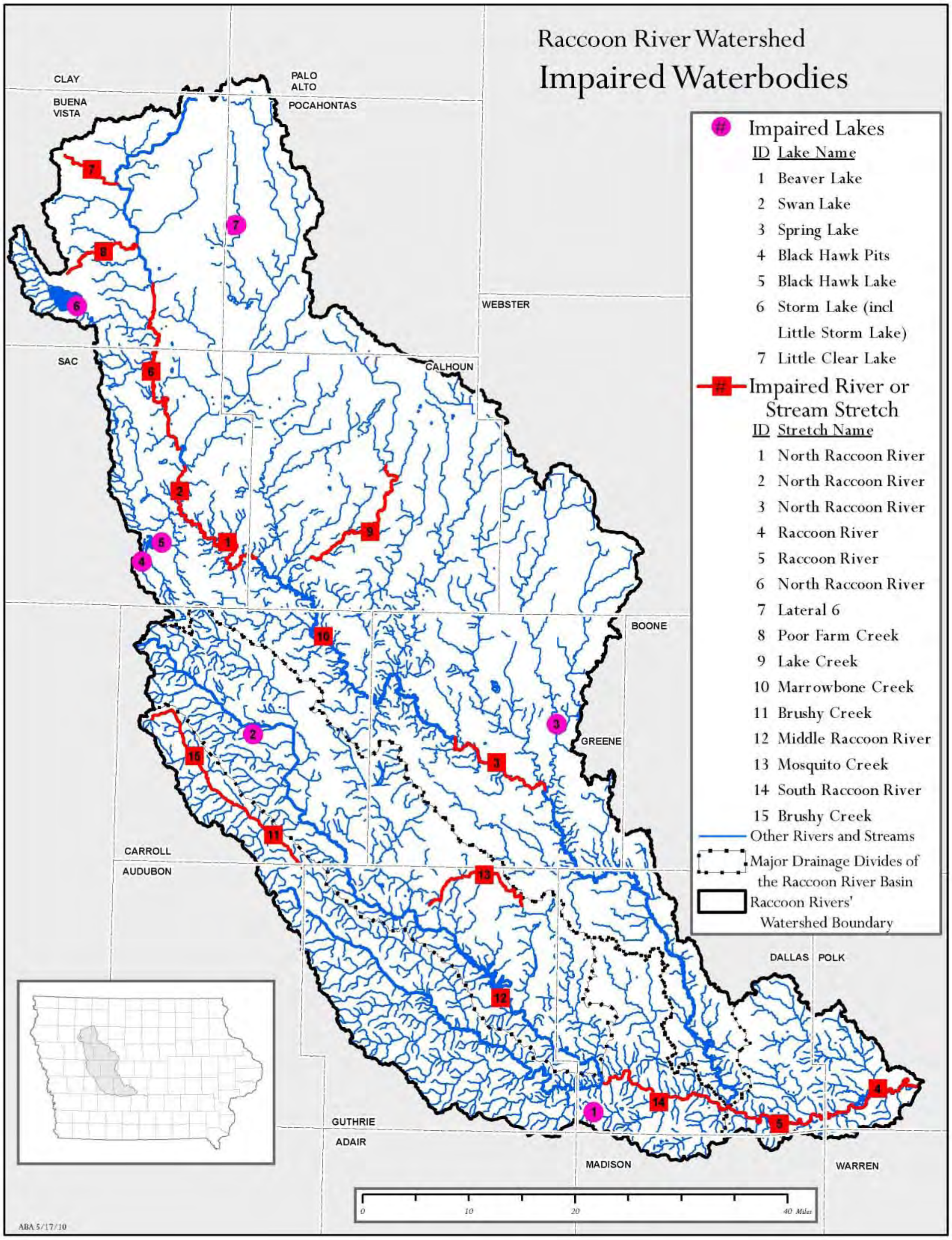
Appendix 1. Participants in the Master Plan Process

Adcock, Leigh	Stakeholder
Adkins, Marty	Expert Panelist
Anderson, Dan	Presenter
Andrew, James	Stakeholder
Appelgate, Linda	Expert Panelist
Arends, Dale	Stakeholder
Balk, Carol	Stakeholder
Balk, Dan	Stakeholder
Bauck, Scott	Stakeholder
Bauer, Vance	Stakeholder
Becker, Margaret	Expert Panelist
Bell, Mike	Expert Panelist
Bentsen, Kenny	Stakeholder
Bettin, Tyler	Stakeholder
Bhandari, Alok	Presenter
Blackmer, Tracy	Presenter
Bryant, Larry	Expert Panelist
Buck, Tracy	Stakeholder
Buman, Margaret	Project Staff
Buman, Stan	Project Staff
Buman, Tom	Project Staff
Burkart, Michael	Expert Panelist
Caligiuri, Jim	Stakeholder
Carlson, Sarah	Stakeholder
Carstensen, Kevin	Stakeholder & Presenter
Case, Dan	Stakeholder
Christian, Amy	Stakeholder
Christian, Don	Stakeholder
Clark, Jane	Stakeholder
Clayburg, John	Stakeholder
Clayburg, Karen	Stakeholder
Collins, Jeff	Stakeholder
Coogan, Melinda	Expert Panelist
Coppess, Dave	Stakeholder
Corey, Pat	Presenter
Cox, Craig	Expert Panelist
Crumpton, Bill	Presenter
Cruse, Rick	Expert Panelist
Danzhig, Bob	Stakeholder
Delaney, Mike	Expert Panelist
DePew, Jerry	Stakeholder
Dettman, Dana	Stakeholder
Diebel, Matthew	Expert Panelist
Dooley, Wade	Presenter
Downing, John	Presenter
Dreith, Amy	Project Staff
Edwards, Gary	Expert Panelist
Ehm, Bill	Expert Panelist
Finley, Terry	Stakeholder
Frederick, Jim	Stakeholder
Garst, Liz	Stakeholder
Gassman, Philip	Expert Panelist & Stakeholder
Gillespie, Jim	Expert Panelist
Greving, Larry	Tour Host
Gulliford, Jim	Expert Panelist
Hafner, Earl	Stakeholder
Hanson, Mark	Stakeholder
Harden, Ray	Stakeholder
Harr, Doug	Stakeholder
Harrison, Brad	Stakeholder
Hart, Jason	Stakeholder
Haupert, Steve	Stakeholder
Hays, Mary	Stakeholder
Heater, Michelle	Stakeholder
Heathcote, Susan	Expert Panelist
Hebenstreit, Sheila	Stakeholder
Helmers, Matt	Expert Panelist
Higgins, Chris	Stakeholder
Hiler, Tom	Stakeholder
Hinrichs, Dennis	Stakeholder
Holl, Randy	Expert Panelist
Hoover, Denny	Stakeholder
Hunsaker, Rick	Expert Panelist
Hunt, Tolif	Expert Panelist & Stakeholder
Isenhart, Tom	Presenter
Jaynes, Dan	Expert Panelist
Jha, Manoj	Stakeholder

Jones, Chris	Expert Panelist	Poen, Kevin	Stakeholder
Karlen, Doug	Presenter	Pottroff, Don	Stakeholder
Kasper, Tom	Presenter	Pottroff, Jean	Stakeholder
Kestel, Jeff	Stakeholder	Ramsey, Jonathan	Stakeholder
Kiel, Adam	Expert Panelist	Reeder, Katy	Expert Panelist
Kinman, Linda	Stakeholder & Expert Panelist	Reinert, Steve	Stakeholder
		Ridgely, Jamie	Project Staff
Kirkholm, Mark	Stakeholder	Riesberg, Jim	Stakeholder
Klein, John	Stakeholder	Riphagen, Brad	Stakeholder
Kolbe, Larrette	Stakeholder	River, Mark	Stakeholder
Kuhn, Kevin	Stakeholder	Robinson, Rick	Expert Panelist
Lally, Joseph	Expert Panelist	Roe, Steve	Stakeholder
Langgin, Mark	Stakeholder	Ryan, Docan	Stakeholder
Lechtenberg, Matt	Presenter	Sand, Duane	Expert Panelist
Ledford, Adam	Expert Panelist	Sandberg, Seth	Stakeholder
Lindquist, Kenny	Stakeholder	Schilling, Keith	Expert Panelist
Lindquist, Paula	Stakeholder	Schmitz, David	Expert Panelist
Lindstrom, Eric	Stakeholder	Schnell, Jeff	Stakeholder
Long, Sarah	Stakeholder	Schnieders, Adam	Expert Panelist
Lund, Dick	Stakeholder	Sexton, Keith	Stakeholder
McCool, Don	Stakeholder	Simpson, Tom	Expert Panelist
McCool, Rina	Stakeholder	Sindt, Gregory	Expert Panelist
Meiners, Gene	Expert Panelist	Smith, Etta	Stakeholder
Melvin, Stewart	Presenter	Smith, Kent	Stakeholder
Mendenhall, Joanne	Stakeholder	Smith, Lynn	Stakeholder
Mendenhall, Mike	Stakeholder	Smith, Seth	Stakeholder
Meylor, Ray	Stakeholder	Snyder, Curt	Stakeholder
Miller, Clint	Stakeholder	Snyder, Ken	Project Staff
Miller, Dave	Expert Panelist	Soenen, Jill	Expert Panelist
Miller, Lannie	Expert Panelist	Sol, Karen	Stakeholder
Miller, Paul	Stakeholder	South, Bob	Expert Panelist
Mowrer, Bryan	Stakeholder	Sporrer, Dale "Sonny"	Presenter
Murphy, Mike	Expert Panelist & Stakeholder	Stipe, Dan	Expert Panelist
		Stroud, Rene	Stakeholder
Olson, Daniel	Expert Panelist	Tomer, Mark	Expert Panelist
Olson, Dave	Stakeholder	Tomka, Joe	Presenter
Olson, Geri	Stakeholder	Torbert, John	Expert Panelist
Overton, Kip	Expert Panelist	Towers, Dan	Stakeholder
Patrick, James	Expert Panelist	Towery, Dan	Presenter
Pauli, John	Stakeholder	Trometer, Dennis	Stakeholder
Penney, Jim	Expert Panelist	VanMeter, Charlie	Stakeholder
Perry, David	Expert Panelist	Viles, Jeremy	Stakeholder
Petersen, Wayne	Expert Panelist	Wadley, Rick	Tour Host

Wall, Don	Stakeholder
Wallace, Mike	Stakeholder
Wendel, Jeff	Expert Panelist
Whitaker, Chris	Expert Panelist
Wilbeck, Kevin	Stakeholder
Wilde, Carrie	Stakeholder
Wilde, Guest	Stakeholder
Wilson, Larry	Stakeholder
Wolter, Calvin	Expert Panelist
Young, Nate	Stakeholder
Zimmerman, Jim	Tour Host & Stakeholder
Zimmerman, Judy	Tour Host & Stakeholder

Appendix 2. Impaired waterbodies map

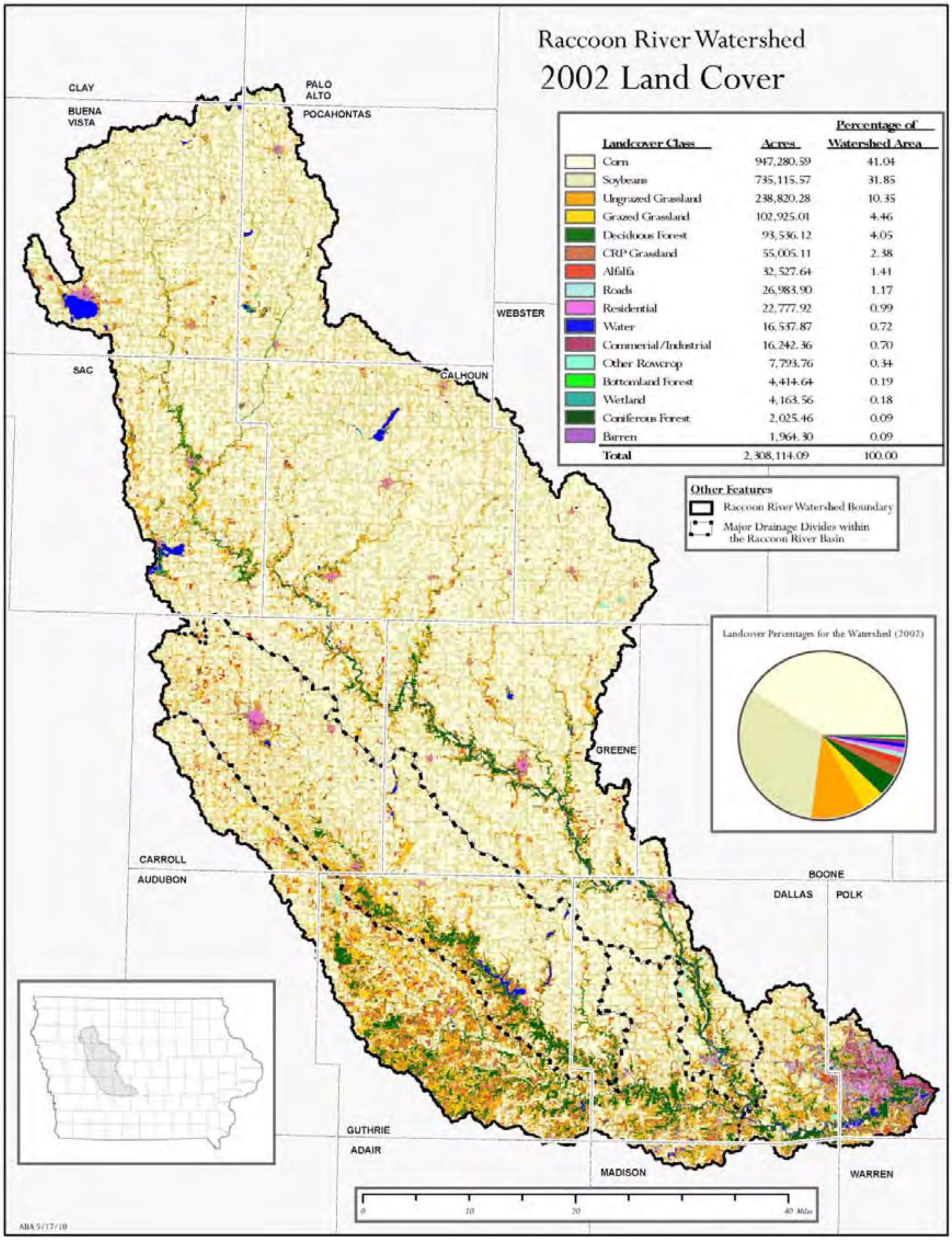


Appendix 3. 12-digit HUC subwatershed identification key

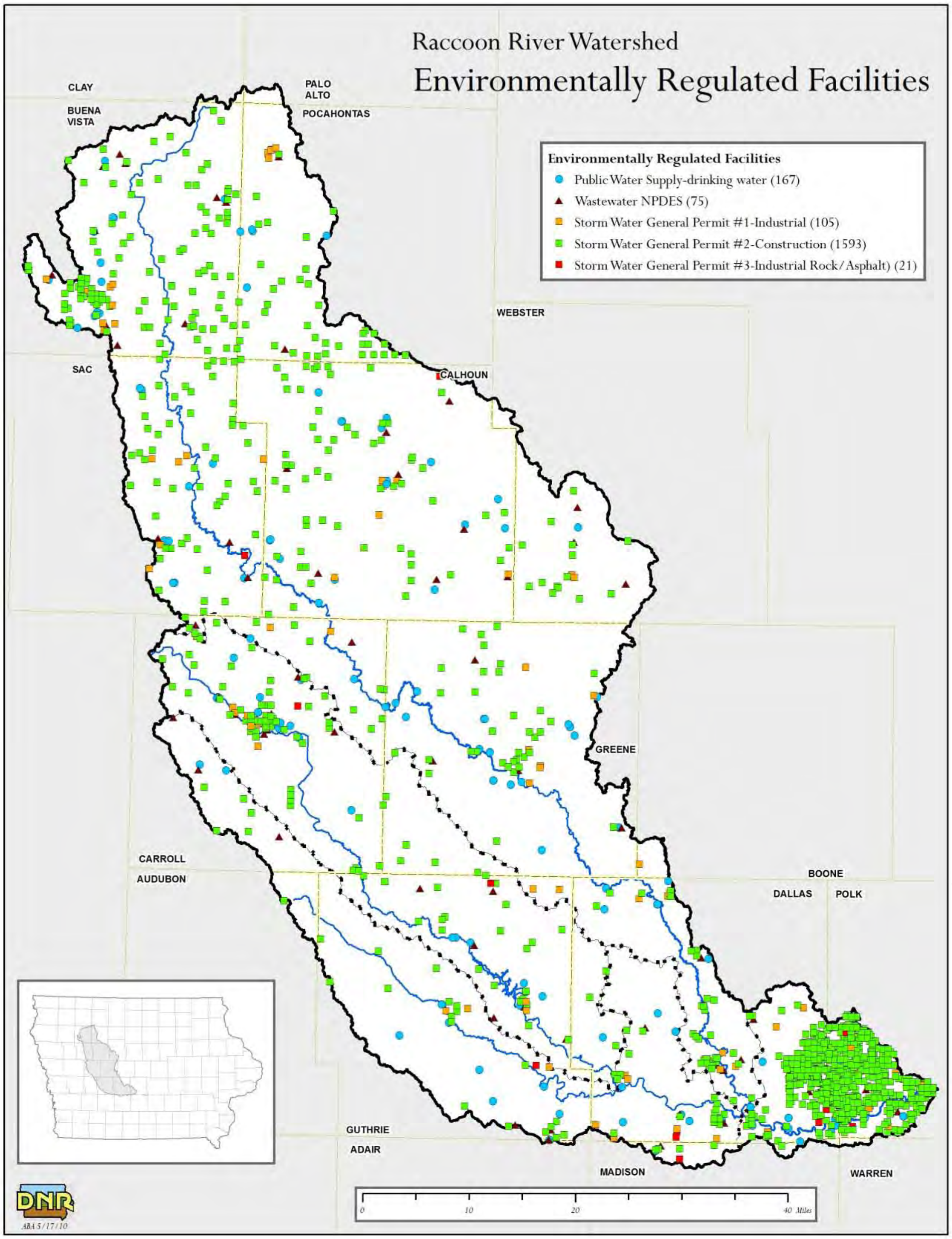
ID	Subwatershed Name
1	Bay Branch
2	Bear Creek-South Raccoon River
3	Beaver Creek-South Raccoon River
4	Buck Run
5	Bulger Creek
6	Buttrick Creek
7	Cedar Creek-Branch 6
8	Cedar Creek-Drainage Ditch 121
9	Cedar Creek-Drainage Ditch 20
10	Cedar Creek-Drainage Ditch 37
11	Cedar Creek-Drainage Ditch 74
12	Drainage Ditch 1-Camp Creek
13	Drainage Ditch 21-Cedar Creek
14	Drainage Ditch 29
15	Drainage Ditch 57
16	Drainage Ditch 67
17	Drainage Ditch 81-Cedar Creek
18	Drainage Ditch 9-13
19	East Branch Panther Creek
20	East Cedar Creek
21	East Fork Hardin Creek
22	Elk Run-North Raccoon River
23	Hardin Creek Headwaters
24	Indian Creek-North Raccoon River
25	Lateral 2
26	Lateral 4
27	Lower Brushy Creek-South Raccoon River
28	Lower Camp Creek-North Raccoon River
29	Lower Drainage Ditch 9 & 13
30	Lower East Buttrick Creek
31	Lower Greenbrier Creek
32	Lower Hardin Creek
33	Lower Lake Creek
34	Lower Little Cedar Creek
35	Lower Mosquito Creek-Middle Raccoon River
36	Lower Purgatory Creek
37	Lower Raccoon River
38	Lower West Buttrick Creek
39	Lower West Fork Camp Creek
40	Mason Creek
41	Middle Brushy Creek-South Raccoon River
42	Middle Hardin Creek
43	Middle Lake Creek
44	Middle Raccoon River-Kings Creek
45	Middle Raccoon River-Mosquito Creek
46	Middle Raccoon River-Spring Branch
47	Middle Raccoon River-Storm Creek
48	Middle Raccoon River-Willey Branch
49	Middle Raccoon River-Willow Creek
50	Middle Raccoon River Headwaters
51	North Raccoon River-Buck Run
52	North Raccoon River-Buttrick Creek
53	North Raccoon River-Cedar Creek
54	North Raccoon River-Doe Brook
55	North Raccoon River-Drainage Ditch 101
56	North Raccoon River-Drainage Ditch 171
57	North Raccoon River-Drainage Ditch 25
58	North Raccoon River-Drainage Ditch 73
59	North Raccoon River-Fannys Branch
60	North Raccoon River-Frog Creek
61	North Raccoon River-Hickory Creek
62	North Raccoon River-Lateral 3
63	North Raccoon River-Lateral 6
64	North Raccoon River-Lateral 9
65	North Raccoon River-Marrowbone Creek

66	North Raccoon River-Prairie Creek
67	North Raccoon River-Swan Lake Branch
68	Outlet Creek
69	Panther Creek
70	Poor Farm Creek
71	Prairie Creek-Drainage Ditch 1
72	Prairie Creek-Drainage Ditch 198
73	Seely Creek
74	Short Creek-North Raccoon River
75	South Raccoon River-Bear Creek
76	South Raccoon River-Beaver Creek
77	South Raccoon River-Bulger Creek
78	South Raccoon River-Deer Creek
79	South Raccoon River-Frost Creek
80	South Raccoon River-Long Branch
81	South Raccoon River-Mason Creek
82	Storm Creek
83	Sugar Creek-Raccoon River
84	Swan Lake Branch
85	Tank Pond
86	Unnamed Creek-North Raccoon River
87	Upper Brushy Creek-South Raccoon River
88	Upper Camp Creek-North Raccoon River
89	Upper Drainage Ditch 9 & 13
90	Upper East Buttrick Creek
91	Upper Greenbrier Creek
92	Upper Hardin Creek
93	Upper Lake Creek
94	Upper Little Cedar Creek
95	Upper Mosquito Creek-Middle Raccoon River
96	Upper Purgatory Creek
97	Upper Raccoon River
98	Upper West Buttrick Creek
99	Upper West Fork Camp Creek
100	Wall Lake Inlet
101	Walnut Creek-Little Walnut Creek
102	Walnut Creek-Raccoon River
103	Welshs Slough
104	West Branch Panther Creek
105	West Cedar Creek
106	Willow Creek-Drainage Ditch 117
107	Willow Creek-Drainage Ditch 9-13
108	Willow Creek Headwaters

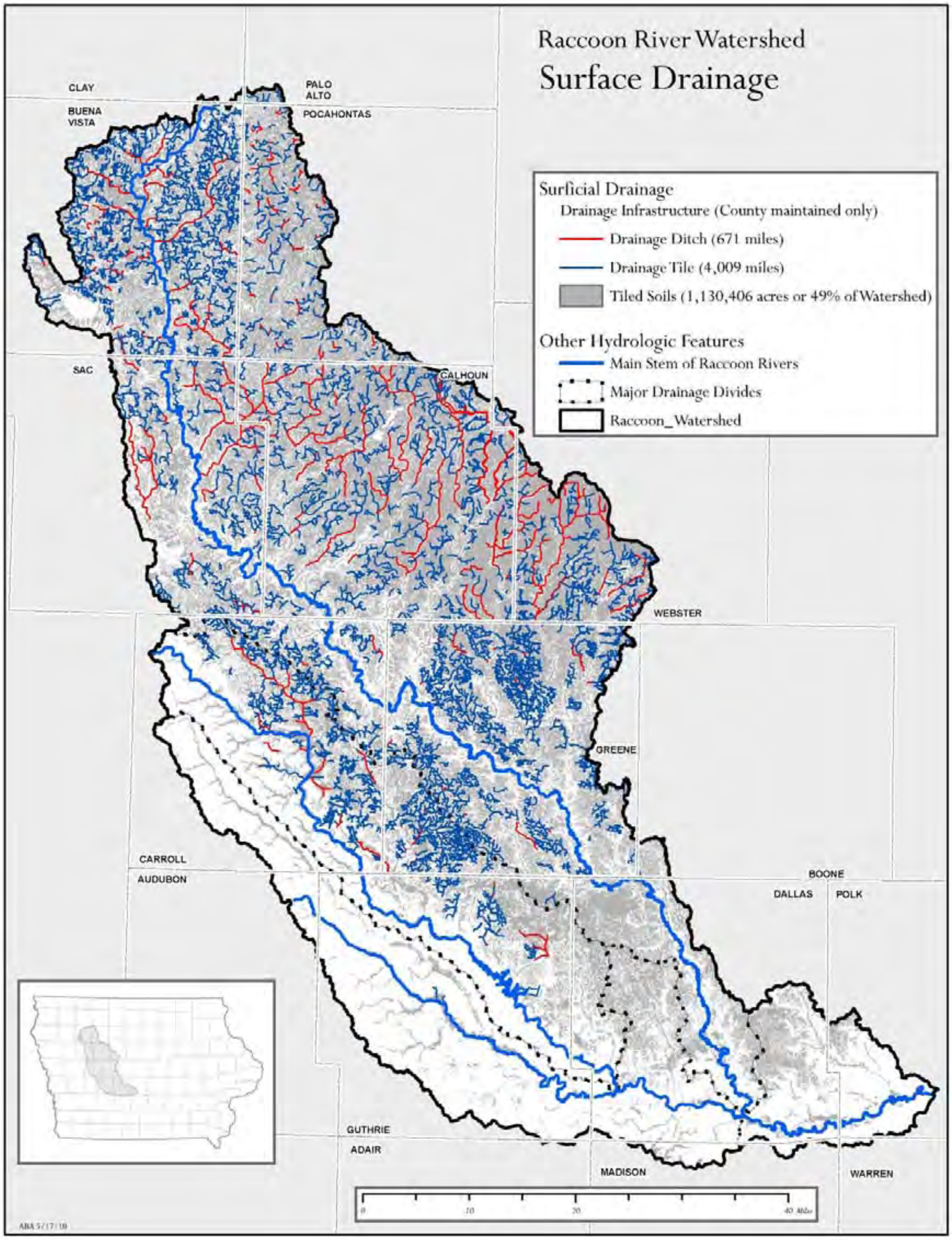
Appendix 4. Landcover map



Appendix 5. Environmentally regulated facilities



Appendix 6. Surface and subsurface drainage



Appendix 7. Water quality modeling report

Introduction

The Center for Agriculture and Rural Development at Iowa State University provided computer modeling and analysis for water quality as part of the Master Plan development process. The analysis is intended to provide additional insights to how widespread adoption of a selected set of alternative nutrient and cropping system practices could potentially impact water quality in the watershed. The study was performed with the Soil and Water Assessment Tool (SWAT) water quality model (Arnold and Fohrer 2005, Gassman, et al. 2007, Douglas-Mankin, Srinivasan and Arnold 2010). SWAT is a river basin scale model developed to quantify the impact of land management practices in large, complex watersheds (USDA Agricultural Research Service 2011). This study builds on several previous Raccoon River Watershed modeling studies conducted by the Center for Agriculture and Rural Development and the Iowa Department of Natural Resources Geological and Water Survey Bureau.

Appropriate use of modeling results

Computer-aided water quality modeling provides a structured mechanism to consider physical, chemical, and biological processes that impact water quality in a watershed. This type of analysis can be very helpful to a watershed planning process. The modeling results allow planners the ability to consider "what-if" scenarios for future changes in a wide range of variables including land use, climate, and others. Over-simplified, average conditions for these variables are appropriate and useful when they are used to predict how the watershed will respond to broad shifts in management practices averaged over long time periods (Folle, Dalzell and Mulla 2007).

However, to prevent misuse of this analysis, it is important to note the weaknesses of computer-aided water quality modeling. Some of these weaknesses are generally the result of the tradeoff that occurs between having a field study that can be detailed but occur over a short time period on a small geographic area, versus applying general principles to a broader geographic area to estimate and predict landscape-scale changes of water, sediment, and nutrients. Other weaknesses are specific to the specific water quality model used, in this case, the SWAT model (Folle, Dalzell and Mulla 2007). Notable limitations of the analyses conducted for the Master Plan include the following:

- Simulation of non-field sources of sediment and phosphorus, such as stream bank erosion, is not possible in SWAT
- Targeted placement of best management practices within a subwatershed is not possible in SWAT

- Simulation of some of the most desirable best management practices in the Raccoon River Watershed, for example nitrate-removal wetlands, cannot be adequately modeled in SWAT
- Generalizations in land management and average conditions are made and applied watershed-wide, for example a single corn planting date is assumed for the entire watershed

Given the complexity of water quality modeling and the level of detail available in the model outputs, it can be tempting to place too much confidence in model results or interpret the results inappropriately. However, output from model scenarios is most valuable when applied in the following ways:

- **Evaluate the relative effectiveness of alternative management scenarios**. Model results can be very useful in evaluating the relative effectiveness of alternative management scenarios to impact water quality. Less emphasis should be given to the absolute concentration, or loading, of a pollutant and more attention should be placed on the relative effectiveness of one management scenario over another.
- **Compare to experimental field data when possible.** Actual measurements of water quality parameters in the field can be expensive, and time-consuming, but they provide the best way to assess the effects of management practices on water quality parameters. In scenarios where model results agree with field and lab-based studies, then model results become more meaningful and can be interpreted and applied with greater confidence. In contrast, if the model results do not agree with measured data, this can provide substantial insight to help identify areas where the model does not perform well.
- **Couple with stakeholder input and expert judgment.** The simple fact that a management scenario can be simulated in a model does not mean that it is practical, economical, or suitable to achieve water quality goals in a particular watershed. **As is the case in this Master Plan, the modeled scenarios are not meant as recommendations.** Rather, the scenarios provide a relative benchmark for which alternative management strategies provide opportunity for achieving desired water quality objectives.

Application of the Soil and Water Assessment Tool (SWAT) Model for the Raccoon River Watershed Master Plan

By

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and

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Submitted

to

AGREN Inc.
1238 Heires Avenue, Carroll, Iowa 51401

Introduction

The Raccoon River Watershed (RRW) covers nearly 3,630 mi^2 are in portions of 17 Iowa counties in west central Iowa (Figure 1). The main tributaries of the Raccoon River system consist of the North, Middle and South Raccoon Rivers, with the longest segment extending 186 miles from its origin in Buena Vista County to the confluence of the Raccoon River with the Des Moines River in the City of Des Moines. The North and Middle Raccoon Rivers flow through the recently glaciated (<12,000 years old) Des Moines Lobe landform region, a region dominated by low relief and poor surface drainage (Prior, 1991). In contrast, the South Raccoon River drains an older (>500,000 years old) Southern Iowa Drift Plain landscape region characterized by higher relief, steeply rolling hills, and well-developed drainage

The RRW land use is dominated by agricultural row crop production, with 73.2% of the areas planted primarily to corn and soybeans. Other main land use includes grassland (16.3%), woodland (4.4%), and urban (4.0%). The grasses and trees generally are scattered throughout the South Raccoon basin on terrain difficult to cultivate. Fertilizer applied to cropland, primarily corn, is a key source of nitrogen and phosphorus in the RRW. The watershed is also characterized by intensive livestock production, with a total of 135 cattle feedlots and 424 confinement operations (Schilling et al., 2008) distributed across the watershed as shown in Figure 2. Land-applied manure generated by these livestock operations is another key source of nitrogen and phosphorus in the watershed; relatively minor nutrient inputs to the watershed occur from cattle grazing on pasture. There are also 77 wastewater treatment facilities in the RRW with National Pollution Discharge Elimination System permits (Figure 1). These facilities are the primary point sources that contribute some additional nitrate to the Raccoon River.

Figure 1. Raccoon River watershed stream system and subwatersheds, plus locations of monitoring gauges, weather stations, wastewater facilities, and stream segments designated with Total Maximum Daily Loads (TMDLs) within the watershed.

The RRW stream system has been impacted by elevated levels of nitrogen, phosphorus, sediment, and bacteria pollutants during recent decades, primarily from nonpoint sources (Hatfield et al., 2009; Jha et al., 2010; Schilling et al., 2008). Two segments of the Raccoon River have officially been identified as impaired by nitrate-nitrogen (nitrate), and three segments

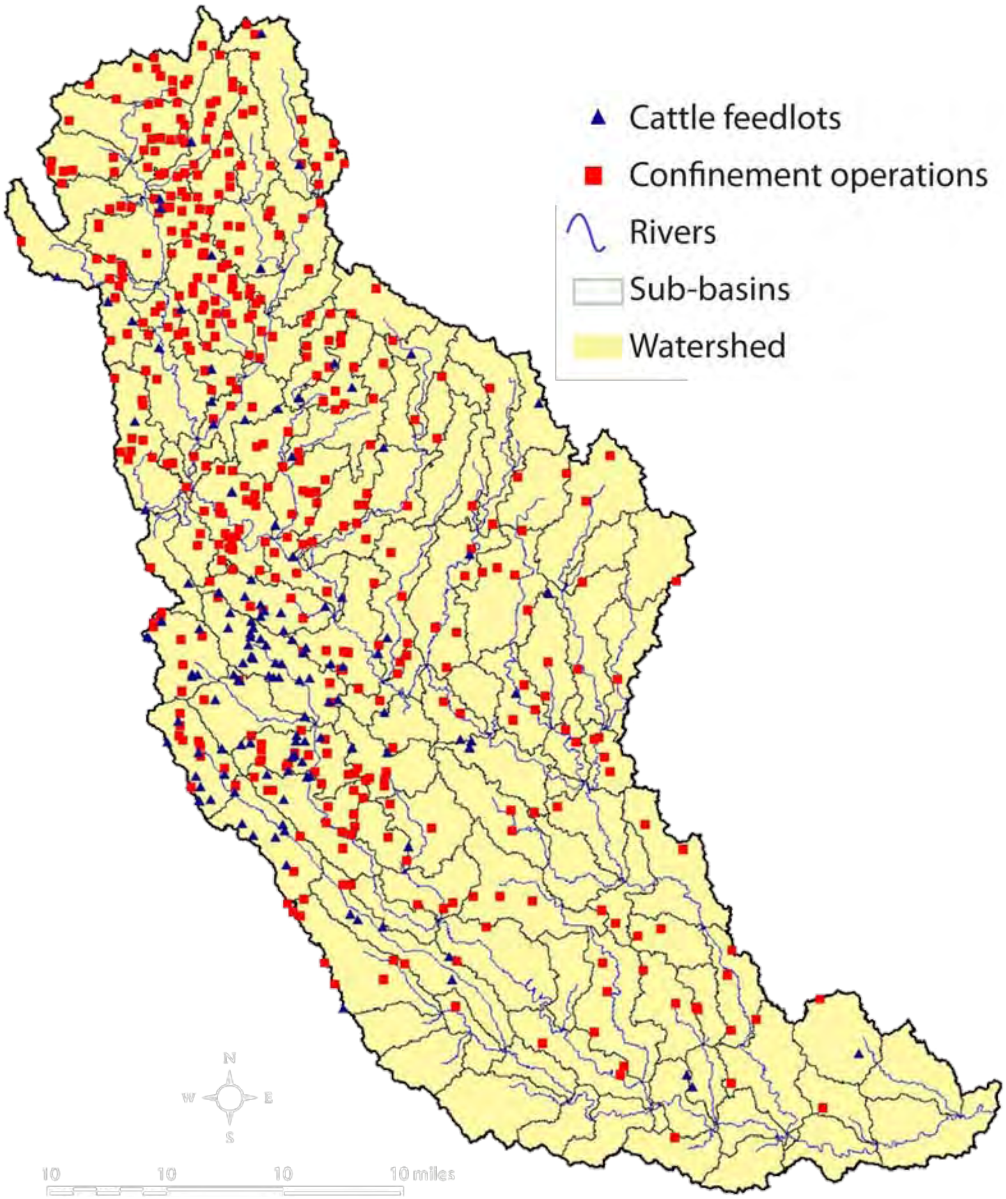

Figure 2. Distribution of cattle feedlots and swine confinement operations in the Raccoon River watershed.

have been identified as impaired by the pathogens indicator *E. Coli* bacteria (Schilling et al., 2008; Jha et al., 2010). Nitrate concentrations were found to exceed the maximum contaminant level (MCL) standard of 10 mg/l for drinking water at the Des Moines Water Works (DMWW) intake 32.3% of the time from 1996 to 2005 (Jha et al., 2010). The DMWW installed the world's largest nitrate removal facility in 1991 (Hatfield et al., 2009) which has been used an average of 45 days per year at a cost of $3,000 per day (IDNR fact sheet). The Total Maximum Daily Load (TMDL) target for nitrate in the Raccoon River was established at 9.5 mg/l, with a margin of safety of 0.5 mg/l, which requires that stream nitrate concentrations do not exceed the target level for the entire range of streamflow (Schilling et al., 2008). A load duration curve approach was used to establish this TMDL; it was estimated that a 48.1% reduction in nitrate loads is needed for compliance with the TMDL.

A multi-pronged approach is needed to address these challenging water quality problems, which is being addressed in detail in the Raccoon River Master Plan that is being developed for the watershed. The simulation analysis presented here was conducted in support of the Master Plan development and is intended to provide additional insights in how widespread adoption of a selected set of alternative nutrient and cropping system practices could potentially impact RRW ins-stream water quality. The study was performed with the Soil and Water Assessment Tool (SWAT) water quality model (Arnold et al., 2005; Gassman et al., 2007; Douglas-Mankin et al., 2010) which is designed to estimate the effects of land use change, climate variation, and other environmental shifts on watershed- and subwatershed-level hydrology and water quality.

This study builds on several previous RRW SWAT studies including: (1) three initial studies (Jha et al., 2007; Burkart and Jha, 2007; Feng et al., 2009) that were performed with SWAT version 2000 (SWAT2000), which were constructed using standard 10-digit watersheds (USGS, 2009) to delineate the subwatershed boundaries, and (2) three studies (Schilling et al., 2008a; Schilling et al., 2008b; Jha et al., 2010) conducted with SWAT version 2005 (SWAT2005) that utilized an updated framework that relied on standard 12-digit watersheds (USGS, 2009; Figure 1) as the basis for the subwatershed boundaries. The updated framework and SWAT2005 were also used for this study. Revised baseline assumptions that were required for the Master Plan scenarios are described first followed by a description and results of performing a suite of nutrient management and/or cropping system scenarios.

Revised Baseline Assumptions and Results

The previous SWAT2005 simulations were performed initially in support of the watershed-level TMDL that was developed for the RRW (Schilling et al., 2008a). The assumptions incorporated into that set of simulations were based on the best available nutrient management information at that time and also reflected the fact that the simulations were performed in support of nitrate- and bacteria-related TMDLs. Several of these assumptions were modified for the RRW Master Plan simulations (Table 1) to accommodate specific scenarios, provide better overall accounting of phosphorus inputs to the stream system, and/or to reflect revised convictions regarding fertilizer nutrient management in the watershed. These modifications were based in part from on feedback from the expert panel.

Phosphorus inputs from the wastewater facilities were previously ignored because the TMDL assessment was focused on nitrate and bacteria. However, these were included in the Master Plan baseline simulation to better account for phosphorus discharge from wastewater facilities (Table 1). An iterative process was used to calibrate the simulated phosphorus discharge from the wastewater treatment plants, which included comparisons with annual RRW phosphorus loads estimated during 2000-2002 as part of a statewide nutrient balance study that included accounting of both point and nonpoint source pollution inputs to major Iowa river watersheds (Libra et al., 2004) and additional comparisons with in-stream monitoring data during 2001-2004. Cattle (that grazed either pastures or harvested crop fields) were assumed to access the streams for a portion of each day for the TMDL SWAT baseline but were removed for the

Table 1. Change in the calibrated baseline assumptions between the SWAT analysis performed for the Raccoon River watershed TMDL and the present Master Plan study

TMDL SWAT Assumption	Master Plan SWAT Assumption (Change from TMDL assumption)
No phosphorus discharge from wastewater treatment facilities	Phosphorus discharge from wastewater treatment facilities accounted for
Planting, harvesting, and other field operations simulated using heat scheduling approach	Planting, harvesting, and other field operations simulated using specific dates
Cattle grazing pastures or harvested fields assumed to access streams for a percentage of each day	Cattle grazing pastures or harvested fields assumed to not access streams
Anhydrous ammonia (nitrogen) applications were always applied in the fall	50% of the anhydrous ammonia (nitrogen) applications applied in the fall and 50% applied in the spring
Anhydrous ammonia (nitrogen) applications were simulated to occur on all cropland that was designated for livestock manure applications	The anhydrous ammonia (nitrogen) applications were assumed to occur on only 50% of the cropland that was designated for livestock manure applications
Anhydrous ammonia (nitrogen) was applied at 212.8 lb.ac (190 kg/ha) on both cropland that was managed with manure and cropland that did not receive manure	Anhydrous ammonia (nitrogen) was applied at 112 lb/ac (100 kg/ha) on cropland that was managed with manure and 285.6 lb/ac (255 kg/ha) on cropland that did not receive manure

Master Plan baseline, due to the very minor effects that occurred from those direct stream nutrient inputs (see Jha et al., 2010a) and to reflect an assumed improved management of the grazed cattle. Also, as noted in Table 1, the scheduling of planting, harvesting, and other field operations that were simulated in SWAT was converted from a "heat unit scheduling" approach used in the original TMDL baseline, which allows the operation dates to fluctuate as a function of temperature trends during a given growing season, to specific dates for the Master Plan simulations to facilitate scenarios that involved specific changes in fertilizer application timing.

Three key fertilizer application assumptions that were built into the baseline simulation and subsequent scenarios for that study were also adjusted for the Master Plan baseline (Table 1). First, the anhydrous ammonia applications, which were the primary simulated nitrogen fertilizer inputs for corn[1], were always applied in the fall for the TMDL SWAT baseline. However, these

[1]Anhydrous ammonia consists of 82% nitrogen (see example product data sheet including physical characteristics information at http://www.simplot.com/agricultural/plant/upload/Anhyd_Ammon_82_0_0.pdf)

anhydrous ammonia applications were redistributed such that 50% of the primary nitrogen fertilizer applications occurred in the fall and 50% in the spring for the Master Plan baseline. Second, the anhydrous ammonia applications were also simulated to occur on all cropland that was designated for livestock manure applications in the original TMDL assumptions. This assumption was again modified, so that the anhydrous ammonia applications occurred on only 50% of the cropland that was designated for livestock manure applications. These changes reflected the overall convictions of the expert panel that the fertilizer applications are more balanced at present as compared to a few years ago for the RRW, both in terms of timing of application and that the over-utilization of nitrogen fertilizer on manured cropland was not as severe as previously believed. These assumptions were also supported by a limited amount of data available for the region, including Agricultural Coop fertilizer sales data that indicated stronger usage of anhydrous ammonia in the spring than previously observed and a small RRW subwatershed study that showed that over 40% of manured cropland also received relatively high levels of nitrogen fertilizer. Third, it was also the prevailing opinion of the expert panel that the anhydrous ammonia applications should be limited to 112 lb/ac (100 kg/ha) rather than the 212.8 lb/ac (190 kg/ha) application rate that was assumed for the TMDL baseline (Table 1).

The third fertilizer application rate adjustment resulted in the need to adjust the anhydrous application rates upward for nonmanured cropland in order to maintain, as close as possible, the overall nutrient balance between the TMDL and Master Plan baselines. This resulted in an increase in the anhydrous ammonia application rate from 212.8 lb/ac (190 kg/ha) in the TMDL baseline to 285.6 lb/ac (255 kg/ha) for the Master Plan baseline for cropland that was not managed with manure (Table 1). Achieving an exact nitrogen and phosphorus balance between the two baselines proved difficult, in spite of these adjustments, due mainly to the structure of the hydrologic response units (HRUs)[2] used in the SWAT framework. As a result, there was slightly less actual overall nitrogen and phosphorus applied across the simulated RRW in the SWAT Master Plan baseline as compared to the original TMDL baseline. In general, these modifications underscore the important need to establish the overall nitrogen and phosphorus inputs to the RRW.

The restructured baseline was then calibrated and validated using a split-time approach that relied on the same calibration and validation periods as previously described by Jha et al. (2010a;b); those previous studies should also be consulted for other specific details of the calibration and validation approach that were also used for the testing of SWAT in this study. Graphical and statistical results for the calibration and validation phases are described in Appendix A. The resulting subwatershed-level water yields or pollutant loads of the calibrated baseline are shown in Figures 2-6. Figure 2 shows the predicted distribution of water yields across the RRW, which reflect the effects of varying land use, topography, and soil types. Figure 4 indicates that the highest baseline sediment losses occurred primarily in the South Raccoon subwatershed, reflecting the more rolling landscapes and steeper slopes that characterize that area as compared to the rest of the RRW. Figure 5 presents a similar pattern for total phosphorus losses as compared to the sediment losses in Figure 4, which is consistent with expectations due to higher surface runoff and sediment losses that occurred from the higher sloped landscapes in the South Raccoon subwatershed. In contrast, the highest nitrate losses were predicted to occur in the northern and central parts of the RRW, which is coincident with the highest concentration of swine operations and areas of the watershed with high levels of subsurface tile drainage.

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[2]Subwatersheds in a SWAT simulation are usually subdivided into smaller areas consisting of homogeneous soils, land use, and management that are called hydrologic response units (HRUs). These can be roughly thought of as crop fields although HRU sizes may be much larger than a typical crop field. HRUs are also not spatially represented in the model but rather represent simply the percentage of subwatershed that contains the given HRU characteristics.

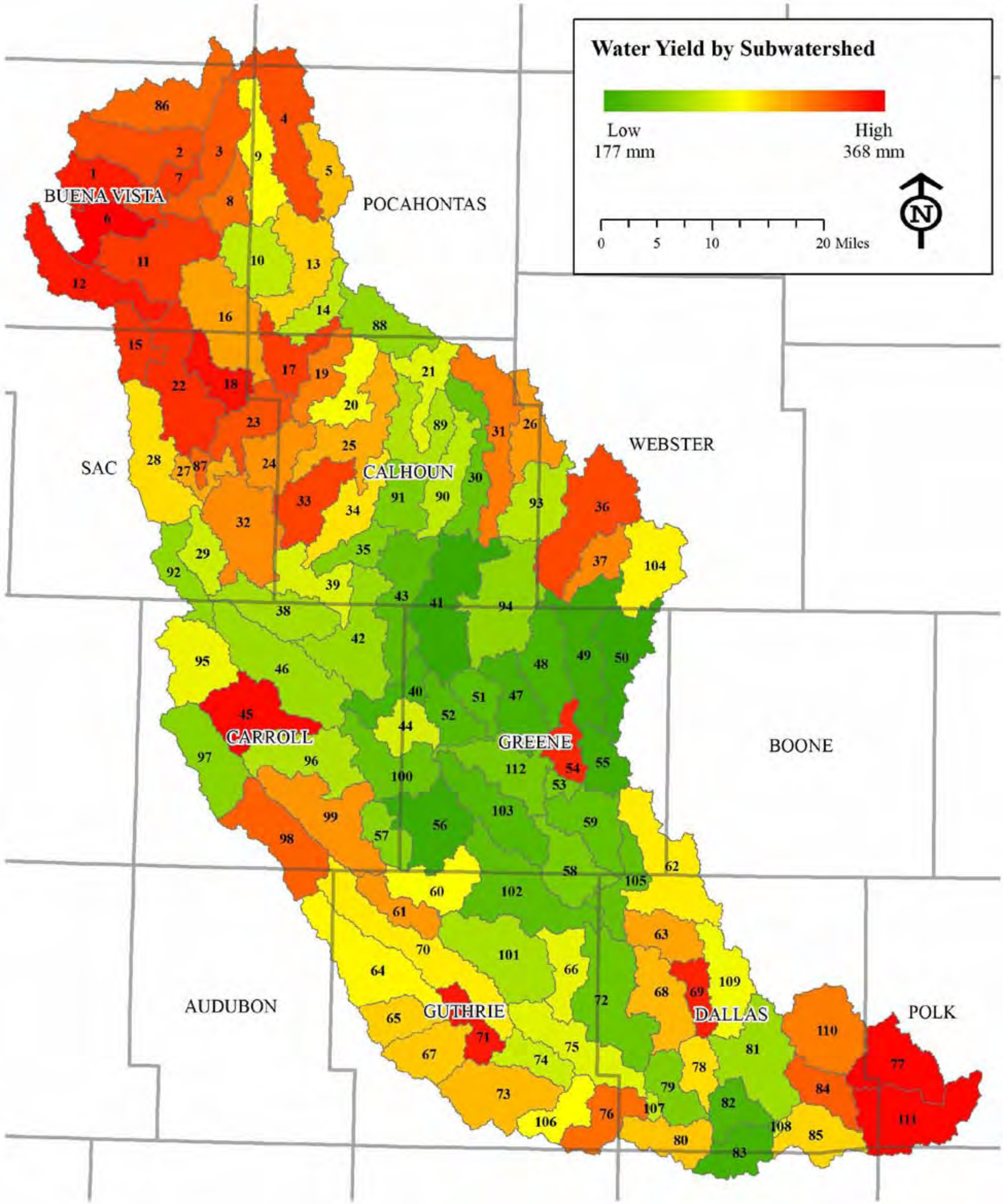

Figure 3. Simulated distribution of water yields by subwatershed for the Raccoon River watershed baseline.

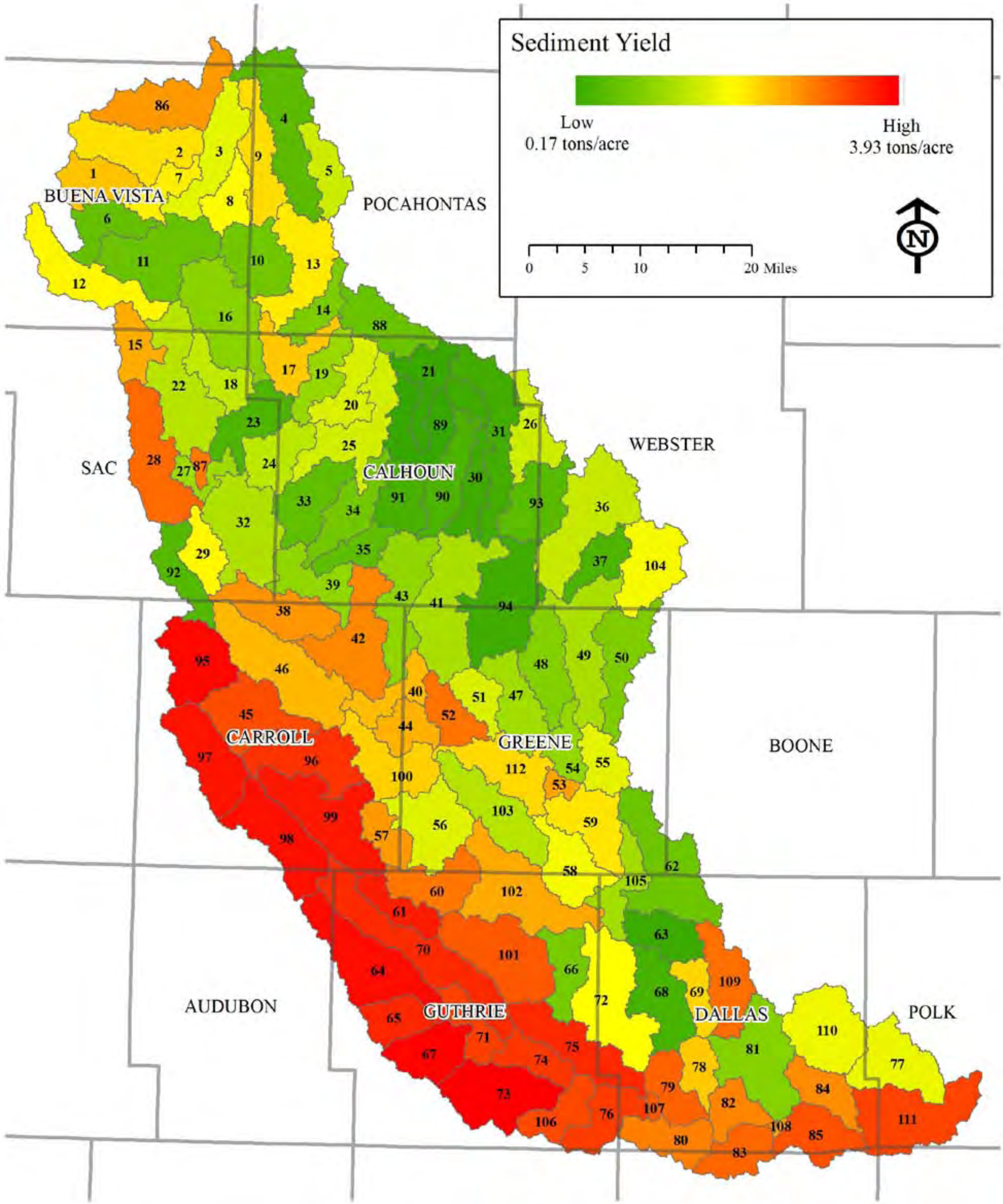

Figure 4. Simulated distribution of sediment losses by subwatershed for the Raccoon River watershed baseline.

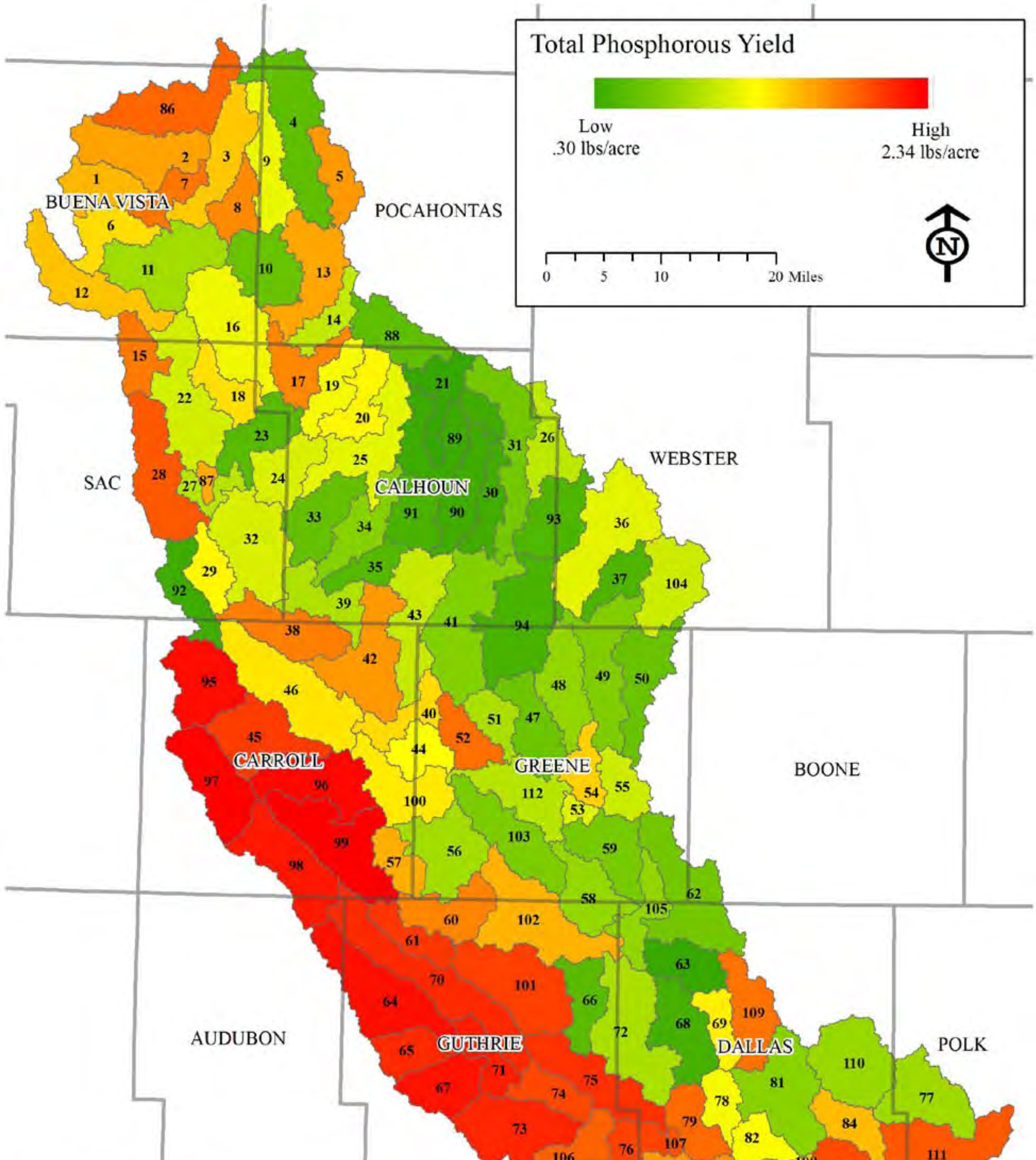

Figure 5. Simulated distribution of total phosphorus losses by subwatershed for the Raccoon River watershed baseline.

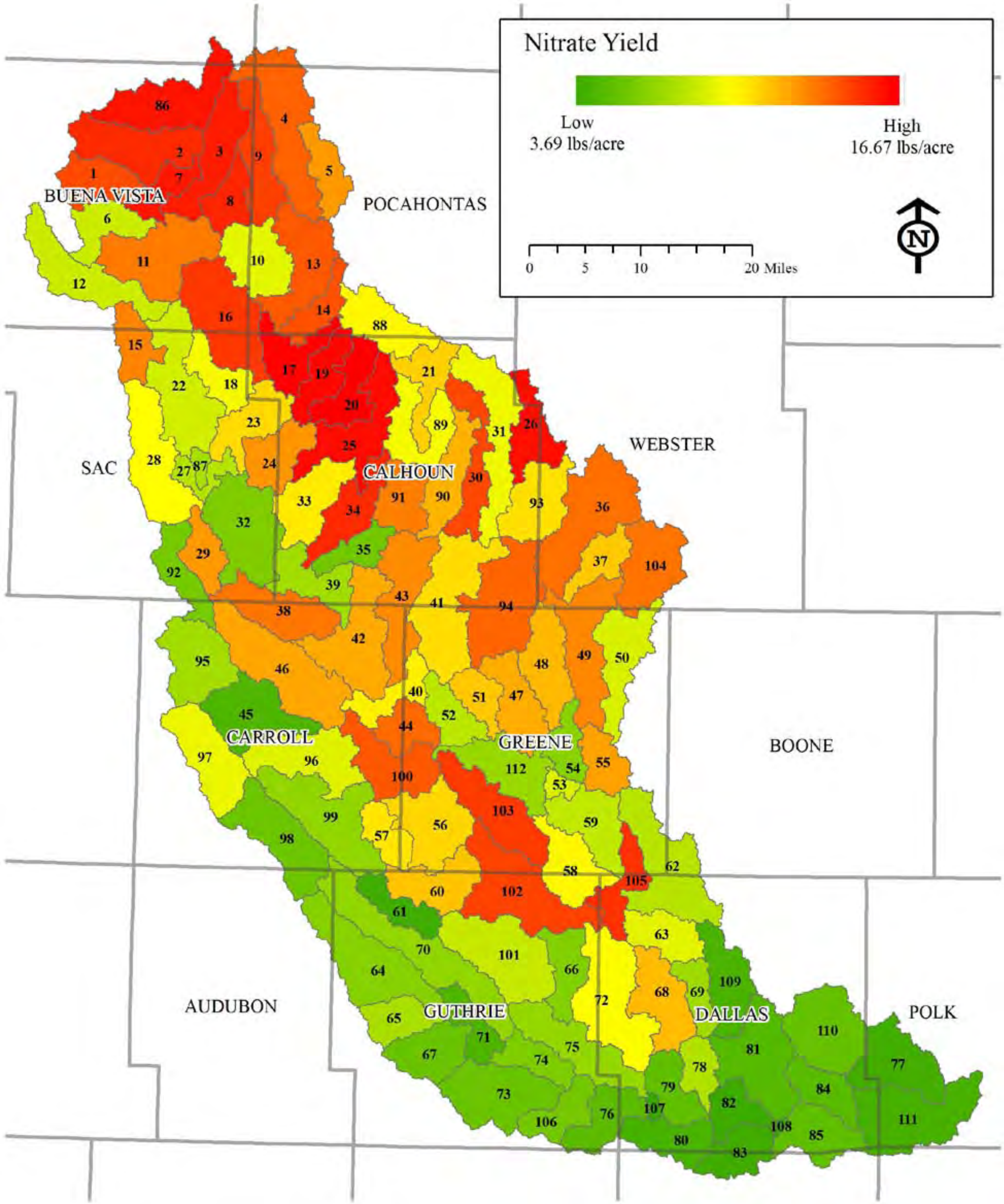

Figure 6. Simulated distribution of nitrate losses by subwatershed for the Raccoon River watershed baseline.

Scenario Assumptions and Results

The calibrated SWAT model was used to simulate 22 different scenarios that are listed in Table 2. The calibrated baseline is identified as scenario 1; the other scenarios are then numbered according to main categories (e.g., scenario 4 category: shift of fall anhydrous applications to spring applications) and variants within those categories (e.g., scenarios 4a, 4b, 4c, and 4d for different spring application dates for the anhydrous ammonia applications). Scenario 2 depicted a shift in the main phosphorus fertilizer applications for cropland from diammonium phosphate (DAP; 18-46-0) with monoammonium phosphate (MAP; 11-52-0), which reflects increasing use of the MAP material and a perceived conviction that the trend will continue. The DAP application rate of 156 lb/ac (175 kg/ha) used in the calibrated baseline was also used for the MAP applications in scenario 2. The shift to MAP was then incorporated in all subsequent scenarios listed in Table 2, starting with scenario 3. Scenario 3 was intended to represent improved nutrient management of manured cropland areas by taking better account of available nutrients in the applied manure and not over-applying fertilizer. This scenario was performed by removing both the anhydrous ammonia and MAP fertilizer inputs from the 50% of cropland that was managed with both manure and fertilizer applications in the calibrated baseline and scenario 2. Thus, the only source of nutrients for all manured cropland in this scenario was the manure itself. The removal of the fertilizer applications on manured cropland was also included in all subsequent scenarios starting with scenario 4.

Scenario 3 can also be viewed as a “scenario baseline” because all subsequent scenarios incorporated both the changes from scenario 2 and scenario 3. Thus the following description of the impacts of the different scenarios is discussed primarily in the context of comparing the scenario impacts (starting with scenario 4a) versus this scenario baseline. The only exception to

Table 2. Scenario numbers and descriptions

ID	Scenario Description
1	Calibrated baseline; all cropland is cropped with two-year rotations of corn and soybean[a]
2	Conversion from diammonium phosphate (DAP;18-46-0) to monoammonium phosphate (MAP; 11-52-0); effects incorporated in all remaining scenarios starting with 3.
3	Removal of all anhydrous ammonia (main nitrogen fertilizer input) and DAP applications from cropland that also managed with livestock manure; effects incorporated in all remaining scenarios starting with 4a.
Scenarios 4a-4d: The timing of the baseline spring fertilizer application remain unchanged[b]	
4a	The fall anhydrous ammonia applications (50% of total) are shifted to two weeks before planting (May 1)
4b	The fall anhydrous ammonia applications (50% of total) are shifted to the day of planting (May 1)
4c	The fall anhydrous ammonia applications (50% of total) are shifted to two weeks after planting (May 1)
4d	The fall anhydrous ammonia applications (50% of total) are shifted to four weeks after planting (May 1)
Scenarios 4e-4h: The timing of the baseline fall and spring fertilizer applications are set to the same dates[b]	
4e	Both fall and spring anhydrous ammonia applications are shifted to two weeks before planting (May 1)
4f	Both fall and spring anhydrous ammonia applications are shifted to the day of planting (May 1)
4g	Both fall and spring anhydrous ammonia applications are shifted to two weeks after planting (May 1)
4h	Both fall and spring anhydrous ammonia applications are shifted to four weeks after planting (May 1)
Scenarios 5a-5d & 6a-6d: Alternative cropping system scenarios[c]	
5a	25% of cropland is converted to a six-year rotation of corn-soybean-corn-alfalfa-alfalfa-alfalfa (CSCAAA)
5b	50% of the cropland is converted to a six-year rotation of CSCAAA
5c	75% of the cropland is converted to a six-year rotation of CSCAAA
5d	100% of the cropland is converted to a six-year rotation of CSCAAA
6a	Rye winter cover crop is inserted between corn and soybean across 25% of the cropland acres[c]
6b	Rye winter cover crop is inserted between corn and soybean across 50% of the cropland acres
6c	Rye winter cover crop is inserted between corn and soybean across 75% of the cropland acres
6d	Rye winter cover crop is inserted between corn and soybean across 100% of the cropland acres
Scenarios 7a-7c: Nitrogen application timing shifts and alternative cropping system combination scenarios[c]	
7a	All anhydrous applications shifted to four weeks after planting (scenario 4h); 25% conversion of cropland to CSCAAA (scenario 5a); insertion of rye cover crop on 25% of the cropland (scenario 6a)
7b	All anhydrous applications shifted to four weeks after planting (scenario 4h); 100% conversion of cropland to CSCAAA (scenario 5d) and insertion of rye cover crop on 25% of the cropland (scenario 6a)
7c	All anhydrous applications shifted to four weeks after planting (scenario 4h); 100% conversion of cropland to CSCAAA (scenario 5d); insertion of rye cover crop between corn and soybean years in six-year rotation

[a]Cropland rotations held constant for scenarios 1 to 4h; conversions occur for scenarios 5a-7c
[b]The 50% of the simulated anhydrous applications that were applied in the spring for the calibrated baseline (and scenarios 2 and 3) were applied on May 2, the day before planting. Those applications were also applied on May 2 for scenarios 4a through 4d while the 50% of fall applications were shifted to the new spring dates as indicated in the scenario descriptions. However, the original spring applications were shifted to the same spring application dates as the fall applications for scenarios 4e to 4h, again is indicated in the scenario descriptions.
[c]Selection of cropland HRUs to be converted to CSCAAA rotation or for insertion of rye winter cover crop was based on a %slope targeting scheme that targeted the highest slopes first and then targeted progressively lower slopes. The initial targeting for scenario 7a was for the CSCAAA rotation followed by the cover crops.
[d]The rye cover crop was inserted between every sequence of corn-soybean and soybean-corn that was simulated during the 25-year (1986-2004) simulation period.

this is for scenarios 2-3, which are initially compared with the calibrated baseline. Three sets of complete scenario comparisons are included in Appendix B that provide comparisons of the different scenarios with both the calibrated baseline (scenario 1) and the scenario baseline (scenario 3) as follows: (1) comparisons of the average annual streamflow (mm) and pollutant loss (tons) for the calibrated baseline and subsequent 22 scenarios in Table B-1, (2) percentage reduction comparisons of the 22 scenarios (scenarios 2 through 7c) versus the calibrated baseline in Table B-2, and (3) percentage reduction comparisons of 19 scenarios (scenarios 4a through 7c) versus the scenario baseline in Table B-2 (streamflow and pollutant loads are listed for scenarios 1, 2, and 3).

Impacts of Scenarios 2 and 3

The results of scenarios 2 and 3 are presented in Tables 3 and 4. Table 3 reports the 1984-2004 average annual streamflow and pollutant loads relative to the calibrated baseline (scenario 1) while Table 4 lists the percentage differences between the two scenarios and the calibrated baseline. A decrease close to 3% was predicted for the nitrate loss versus slight increases of about 1 to 3% in the estimated organic P and mineral P losses. These impacts are consistent with the formulation differences between DAP and MAP (Table 1) and indicate that only minor environmental impacts would occur with widespread conversion to MAP. Reductions in nitrate and mineral P losses of over 10% were predicted for scenario 3 versus the calibrated baseline, due to the removal of fertilizer applications to the manured cropland areas. Slight increases in streamflow and sediment loss were also predicted for scenario 3. This was due to a slight decrease in the average corn yields of 3.5% (which occurred due to the removal of fertilizer from the manured cropland) which apparently resulted in slightly less evapotranspiration and slightly more surface runoff. The latter also resulted in slightly higher sediment losses.

Table 3. Comparison of average annual (1986-2004) streamflow and pollutant load levels between the calibrated baseline (scenario 1) and scenarios 2 and 3

Scenario	Streamflow (mm)	Sediment (Tons)	Nitrate (Tons)	Organic N (Tons)	Mineral P (Tons)	Organic P (Tons)
1	224	1,022,934	19,266	2,879	490	427
2	224	1,022,181	18,749	2,879	506	431
3	227	1,040,455	17,242	2,879	435	421

Table 4. Percentage differences between the calibrated baseline (scenario 1) and the average annual (1986-2004) streamflows or pollutant losses for scenarios 2 and 3

Scenario	Streamflow (mm)	Sediment (Tons)	Nitrate (Tons)	Organic N (Tons)	Mineral P (Tons)	Organic P (Tons)
1	224	1,022,934	19,266	2,879	490	427
2	-0.1	-0.1	-2.7	0.0	3.2	0.9
3	1.2	1.7	-10.5	0.0	-11.2	-1.5

Subwatershed-level water or pollutant yields for scenario 3 are shown in Figures 7-10, which serve as the scenario baseline water yields and pollutant losses for the remaining scenario comparisons. Very little difference can be discerned between the water yields and sediment losses in Figures 7 and 8 as compared to the counterpart calibrated baseline results in Figures 3 and 4, due to the small changed that occurred between the two simulations (Tables 3 and 4). Some differences in spatial patterns can be seen between the phosphorus and nitrate losses for scenario 3 (Figures 9 and 10) and the corresponding outputs for scenario 1 in Figures 5 and 6. For example, shifts in the nitrate yield priority status for subwatershed 38, 46, and 100 can be seen between the two scenarios in Figures 6 and 10. It is also obvious that lower overall magnitudes of phosphorus and nitrate losses occurred for scenario 3, based on comparisons between Figures 6 and 10 and the tabulated results in Tables 3 and 4. Subwatershed spatial results reported for selected scenarios below are compared versus the results shown here for Figures 7-10.

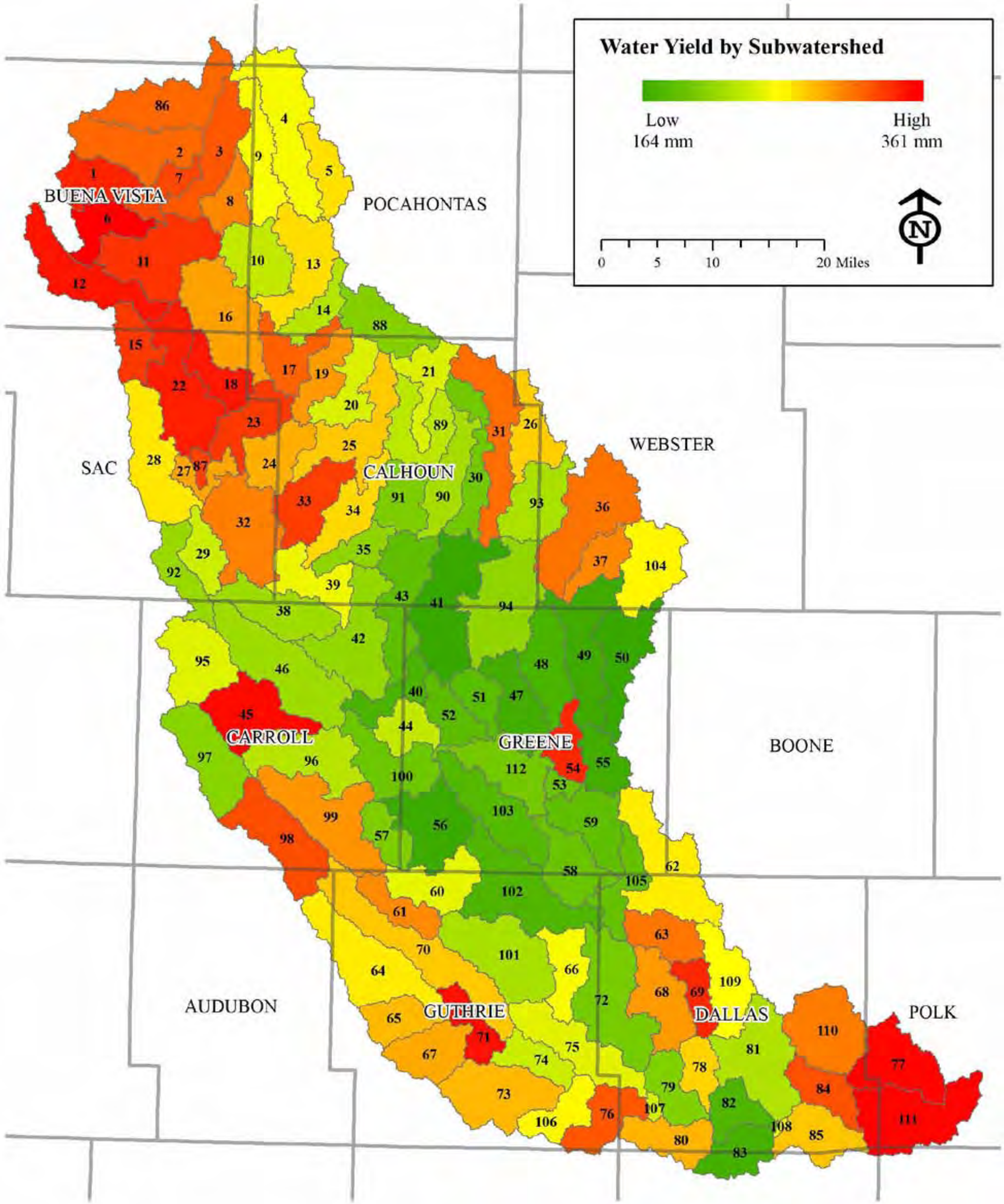

Figure 7. Simulated distribution of water yields by subwatershed for the Raccoon River watershed baseline for scenario 3 (scenario baseline).

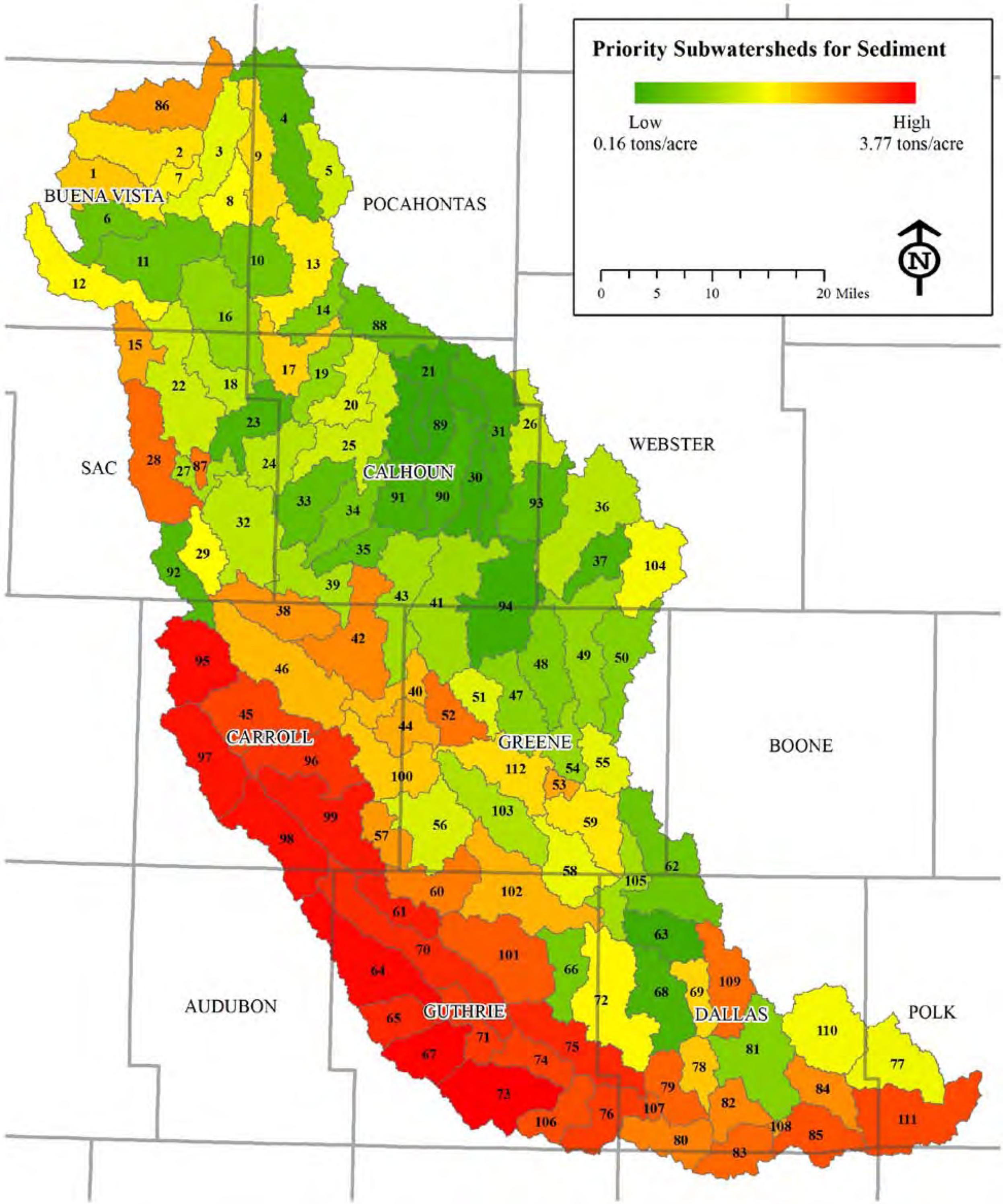

Figure 8. Simulated distribution of sediment losses by subwatershed for the Raccoon River watershed baseline for scenario 3 (scenario baseline).

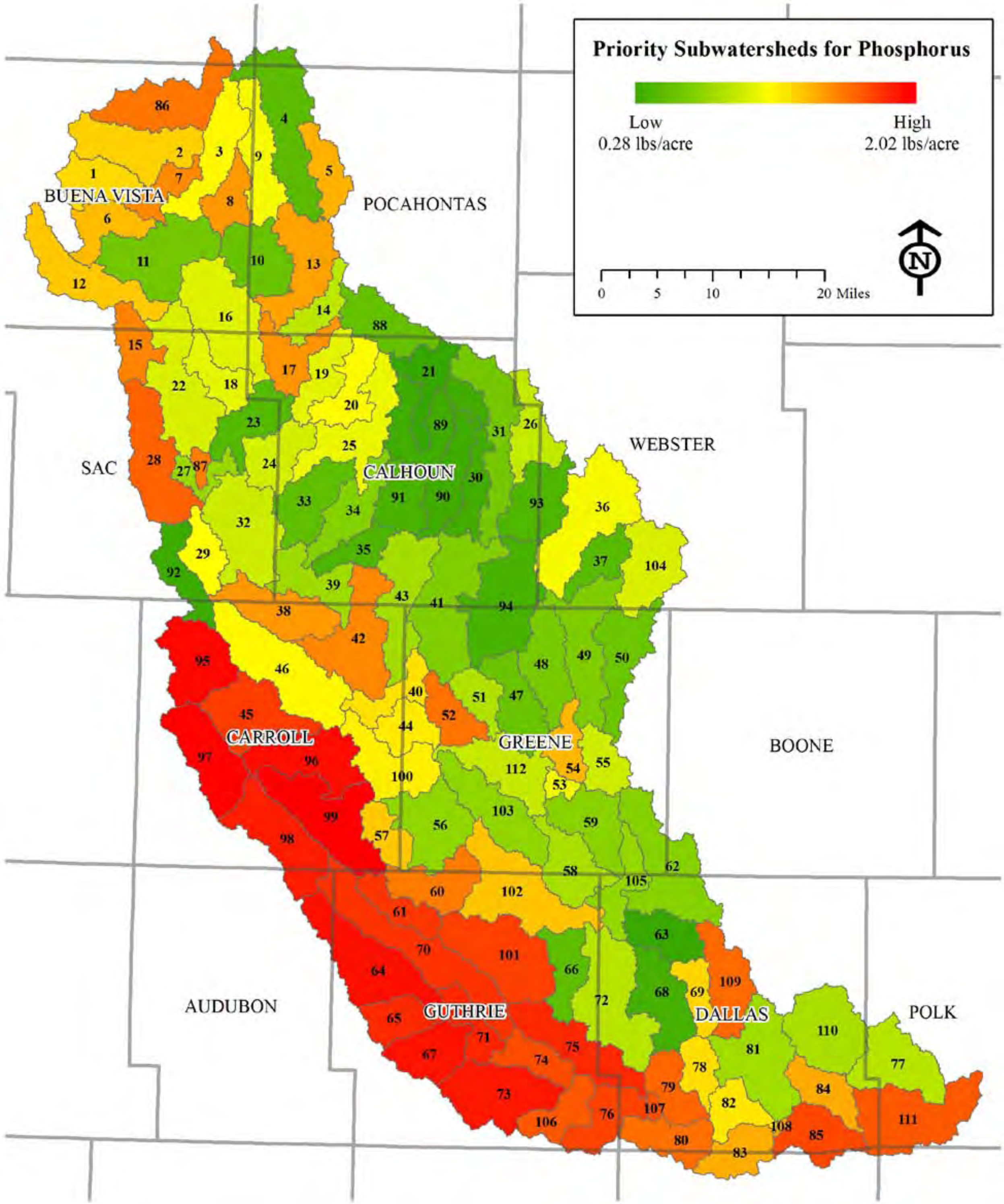

Figure 9. Simulated distribution of phosphorus losses by subwatershed for the Raccoon River watershed baseline for scenario 3 (scenario baseline).

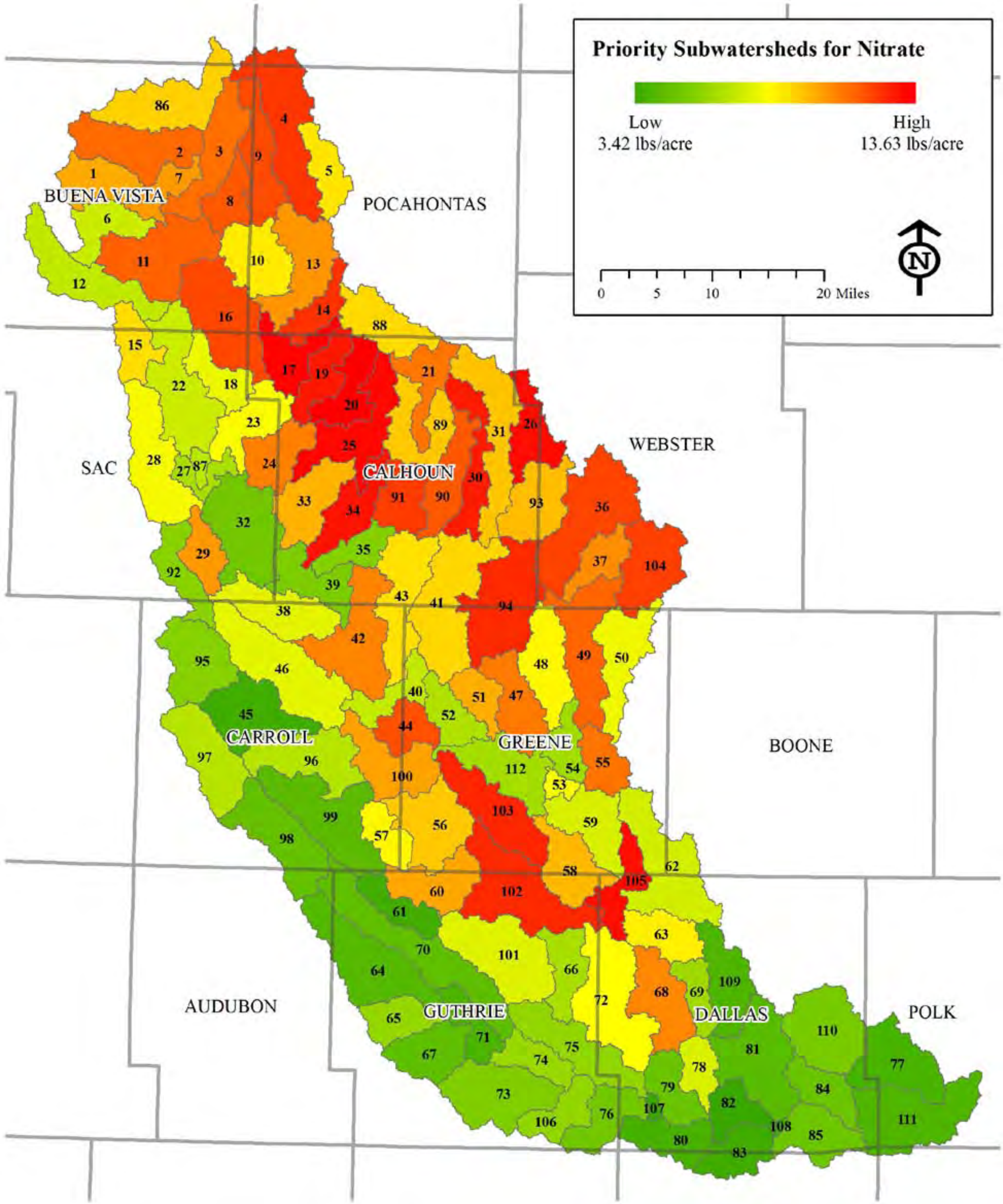

Figure 10. Simulated distribution of nitrate losses by subwatershed for the Raccoon River watershed baseline for scenario 3 (scenario baseline).

Impacts of Scenarios 4a-4d and 4e-4h

Scenarios 4a through 4d and 4e through 4h were designed to be adaptive nutrient management scenarios. The main characteristic of these eight scenarios was the elimination of all fall applications of anhydrous ammonia by shifting the 50% of the applications that were applied in the fall (as simulated in the calibrated baseline and scenarios 2 and 3) to spring applications (Table 2). The fall applications were shifted to four specific dates relative to the assumed May 1 planting date for corn. These dates were two weeks before planting (scenarios 4a and 4e), the day of planting (scenarios 4b and 4f), two weeks after planting (scenarios 4c and 4g), and four weeks after planting (scenarios 4d and 4h). The key difference between the two sets of scenarios was in how the other 50% of the anhydrous ammonia applications were simulated; i.e., the 50% of the anhydrous ammonia applications that were simulated as spring applications in the calibrated baseline and scenarios 2 and 3. The spring anhydrous ammonia applications were all simulated to occur on May 2, the day before planting, in the calibrated baseline and scenarios 2 and 3. This assumption was held constant for scenarios 4a through 4d; in other words, these 50% of the anhydrous ammonia applications were always simulated to occur on May 2 in this set of four scenarios. In contrast, these original spring anhydrous ammonia applications were shifted to the same spring dates as the fall applications in scenarios 4e through 4h; i.e., the original spring applications were also performed two weeks before planting, on the day of planting, and so forth rather than on May 2.

The results of these eight nutrient management scenarios are shown in Table 5 versus the scenario baseline (scenario 3). The main effect of these scenarios was decreased losses in nitrate relative to scenario 3 as was expected. The magnitude of the predicted decrease in nitrate loss increased as the applications were shifted further into the corn growing season, indicating that

Table 5. Percentage differences between the scenario baseline (scenario 3) and the average annual (1986-2004) streamflows or pollutant losses for scenarios 4a through 4h

Scenario	Streamflow (mm)	Sediment (Tons)	Nitrate (Tons)	Organic N (Tons)	Mineral P (Tons)	Organic P (Tons)
3	227	1,040,455	17,242	2,879	435	421
4a	-0.1	-0.1	-2.1	0.1	0.1	-0.1
4b	-0.2	-0.2	-3.1	0.0	0.1	-0.2
4c	-0.3	-0.5	-5.5	0.0	0.1	-0.4
4d	-0.5	-0.8	-8.0	-0.2	0.1	-0.7
4e	0.0	0.0	-1.3	0.1	0.0	0.0
4f	-0.2	-0.2	-3.2	0.0	0.1	-0.2
4g	-0.5	-0.7	-7.5	-0.1	0.1	-0.6
4h	-0.8	-1.2	-12.3	-0.3	0.1	-1.1

applied nitrogen was more efficiently used by the corn plants and less was available for being lost to the stream system. The largest decrease of slightly over 12% occurred when 100% of the anhydrous ammonia was applied four weeks after planting. The average corn yields predicted for these scenarios were slightly higher than those predicted for scenario 3, which was a further confirmation that the applied nitrogen was utilized better by the corn plants. This in turn resulted in small decreases in streamflow (runoff), sediment loss, and organic N and P losses.

Example percentage changes that occurred between scenario 4h and the scenario baseline (scenario 3) by RRW subwatershed are shown for streamflow, sediment, phosphorus, and nitrate yields in Figures 11-14. Small percentage decreases were predicted for streamflow (Figure 11), sediment (Figure 12), and phosphorus (Figure 13), which again resulted from the increased corn biomass. The spatial changes for nitrate (Figure 14) were much more dramatic and decreased by as much as 35% relative to the scenario baseline (scenario 3). In general, the greatest reductions occurred for the row-cropped tile-drained areas of the North Raccoon, especially in areas that had lower densities of swine operations and thus less manure applied to cropland (Figure 2).

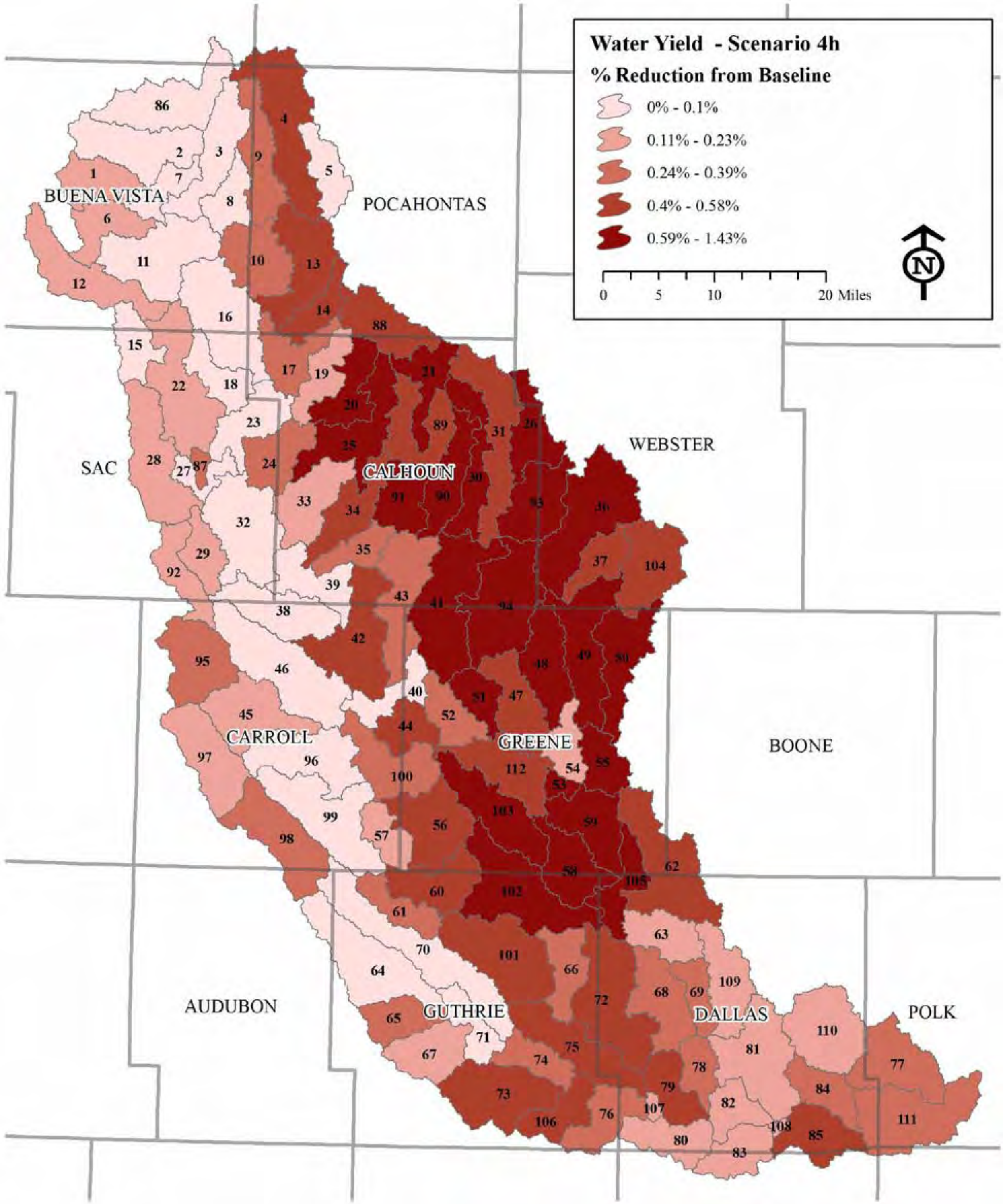

Figure 11. Percentage changes in the simulated distribution of water yields by subwatershed for scenario 4h, as compared to the scenario baseline (scenario 3).

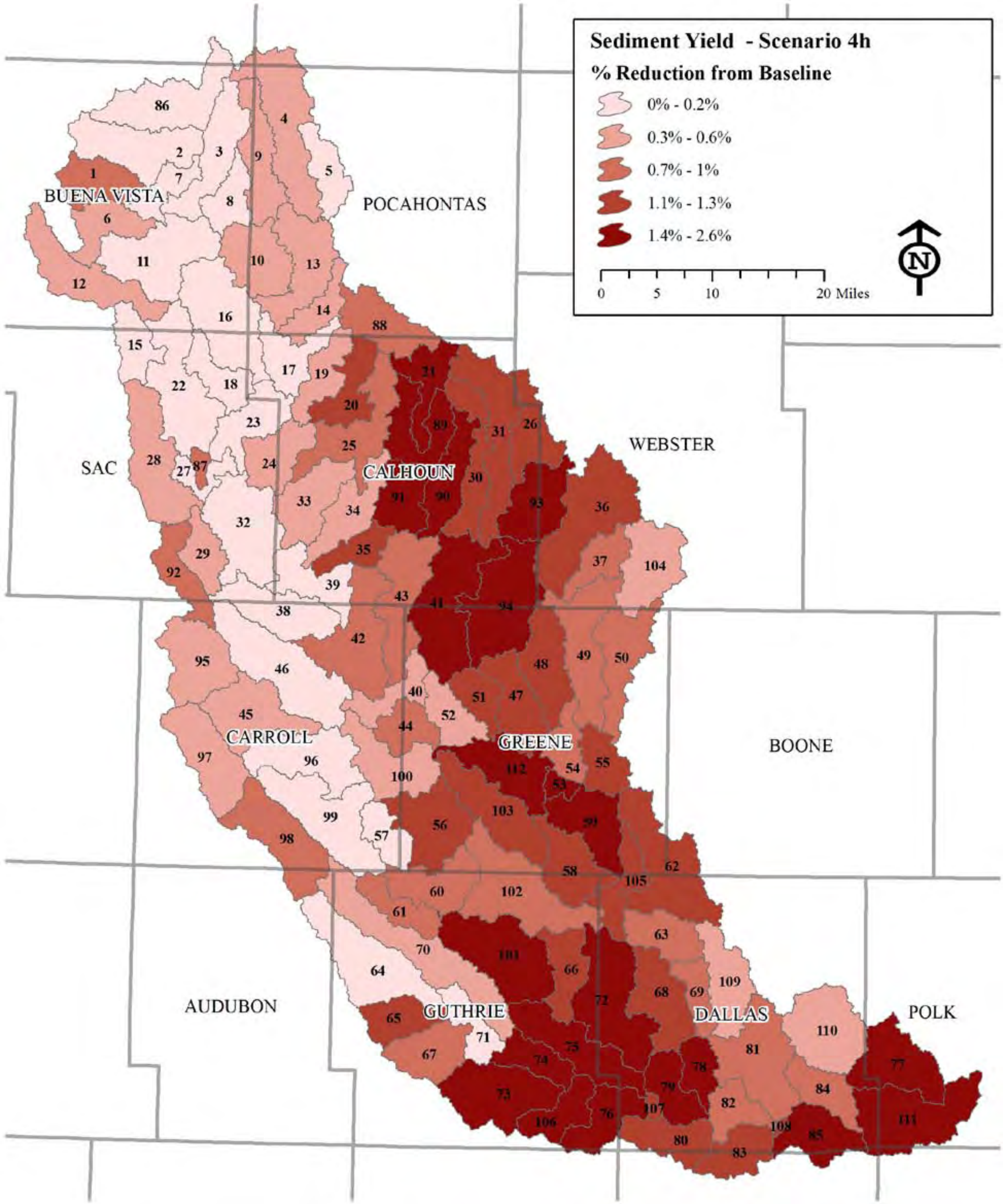

Figure 12. Percentage changes in the simulated distribution of sediment losses by subwatershed for scenario 4h, as compared to the scenario baseline (scenario 3).

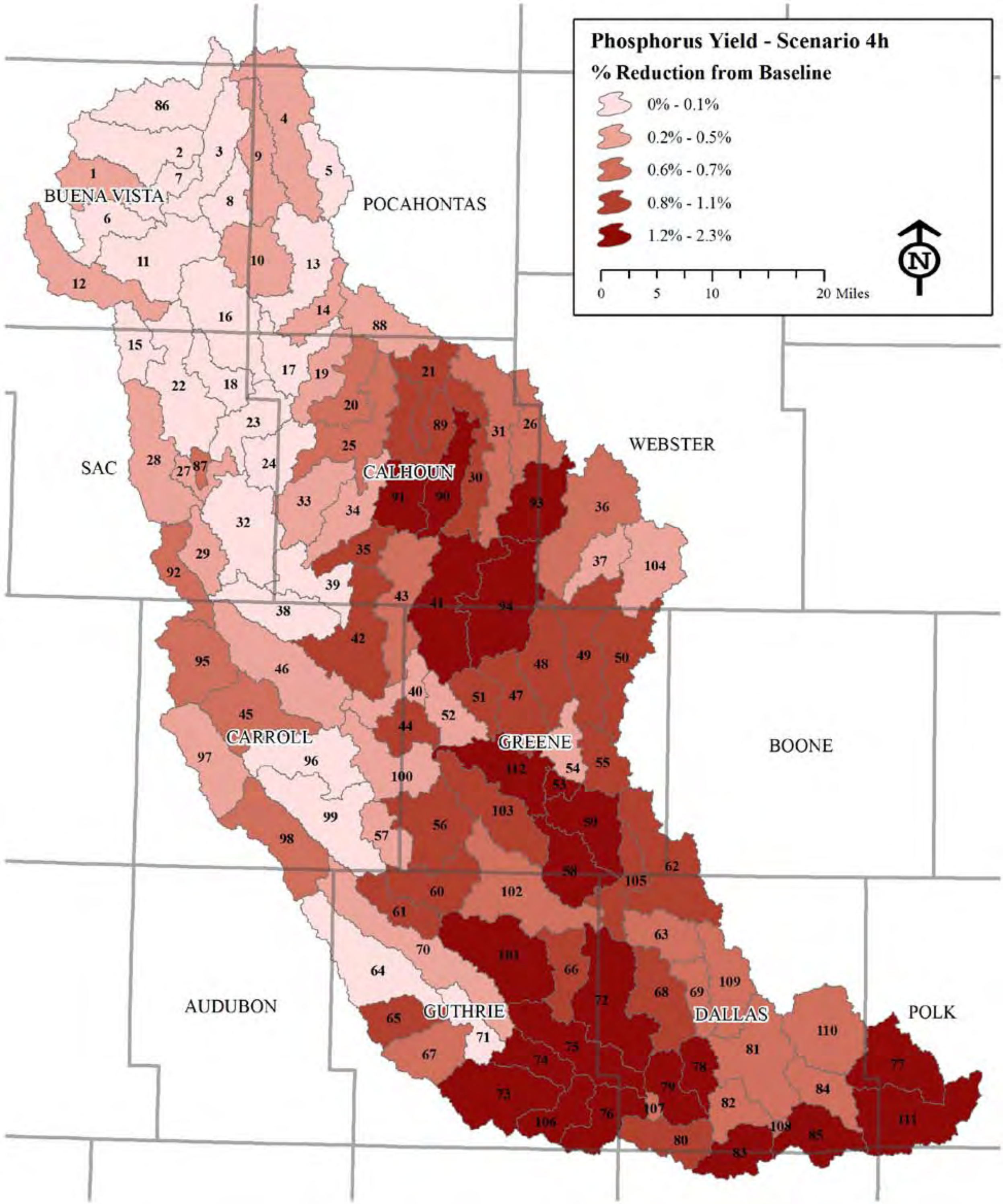

Figure 13. Percentage changes in the simulated distribution of phosphorus losses by subwatershed for scenario 4h, as compared to the scenario baseline (scenario 3).

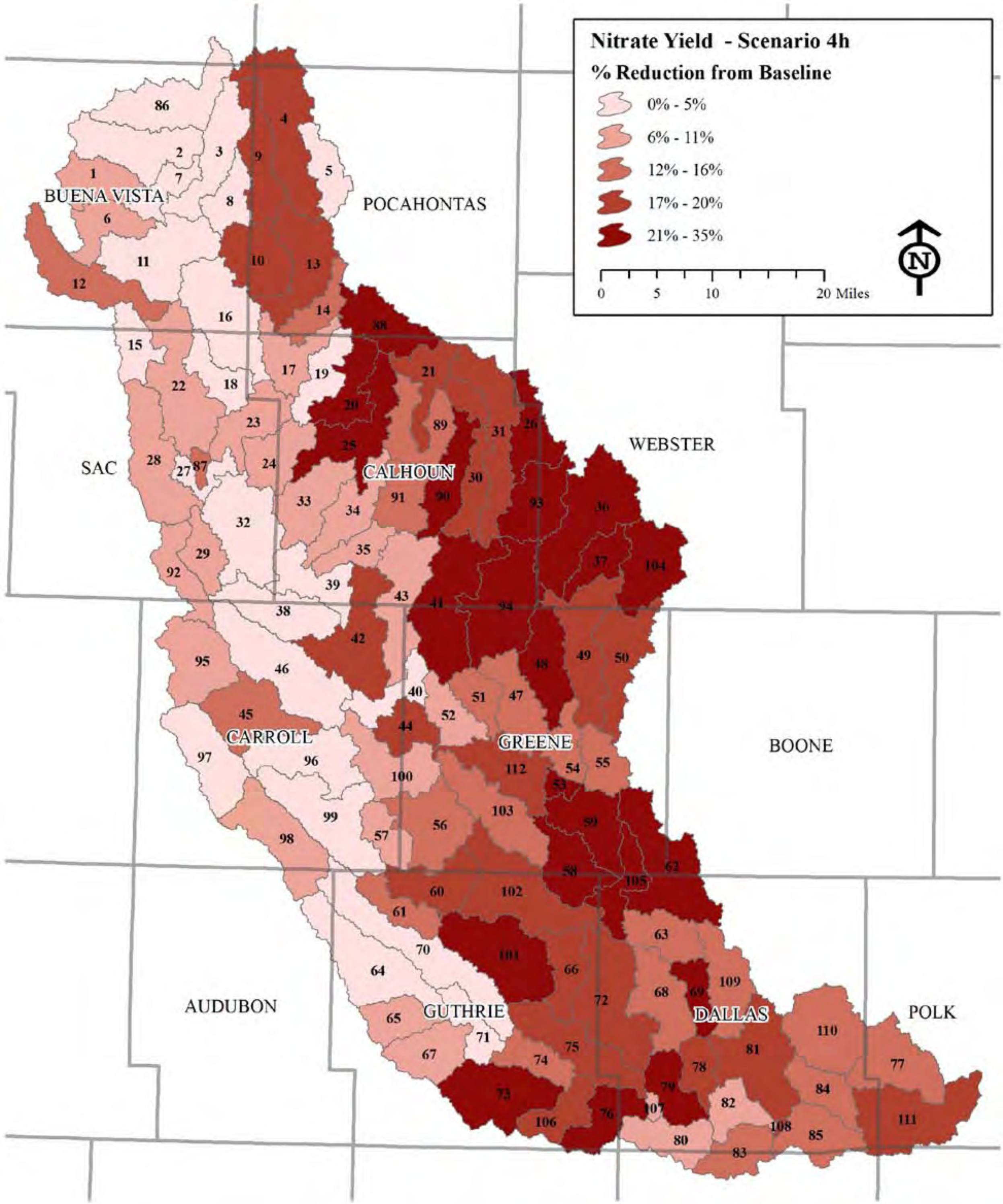

Figure 14. Percentage changes in the simulated distribution of nitrate losses by subwatershed for scenario 4h, as compared to the scenario baseline (scenario 3).

Impacts of Scenarios 5a-5d and 6a-6d

Scenarios 5a through 5d and 6a through 6d were designed to depict the impacts of major shifts in cropping systems across the RRW (Table 1). In scenarios 5a through 5d, the standard RRW corn-soybean cropping systems were progressively converted to a six-year rotation of corn-soybean-corn-alfalfa-alfalfa-alfalfa (CSCAAA), starting with a 25% conversion of the overall RRW cropland in scenario 5a and ending with a 100% conversion in scenario 5d (Table 1). The selection of which cropland HRUs to be converted to the CSCAAA rotation was based on a percent slope targeting scheme that targeted the highest cropland slopes first and then targeted progressively lower slopes, ultimately resulting in all landscapes being converted to the CSCAAA rotation in scenario 5d. Similarly, insertion of the rye cereal cover crop between all simulated sequences of corn and soybean in the RRW was performed in a similar targeted approach, with conversion of the first 25% of cropland (scenario 6a) occurring for the highest sloped cropland and then progressively shifting to lower sloped cropland until a rye cover crop was inserted in 100% of the simulated cropland.

The results of these eight scenarios are compared with the scenario baseline (scenario 3) in Table 6. In general, the largest relative impacts were predicted for the CSCAAA scenarios, with the highest overall reductions estimated for the 100% conversion to CSCAAA (scenario 6d). Reductions in streamflow ranged from 5 to 27% across the eight scenarios, reflecting higher levels of predicted evapotranspiration in response to the increased levels of perennial or annual grass forage crops. Sediment loss reductions ranged from almost 10% to over 38%; the associated organic N and P losses being were even higher, exceeding over 56% and 57%, respectively for 100% conversion to CSCAAA. The impacts on nitrate losses were somewhat lower, reaching a maximum reduction of 31% for the 100% conversion to CSCAAA scenario

Table 6. Percentage differences between the scenario baseline (scenario 3) and the average annual (1986-2004) streamflows or pollutant losses for scenarios 5a to 5d and 6a to 6d

Scenario	Streamflow (mm)	Sediment (Tons)	Nitrate (Tons)	Organic N (Tons)	Mineral P (Tons)	Organic P (Tons)
3	227	1,040,455	17,242	2,879	435	421
5a	-7.0	-13.3	-9.1	-34.2	-14.7	-37.1
5b	-13.2	-22.1	-17.4	-45.1	-20.9	-47.6
5c	-19.7	-30.7	-22.9	-50.2	-26.2	-53.1
5d	-26.2	-38.4	-31.1	-54.6	-31.3	-57.4
6a	-5.0	-9.7	-2.1	-25.2	-2.4	-27.6
6b	-9.1	-15.5	-6.3	-34.3	-4.1	-36.2
6c	-13.5	-21.3	-8.9	-39.5	-5.9	-41.4
6d	-17.8	-26.5	-13.3	-43.6	-7.5	-45.2

and slightly over 13% for 100% adoption of cover crops (scenario 6d). The corresponding predicted percentage decrease for scenario 6d relative to the calibrated baseline was a little over 22% (Table B-2). While encouraging, it also appears from inspection of the SWAT scenarios that the model is underpredicting the rye cover crop biomass. Time and resource constraints prevented the opportunity to correct this problem for this assessment. However, future SWAT RRW applications should include improved simulation of winter cover crops.

Impacts of Scenarios 7a-7c

Scenarios 7a through 7c incorporate various combinations of the adaptive nutrient management and alternative cropping systems (Table 2). The adaptive nutrient management in these three scenarios was represented by shifting all of the anhydrous applications to four weeks after planting (scenario 4h). Conversions of 25% were included in scenario 7a, for conversion to both CSCAAA and cover crops. The percent slope targeting was applied first to the 25% conversion to CSCAAA followed by the next highest 25% sloped cropland for the targeted adoption of over crops. Scenario 7b was an interface of scenarios 4h and 5d, with 100% conversion of cropland to the CSCAAA rotation. Scenario 7c was a variant of scenario 7b, in which adoption of cover crops was depicted for the two winter periods during the CSC sequence of the six-year rotation.

The results of these three scenarios are shown in Table 7, and again are compared versus the scenario baseline (scenario 3). The overall greatest impacts were predicted for these three scenarios, with pollutant reductions ranging from 27% to almost 67%. The nitrate reduction of 50% for scenario 7c meets the previously described TMDL goal of 48%. Both scenarios 7b and 7c meet this nitrate goal when compared against the calibrated baseline (Table B.2). These combination runs underscore the need to look at more complex scenarios that represent the cumulative impact of different management and cropping practices in the RRW, rather than focusing on just the impacts of single practices for all of the simulation scenarios.

Example spatial results by subwatershed are shown in Figures 15-18 for the percentage differences in the water, sediment, total phosphorus, and nitrate yields between scenarios 7c and 3 (scenario baseline). Substantial percentage decreases were predicted for all four indicators but with some variation in the distribution of the greatest impacts. Most of the largest percentage

Table 7. Percentage differences between the scenario baseline (scenario 3) and the average annual (1986-2004) streamflows or pollutant losses for scenarios 7a to 7c

Scenario	Streamflow (mm)	Sediment (Tons)	Nitrate (Tons)	Organic N (Tons)	Mineral P (Tons)	Organic P (Tons)
3	227	1,040,455	17,242	2,879	435	421
7a	-19.2	-30.0	-27.0	-56.6	-32.9	-60.1
7b	-26.5	-38.7	-43.1	-54.5	-31.2	-57.5
7c	-29.0	-42.2	-50.1	-64.5	-34.4	-66.6

decreases were estimated to occur in subwatersheds concentrated in the northeastern portion of the North Raccoon subregion, which as noted above is a heavily row-cropped and tile-drained region. However, some larger percentage decreases were predicted to occur in a subset of South Raccoon subwatersheds for the sediment and phosphorus losses. In contrast, higher percentage decreases for the water and nitrate yields extended more into the central RRW (mainly in the North Raccoon subregion). The pattern of nitrate decreases predicted for scenario 7c were generally similar to those predicted for scenario 4h (Figure 14), although distinct differences can be seen such as a much greater relative impact in the far northern subwatersheds for scenario 7c. High percentage decreases clearly do not translate to high decreases in the magnitude of a given pollutant; e.g., the estimated magnitudes of sediment yield decreases for subwatersheds 64 and 65 are roughly 5 times greater than the magnitude of soil loss decrease predicted for subwatershed 3 and 5.

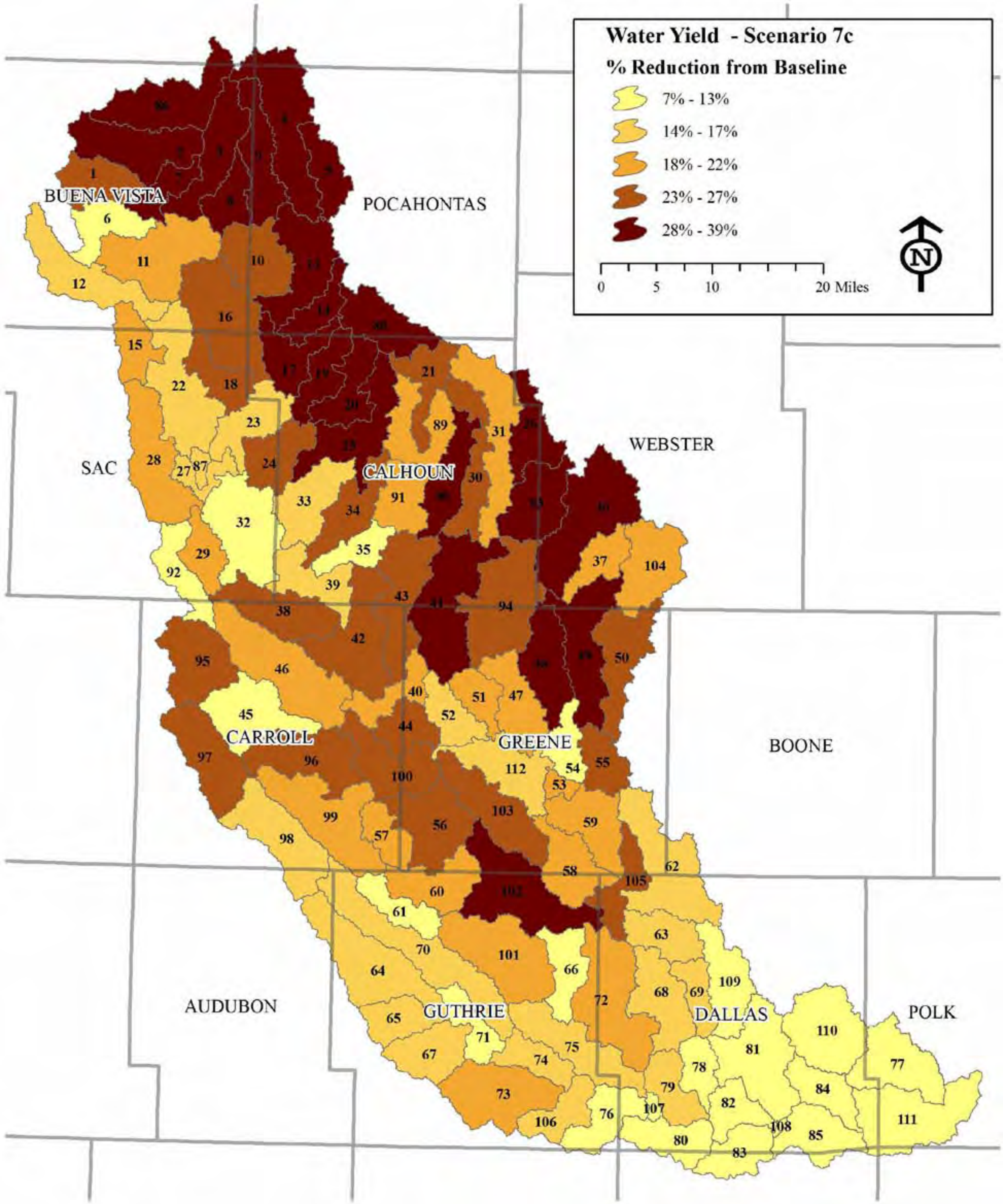

Figure 15. Percentage changes in the simulated distribution of water yields by subwatershed for scenario 7c, as compared to the scenario baseline (scenario 3).

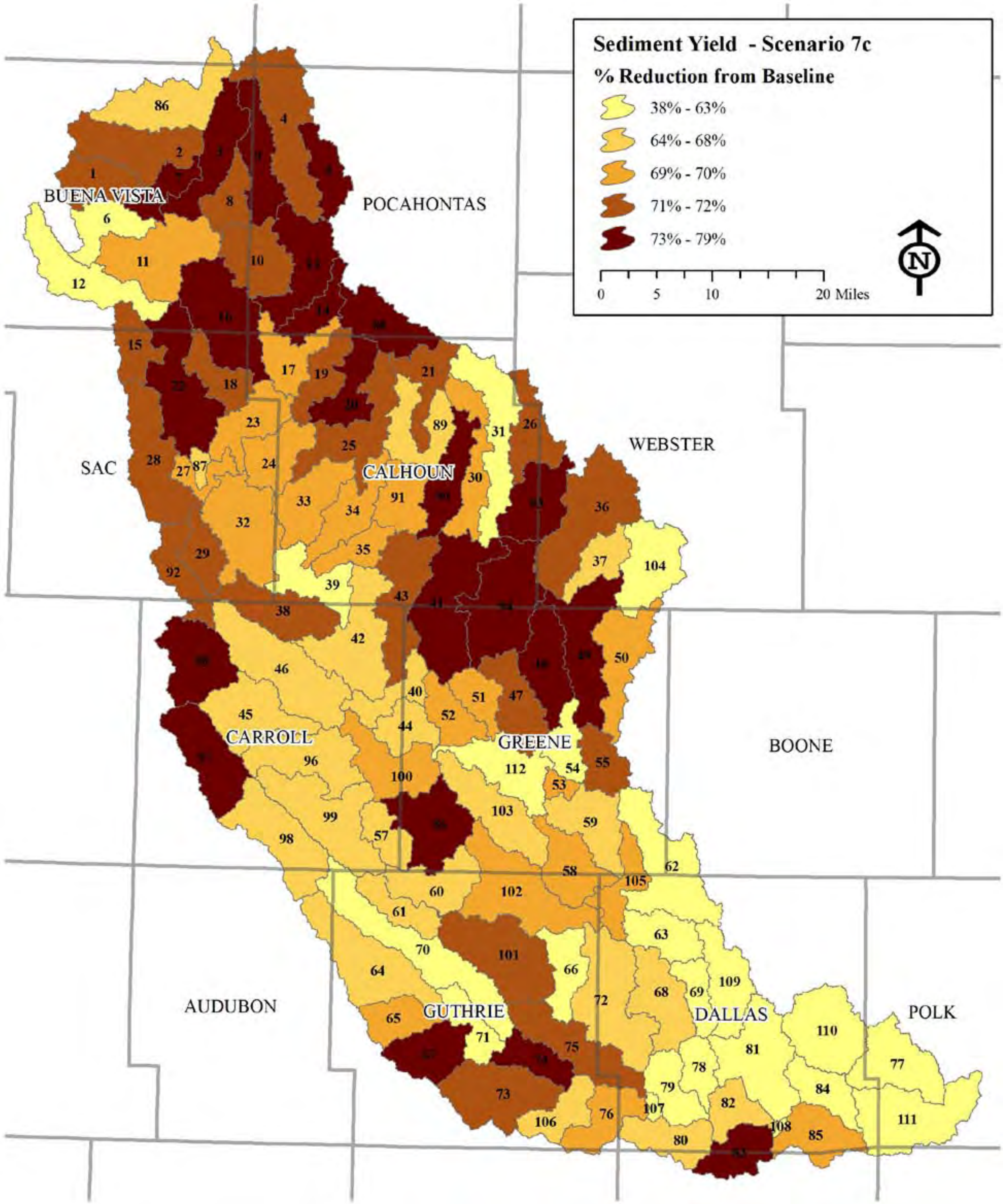

Figure 16. Percentage changes in the simulated distribution of sediment yields by subwatershed for scenario 7c, as compared to the scenario baseline (scenario 3).

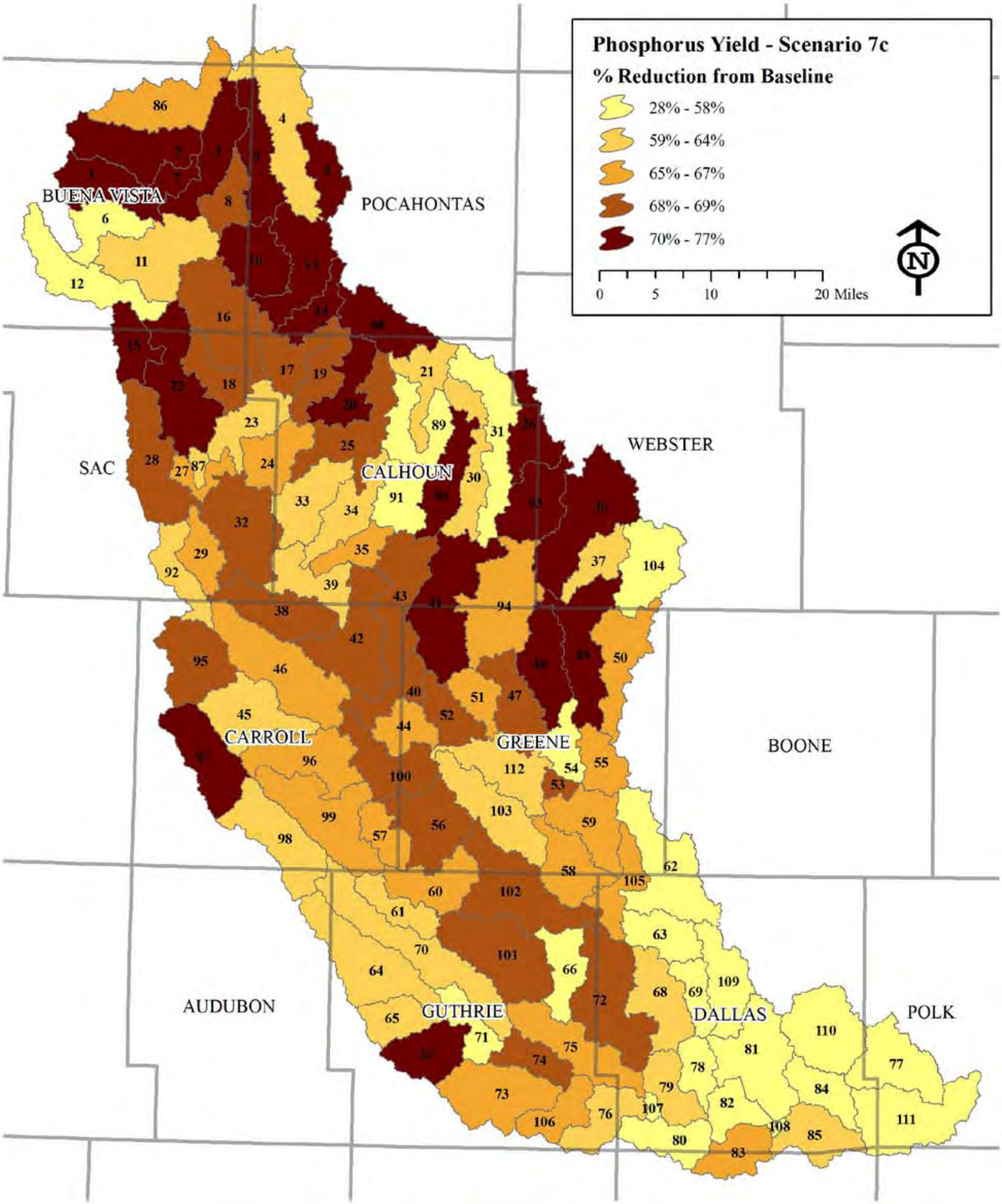

Figure 17. Percentage changes in the simulated distribution of phosphorus yields by subwatershed for scenario 7c, as compared to the scenario baseline (scenario 3).

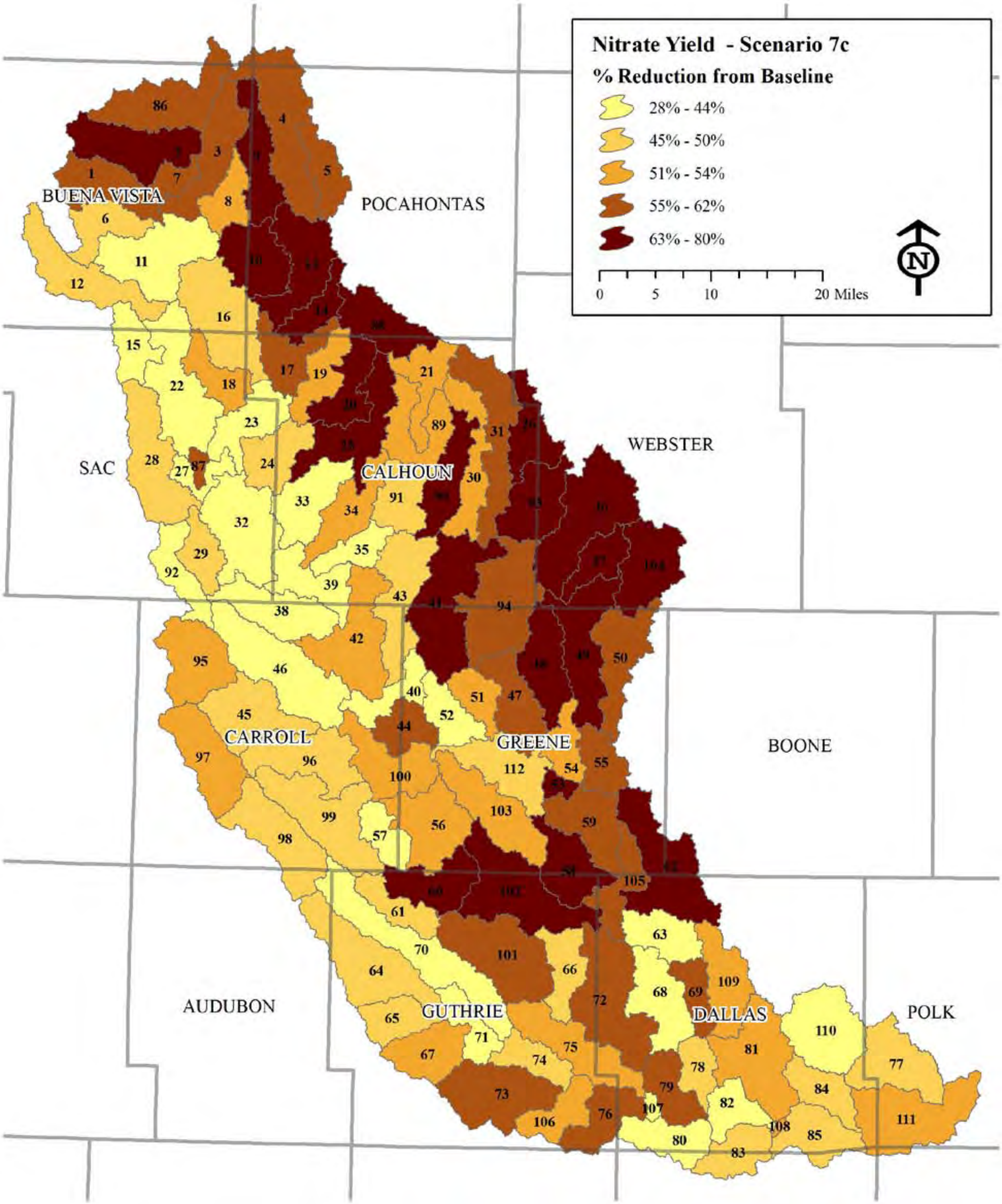

Figure 18. Percentage changes in the simulated distribution of nitrate yields by subwatershed for scenario 7c, as compared to the scenario baseline (scenario 3).

Conclusions and Recommendations

The SWAT modeling system adapted from the previous RRW TMDL assessment proved generally robust for capturing many of the scenarios for the RRW Master Plan simulation study. The modeling results demonstrated that a mix of nutrient management and alternative cropping systems were needed to obtain the most substantial reductions in pollutant loss. The results also show that meeting the TMDL goal of a 48% reduction in nitrate requires adopting relatively extreme shifts in nutrient management and cropping systems which are not realistic considering current agricultural sector commodity needs, market influences, and government incentives (and such shifts likely never will be realistic, even with radical changes in government incentive programs and other factors). This conclusion is consistent with the finding of Jha et al. (2010) who evaluated a different set of scenarios for the RRW with SWAT and also found that radical changes in management practices or cropping systems were needed to meet the TMDL goals. However, these results do provide insights into how environmental improvement can be realized for the RRW with modifications in current production approaches and also generally underscore the findings of the expert panel that targeted mixes of practices will be needed to meet RRW environmental goals , with variation in those mixes depending on the specific cropland landscape conditions and other factors.

One key weakness of the current modeling system was the absence of accounting for key "trapping practices" such as constructed wetlands and filter strips. But new or planned improvements in the SWAT code will provide for the potential to simulate such practices in a realistic manner for the RRW, if additional SWAT simulation scenarios are performed for the watershed in the future.

Some recommendations for potential future SWAT RRW modeling include:

1) Use the latest release of the SWAT model which is currently SWAT version 2009 (SWAT2009). The SWAT application for the RRW Master Plan simulations was constrained to SWAT2005 due to the need to use the existing TMDL modeling framework for the Master Plan assessment.

2) Adopting SWAT2009 for the RRW simulations would already allow the option of performing filter strip simulations using a more realistic methodology, based on the work by White and Arnold (2009) that has been incorporated into the SWAT2009 code. Other enhancements have or are being built into SWAT2009 that would further support better methods for simulating selected best management practices (BMPs).

3) Work has been initiated to develop improved wetland hydrology and nutrient cycling algorithms into SWAT (Ikenberry et al., 2011). When completed, this improved module should also be used for future RRW simulations, which will provide the ability to simulate constructed wetlands in a more accurate manner than is currently possible with the model (which is why wetlands were not included in the current simulation set).

4) Determine the most accurate overall nitrogen and phosphorus mass balances possible for the RRW. This is a key step in determining the total amount of nutrient inputs from fertilizer, manure, wastewater facilities, and other sources. Considerable debate occurred during the course of this modeling study among members of the expert panel regarding the use of fertilizer in different situations, such as use of fertilizer on manure cropland, underscoring the need for obtaining as much actual data as possible regarding nutrient inputs and usage.

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Appendix A. SWAT Model Calibration and Validation Results

Both statistical and graphical comparisons were used to evaluate the calibrated model results versus measured data. The statistical evaluation was performed using the coefficient of determination (r^2) and the Nash-Sutcliffe coefficient (E_{NS}), which are described by Krause et al. (2005) and are the most common statistics used to evaluate SWAT simulations (Gassman et al., 2007; Douglas-Mankin et al., 2009). The R^2 measures how well the simulated versus observed regression line approaches an ideal match and ranges from 0 to 1, with a value of 0 indicating no correlation and a value of 1 representing that the predicted dispersion equals the measured dispersion. The regression slope and intercept also equal 1 and 0, respectively, for a perfect fit. The E_{NS} values can range from $-\infty$ to 1 and indicate how accurately simulated values fit corresponding measured data on a 1:1 line. An E_{NS} value of 1 indicates a perfect fit between the model and the measured data values. If the E_{NS} values equal one, the model predictions are considered perfect. However, the mean of the measured data would be considered to be a better predictor than the model output when an E_{NS} value is equal to or less than zero.

Moriasi et al. (2007) present criteria for several different statistics for judging hydrologic and water quality model results including N_{SE} values, based on a review of previous modeling studies and associated statistical results. They propose that E_{NS} values ≥ 0.5 are satisfactory for monthly comparisons between water quality output and corresponding measured data, with somewhat more stringent criteria used to judge annual comparisons and more relaxed criteria used for assessing daily comparisons. The same criteria were assumed for the r^2 statistics for the RRW baseline, based on a similar extrapolation reported by Gassman et al. (2007).

The majority of statistics reported in Table A.1 do meet these criteria. However, some of the statistics were obviously much weaker, especially some of the r^2 and E_{NS} values calculated

Table A-1. Calibration and/or validation for SWAT streamflow and nutrient predictions near the watershed outlet of the Raccoon River watershed

Indicator	Calibration or validation	Time Period	Annual		Monthly	
			r^2	E	r^2	E
Streamflow	Calibration	1986-1995	0.97	0.97	0.84	0.84
	Validation	1996-2004	0.74	0.68	0.86	0.83
Sediment	Calibration	1986-1995	0.90	0.89	0.79	0.78
	Validation	1996-2004	0.45	0.44	0.57	0.56
Nitrate (NO_3)	Calibration	1986-1995	0.72	0.35	0.58	0.26
	Validation	1996-2004	0.80	0.64	0.76	0.53
Organic N	Calibration	2001-2004	0.47	0.15	0.62	0.56
Mineral P	Calibration	2001-2004	0.60	0.13	0.63	0.55
Organic P	Calibration	2001-2004	0.28	0.17	0.60	0.57
Total P	Calibration	2001-2004	0.90	0.73	0.85	0.82

for the comparisons between the SWAT-predicted annual indicators of organic N, mineral P, and organic P versus corresponding measured values. However, these weaker statistics were influenced by the limited number of data points available for comparison; i.e., only four years as shown in Figures A-7, A-9, and A-11). The annual average levels of these indicators were also generally accurate and the statistical and graphical results for each indicator also indicate that the simulated values captured much of the measured trends and variability. In addition, the annual and monthly estimates tracked the measured levels very well (Table A-1; Figures A-13 and A-14).

The predicted annual nitrate levels were also relatively weak, as reflected by the E_{NS} values shown in Table A-1. The measured nitrate loads were underpredicted in several years and also on an average annual basis (Figures A-5 and A-6), although the model did track the monthly trends well (Table A-1 and Figure A-5). The underpredictions were probably partially a result of the lower overall nitrate inputs simulated for the Master Plan simulations as compared to the previous TMDL assessment, again pointing to the need to determine the most accurate nutrient balance possible for the RRW (as noted in the Conclusions and Recommendations section).

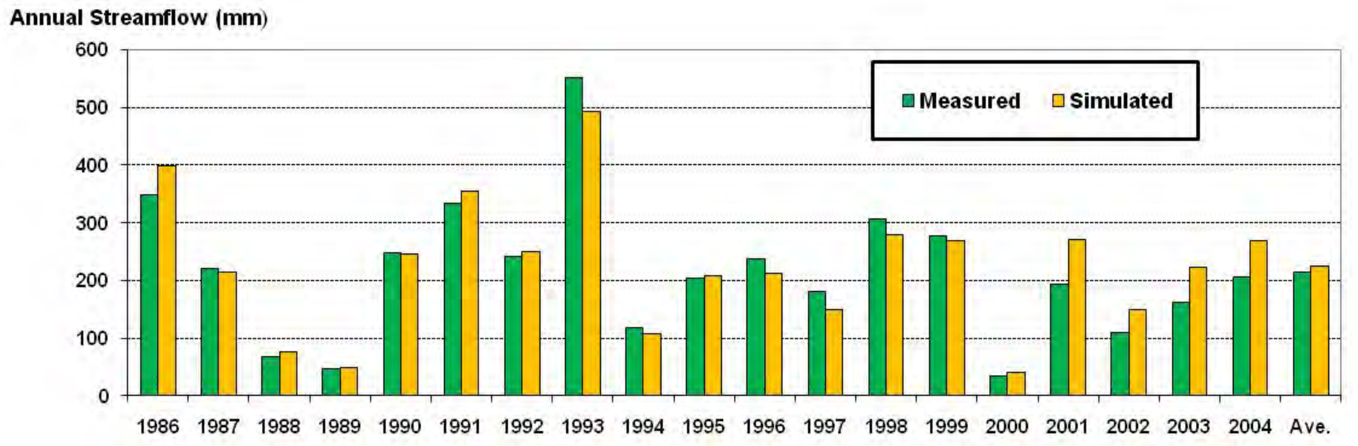


Figure A.1. Comparisons of annual simulated and measured RRW streamflows at Van Meter (Figure 1).

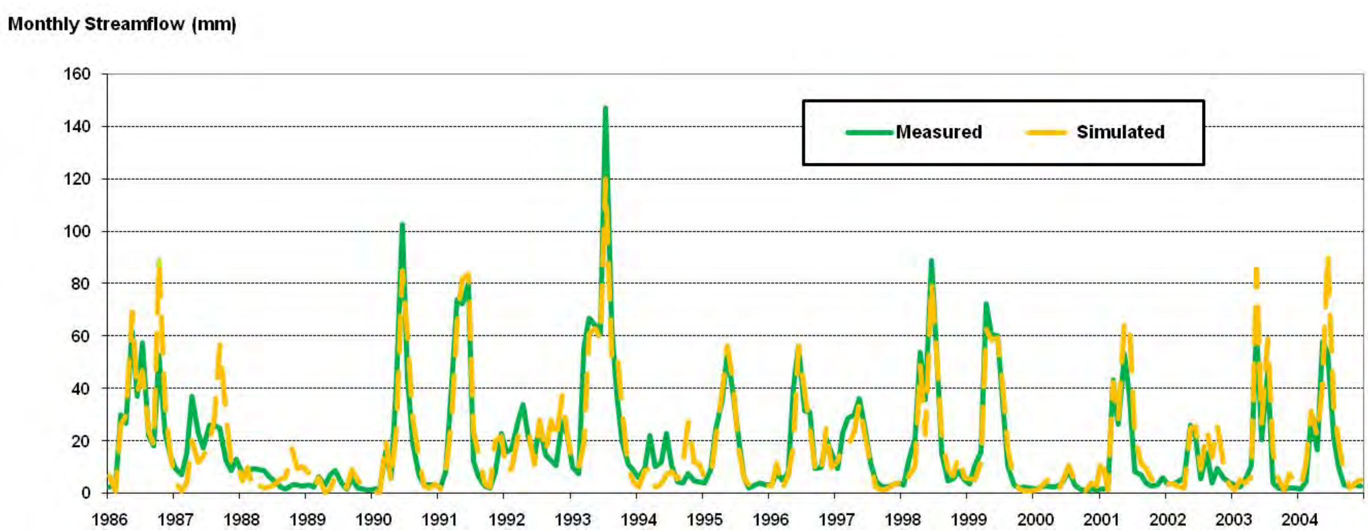


Figure A.2. Comparisons of monthly simulated and measured RRW streamflows at Van Meter (Figure 1).

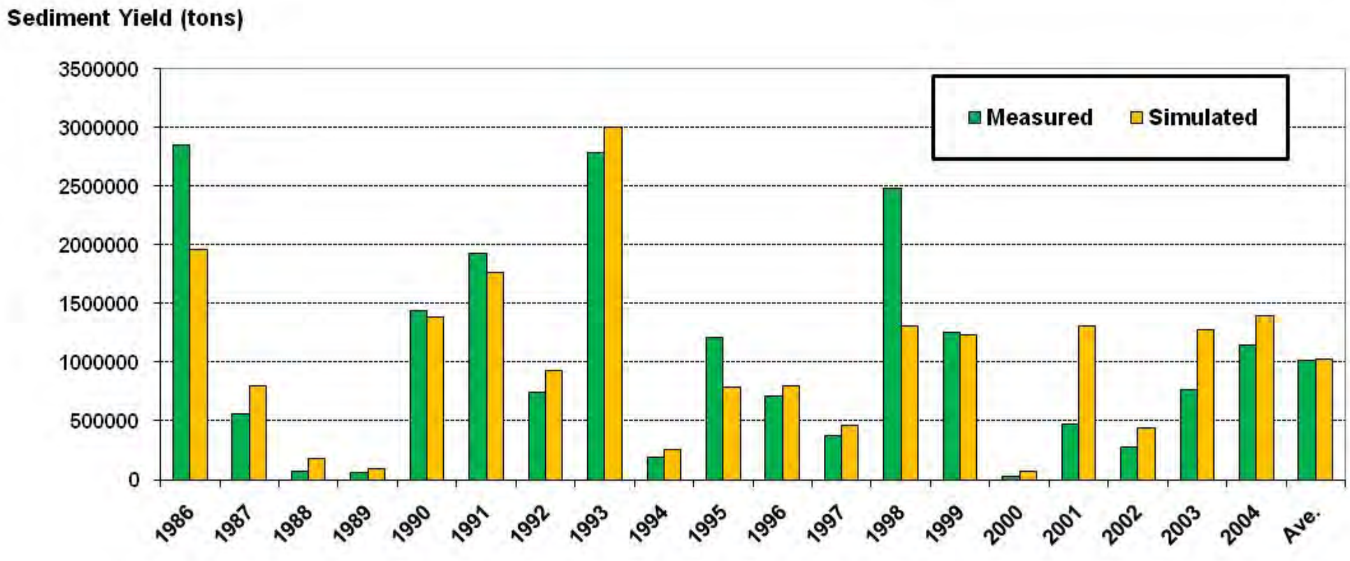


Figure A.3. Comparisons of annual simulated and measured RRW sediment loads at Van Meter (Figure 1).

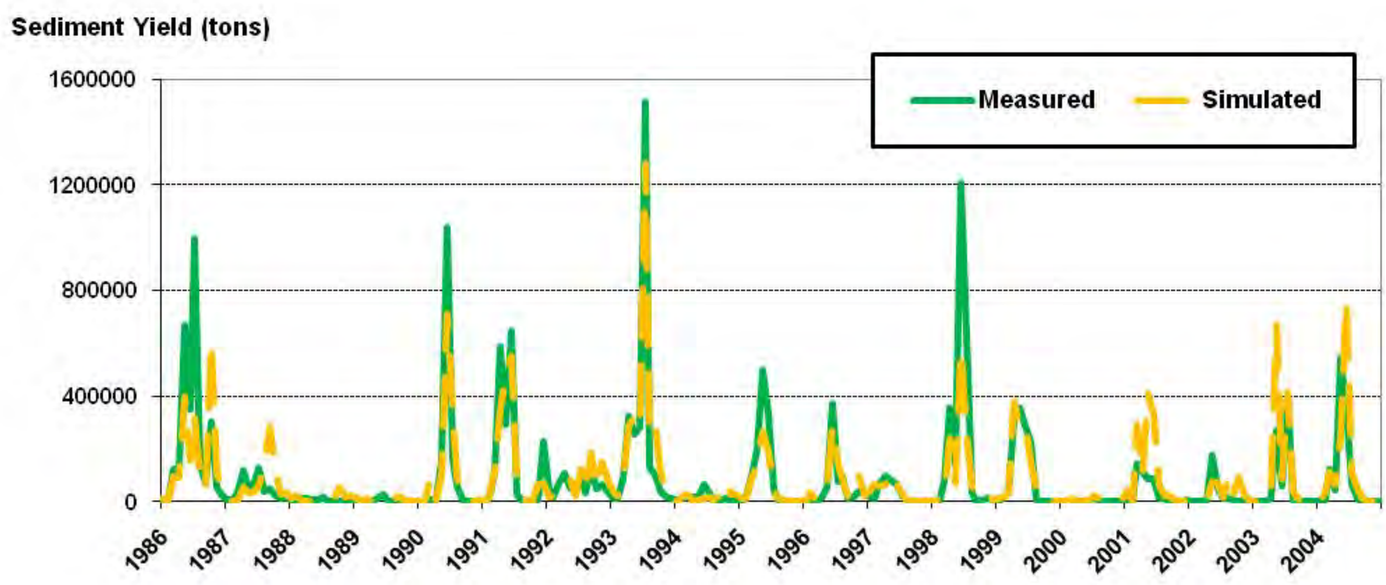


Figure A.4. Comparisons of monthly simulated and measured RRW sediment loads at Van Meter (Figure 1).

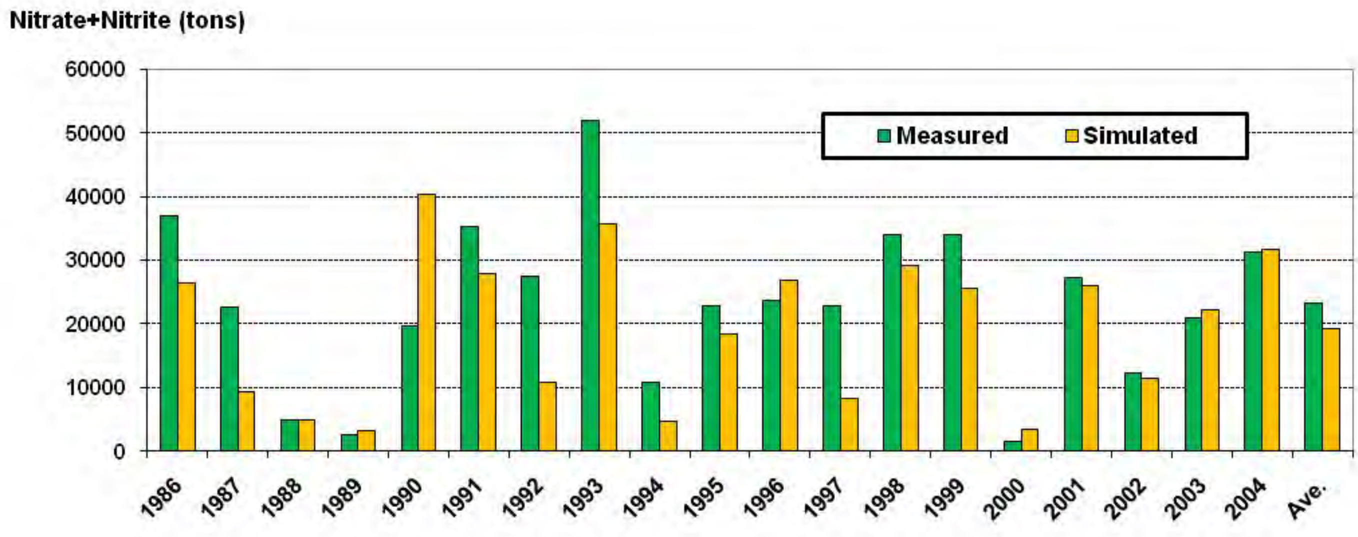


Figure A.5. Comparisons of annual simulated and measured RRW nitrate loads at Van Meter (Figure 1).

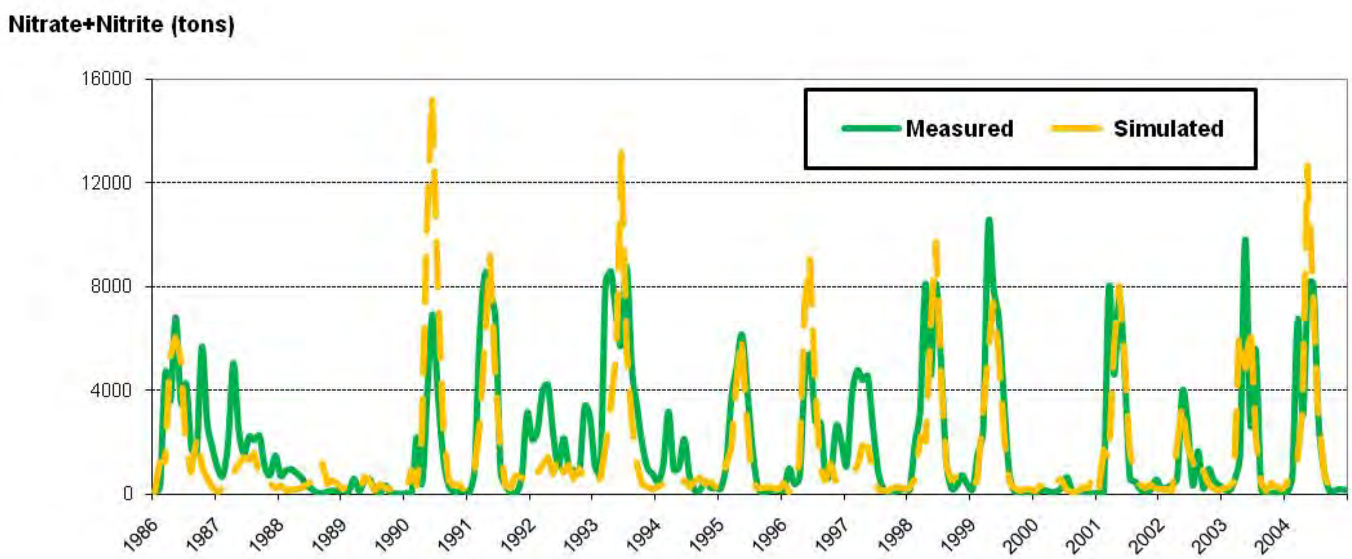


Figure A.6. Comparisons of monthly simulated and measured RRW nitrate loads at Van Meter (Figure 1).

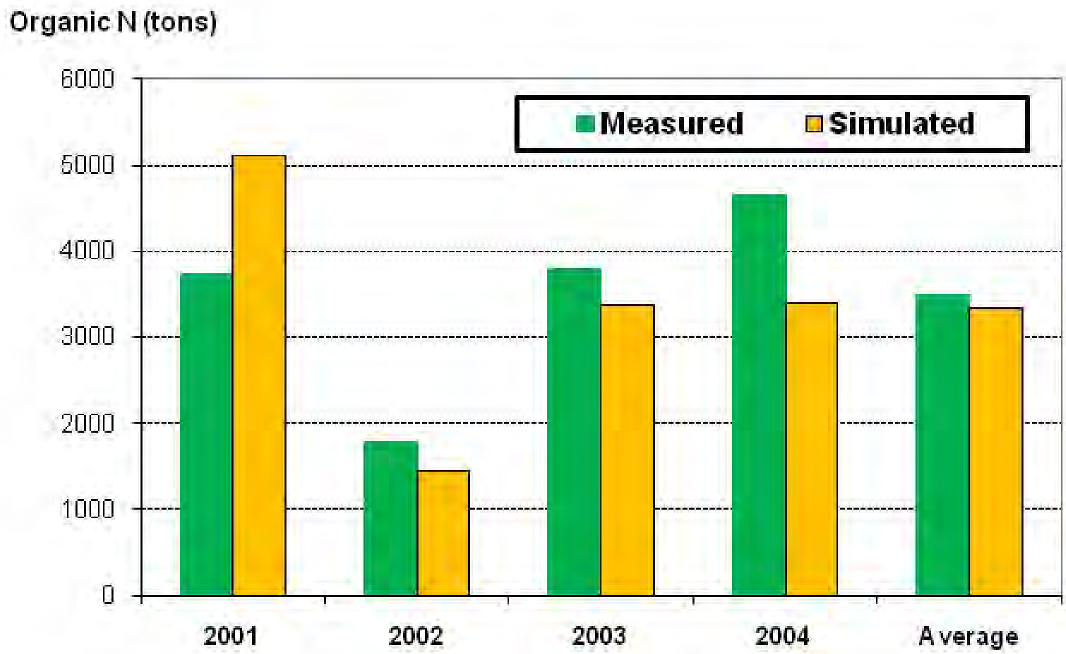


Figure A.7. Comparisons of annual simulated and measured RRW organic nitrogen (N) loads at Van Meter (Figure 1).

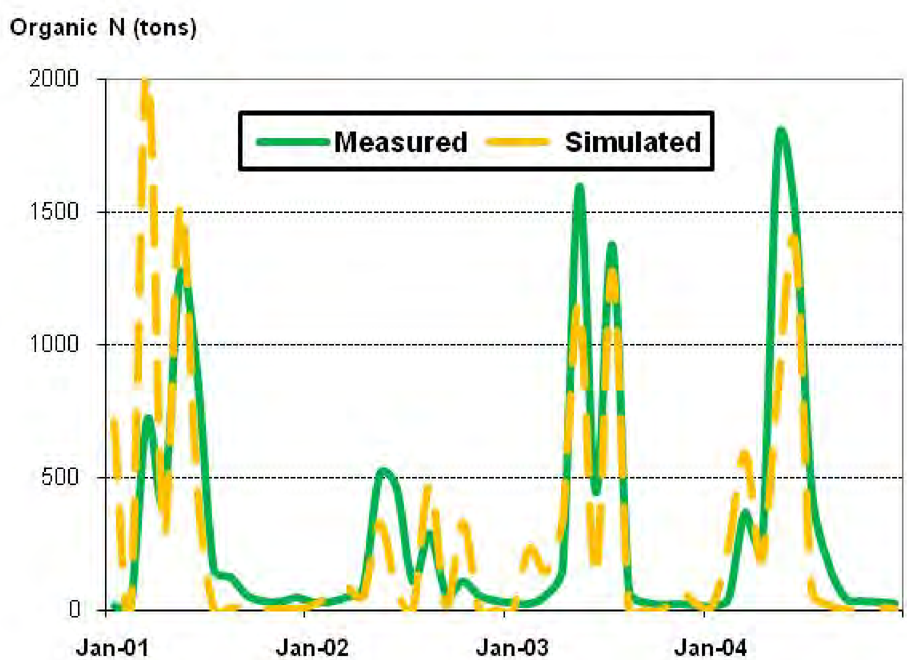


Figure A.8. Comparisons of monthly simulated and measured RRW organic nitrogen (N) loads at Van Meter (Figure 1).

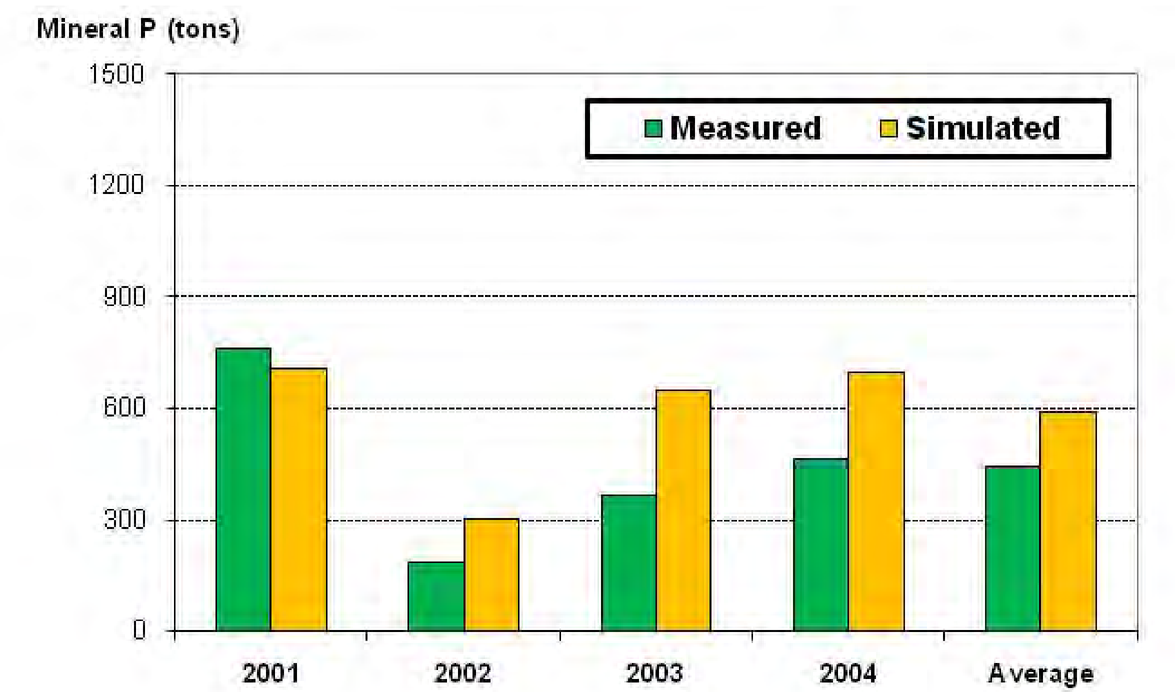


Figure A.9. Comparisons of annual simulated and measured RRW mineral phosphorus (P) loads at Van Meter (Figure 1).

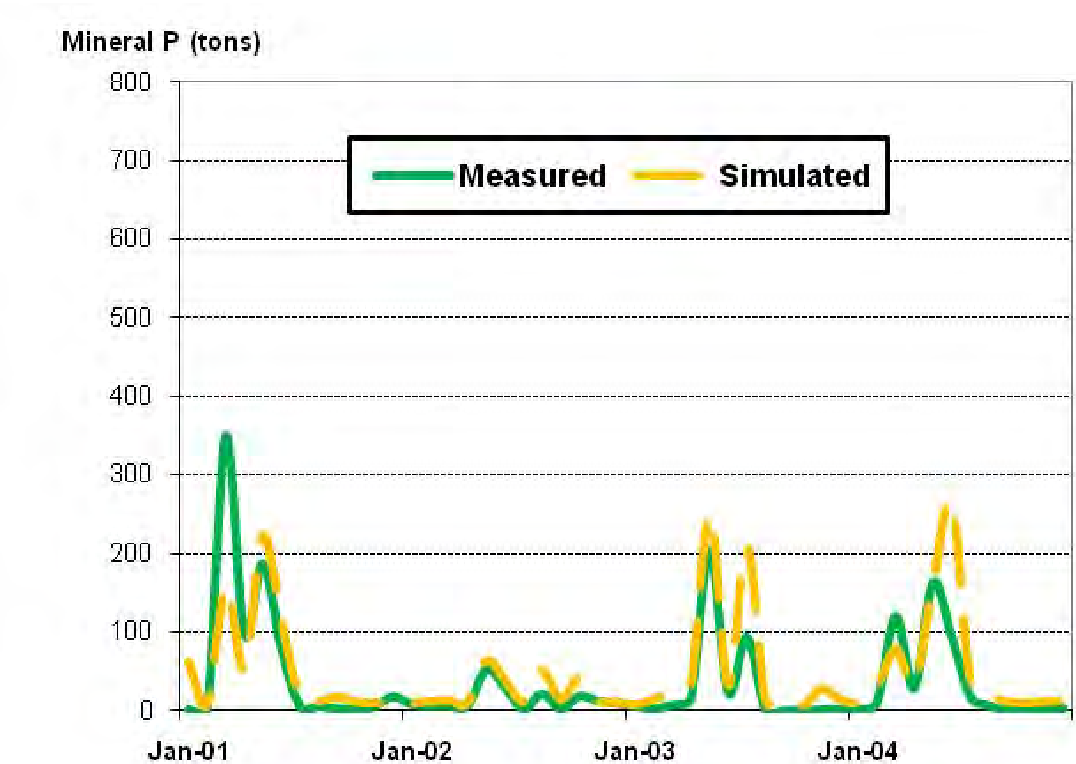


Figure A.10. Comparisons of monthly simulated and measured RRW mineral phosphorus (P) loads at Van Meter (Figure 1).

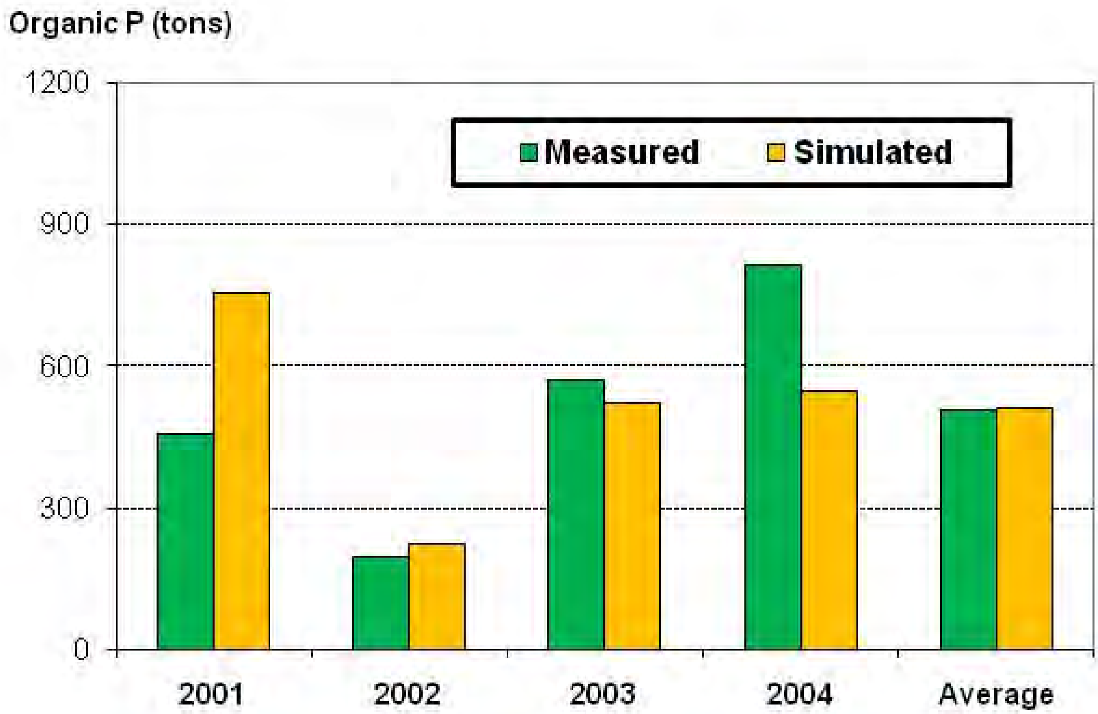


Figure A.11. Comparisons of annual simulated and measured RRW total phosphorus (P) loads at Van Meter (Figure 1).

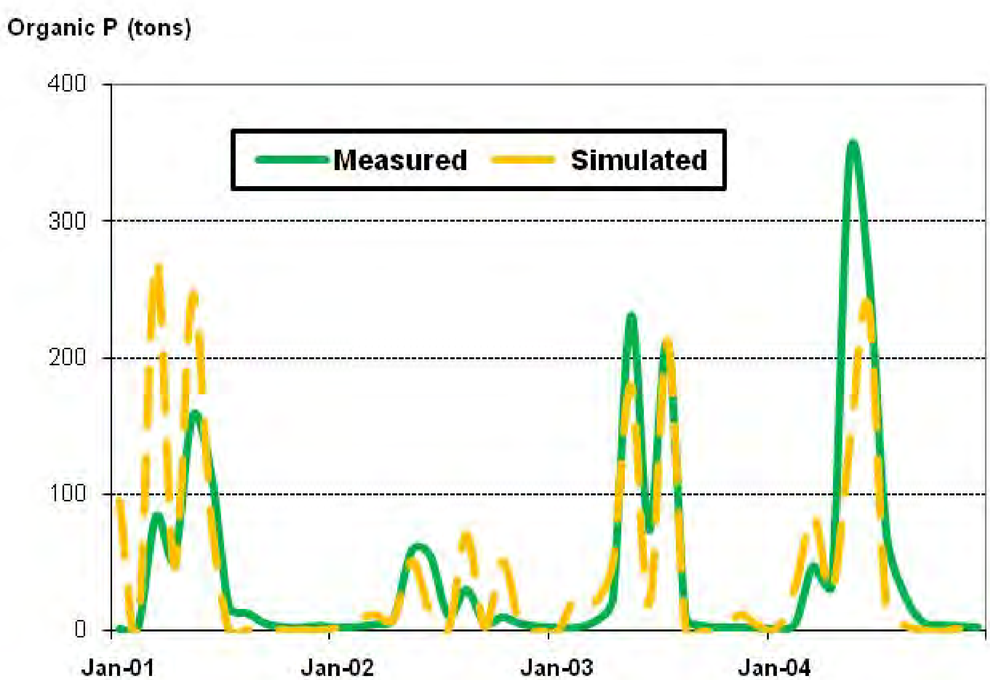


Figure A.12. Comparisons of monthly simulated and measured RRW organic phosphorus (P) loads at Van Meter (Figure 1).

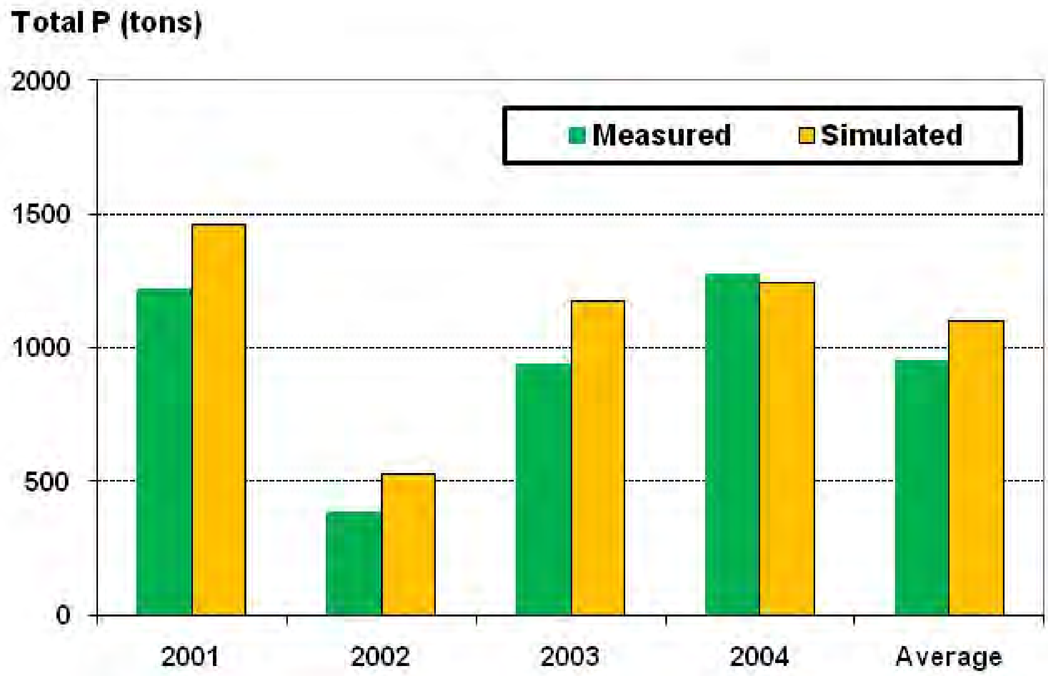


Figure A.13. Comparisons of annual simulated and measured RRW total phosphorus (P) loads at Van Meter (Figure 1).

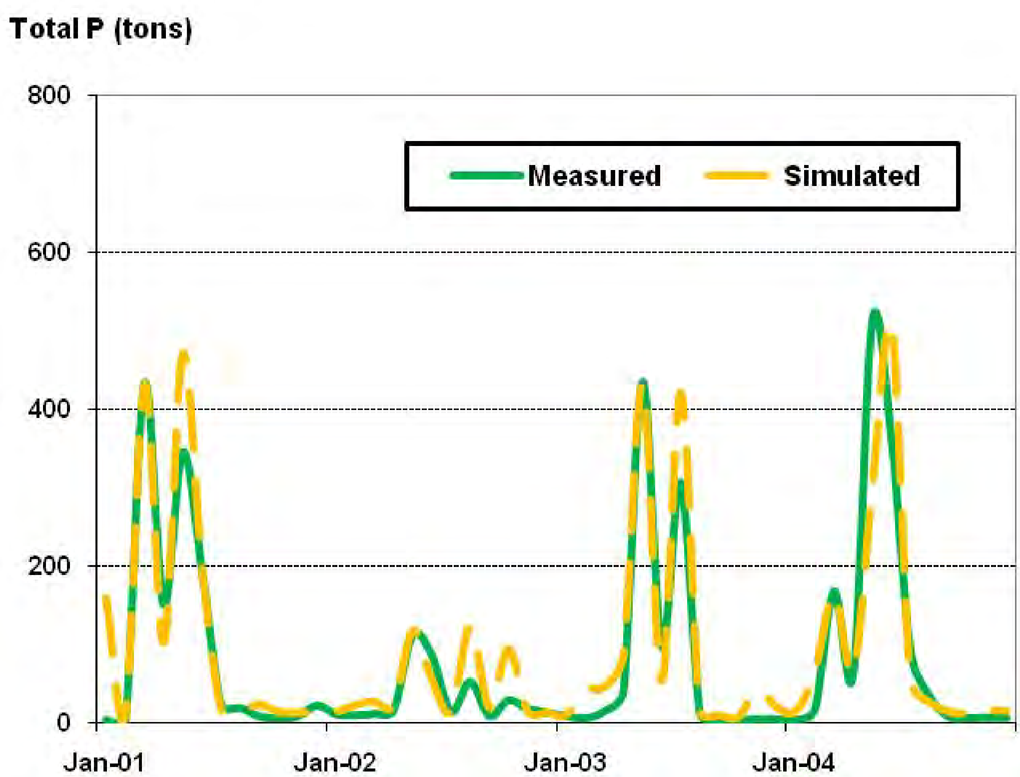


Figure A.14. Comparisons of annual simulated and measured RRW total phosphorus (P) loads at Van Meter (Figure 1).

Appendix B. Summary of Results for All Scenarios

Table B.1. Comparisons of average annual streamflows or pollutant loads across all scenarios (for 1986-2004)

Scenario	Streamflow (mm)	Sediment (Tons)	Nitrate (Tons)	Organic N (Tons)	Mineral P (Tons)	Organic P (Tons)
1; Calibrated baseline	224	1,022,934	19,266	397	2,879	490
2; DAP (18-46-0) replaced with MAP (11-52-0)	224	1,022,181	18,749	397	2,879	506
3; no fertilizer on manured fields	227	1,040,455	17,242	397	2,879	435
All scenarios below include effects of scenarios 2 and 3						
Scenario 1 spring N applics. held constant on May 1 for scenarios 4a-4d						
4a; fall N applic. moved to 2 weeks before planting	227	1,039,084	16,885	398	2,881	435
4b; fall N applic. moved to day of planting	227	1,038,040	16,702	397	2,880	435
4c; fall N applic. moved to 2 weeks after planting	226	1,035,345	16,297	397	2,878	436
4d; fall N applic. moved to 4 weeks after planting	226	1,032,545	15,860	397	2,874	436
Scenario 1 spring N applics. also changed to same "new dates" for 4e-4h						
4e; fall N applic. moved to 2 weeks before planting	227	1,039,999	17,017	394	2,882	435
4f; fall N applic. moved to day of planting	227	1,037,898	16,684	397	2,880	435
4g; fall N applic. moved to 2 weeks after planting	226	1,033,332	15,945	397	2,876	436
4h; fall N applic. moved to 4 weeks after planting	225	1,027,909	15,121	397	2,870	436
5a; 25% conversion of cropland to CSCAAA	211	902,323	15,670	269	1,894	371
5b; 50% conversion of cropland to CSCAAA	197	809,995	14,244	224	1,581	344
5c; 75% conversion of cropland to CSCAAA	182	720,730	13,289	198	1,433	321
5d; 100% conversion of cropland to CSCAAA	168	640,566	11,876	176	1,306	299
6a; 25% conversion to rye cover crop	216	939786	16878	282	2155	425
6b; 50% conversion to rye cover crop	207	879347	16163	234	1890	417
6c; 75% conversion to rye cover crop	197	818632	15702	209	1741	410
6d; 100% conversion to rye cover crop	187	764529	14948	183	1625	403
7a; spring fert + 25% to CSCAAA + 25% to cover crops	183	728231	12587	157	1249	292
7b; spring fert (4 weeks after planting) + 100% to CSCAAA	167	638126	9803	179	1311	299
7c; spring fert (4 weeks after planting) + 100% CSCAAA & CC in C-S-C	161	600899	8598	127	1022	285

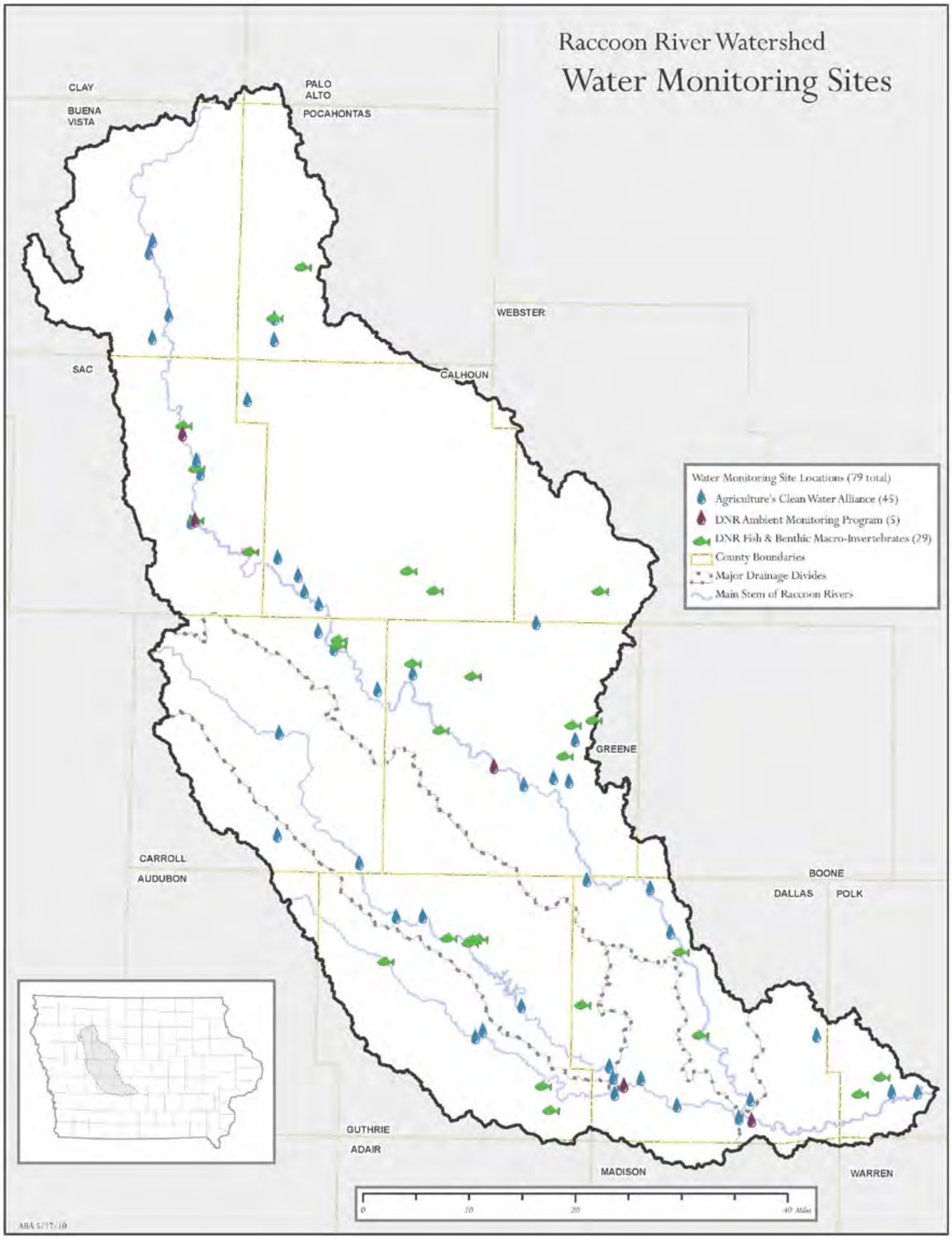
Table B.2. Percentage differences between the calibrated baseline (scenario 1) and the average annual streamflows or pollutant losses for the different scenarios (for 1986-2004)

Scenario	Streamflow (mm)	Sediment (Tons)	Nitrate (Tons)	Organic N (Tons)	Mineral P (Tons)	Organic P (Tons)
1; Calibrated baseline	224	1,022,934	19,266	2,879	490	427
2; DAP (18-46-0) replaced with MAP (11-52-0)	-0.1	-0.1	-2.7	0.0	3.2	0.9
3; no fertilizer on manured fields	1.2	1.7	-10.5	0.0	-11.2	-1.5
All scenarios below include effects of scenarios 2 and 3						
Scenario 1 spring N applics. held constant on May 1 for scenarios 4a-4d						
4a; fall N applic. moved to 2 weeks before planting	1.1	1.6	-12.4	0.1	-11.1	-1.6
4b; fall N applic. moved to day of planting	1.1	1.5	-13.3	0.0	-11.1	-1.7
4c; fall N applic. moved to 2 weeks after planting	0.9	1.2	-15.4	0.0	-11.1	-1.9
4d; fall N applic. moved to 4 weeks after planting	0.7	0.9	-17.7	-0.1	-11.1	-2.2
Scenario 1 spring N applics. also changed to same "new dates" for 4e-4h						
4e; fall N applic. moved to 2 weeks before planting	1.2	1.7	-11.7	0.1	-11.2	-1.5
4f; fall N applic. moved to day of planting	1.0	1.5	-13.4	0.0	-11.1	-1.7
4g; fall N applic. moved to 2 weeks after planting	0.7	1.0	-17.2	-0.1	-11.1	-2.1
4h; fall N applic. moved to 4 weeks after planting	0.4	0.5	-21.5	-0.3	-11.1	-2.6
5a; 25% conversion of cropland to CSCAAA	-5.8	-11.8	-18.7	-34.2	-24.3	-38.1
5b; 50% conversion of cropland to CSCAAA	-12.1	-20.8	-26.1	-45.1	-29.8	-48.4
5c; 75% conversion of cropland to CSCAAA	-18.8	-29.5	-31.0	-50.2	-34.5	-53.8
5d; 100% conversion of cropland to CSCAAA	-25.3	-37.4	-38.4	-54.6	-39.0	-58.0
6a; 25% conversion to rye cover crop	-3.8	-8.1	-12.4	-25.2	-13.3	-28.7
6b; 50% conversion to rye cover crop	-8.0	-14.0	-16.1	-34.3	-14.8	-37.2
6c; 75% conversion to rye cover crop	-12.4	-20.0	-18.5	-39.5	-16.4	-42.3
6d; 100% conversion to rye cover crop	-16.8	-25.3	-22.4	-43.6	-17.8	-46.1
7a; spring fert + 25% to CSCAAA + 25% to cover crops	-18.2	-28.8	-34.7	-56.6	-40.4	-60.7
7b; spring fert (4 weeks after planting) + 100% to CSCAAA	-25.6	-37.6	-49.1	-54.5	-38.9	-58.1
7c; spring fert (4 weeks after planting) + 100% CSCAAA & CC in C-S-C	-28.1	-41.3	-55.4	-64.5	-41.7	-67.1

Table B.3. Percentage differences between the "scenario baseline" (scenario 3a) and the average annual streamflows or pollutant losses for the different scenarios (for 1986-2004)

Scenario	Streamflow (mm)	Sediment (Tons)	Nitrate (Tons)	Organic N (Tons)	Mineral P (Tons)	Organic P (Tons)
1; Calibrated baseline	224	1,022,934	19,266	2,879	490	427
2; DAP (18-46-0) replaced with MAP (11-52-0)	224	1,022,181	18,749	2,879	506	431
3; no fertilizer on manured fields	227	1,040,455	17,242	2,879	435	421
All scenarios below include effects of scenarios 2 and 3a						
Scenario 1 spring N applics. held constant on May 1 for scenarios 4a-4d						
4a; fall N applic. moved to 2 weeks before planting	-0.1	-0.1	-2.1	0.1	0.1	-0.1
4b; fall N applic. moved to day of planting	-0.2	-0.2	-3.1	0.0	0.1	-0.2
4c; fall N applic. moved to 2 weeks after planting	-0.3	-0.5	-5.5	0.0	0.1	-0.4
4d; fall N applic. moved to 4 weeks after planting	-0.5	-0.8	-8.0	-0.2	0.1	-0.7
Scenario 1 spring N applics. also changed to same "new dates" for 4e-4h						
4e; fall N applic. moved to 2 weeks before planting	0.0	0.0	-1.3	0.1	0.0	0.0
4f; fall N applic. moved to day of planting	-0.2	-0.2	-3.2	0.0	0.1	-0.2
4g; fall N applic. moved to 2 weeks after planting	-0.5	-0.7	-7.5	-0.1	0.1	-0.6
4h; fall N applic. moved to 4 weeks after planting	-0.8	-1.2	-12.3	-0.3	0.1	-1.1
5a; 25% conversion of cropland to CSCAAA	-7.0	-13.3	-9.1	-34.2	-14.7	-37.1
5b; 50% conversion of cropland to CSCAAA	-13.2	-22.1	-17.4	-45.1	-20.9	-47.6
5c; 75% conversion of cropland to CSCAAA	-19.7	-30.7	-22.9	-50.2	-26.2	-53.1
5d; 100% conversion of cropland to CSCAAA	-26.2	-38.4	-31.1	-54.6	-31.3	-57.4
6a; 25% conversion to rye cover crop	-5.0	-9.7	-2.1	-25.2	-2.4	-27.6
6b; 50% conversion to rye cover crop	-9.1	-15.5	-6.3	-34.3	-4.1	-36.2
6c; 75% conversion to rye cover crop	-13.5	-21.3	-8.9	-39.5	-5.9	-41.4
6d; 100% conversion to rye cover crop	-17.8	-26.5	-13.3	-43.6	-7.5	-45.2
7a; spring fert + 25% to CSCAAA + 25% to cover crops	-19.2	-30.0	-27.0	-56.6	-32.9	-60.1
7b; spring fert (4 weeks after planting) + 100% to CSCAAA	-26.5	-38.7	-43.1	-54.5	-31.2	-57.5
7c; spring fert (4 weeks after planting) + 100% CSCAAA & CC in C-S-C	-29.0	-42.2	-50.1	-64.5	-34.4	-66.6

Appendix 8. Water quality monitoring sites



Appendix 9. Comments received on draft Master Plan

Comments were taken on a draft version of the Master Plan from May 9, 2011 to June 10, 2011. The draft plan was made available on the Internet, and also sent by email to over 200 individuals who participated in development of the plan. Additionally, press releases announcing the comment opportunity were sent to newspapers and radio stations throughout the watershed. Comments were received via email from 21 individuals and organizations.

All comments were reviewed and taken into consideration for development of the final Master Plan document.

Comments from Rick Hunsaker,
Region XII Council of Governments
Received 5/18/2011

From: rhunsaker@region12cog.org
To: raccoon@agreninc.com; Joe Behrens
Subject: Raccoon River Draft Recommendations
Date: Wednesday, May 18, 2011 10:47:03 AM

Tom/Jamie/Etc.
I just finished what is admittedly a brief review of the draft plan. The document looks great and should prove to be a quality document on which future efforts can build and implement. Thanks for including us in the process as you have developed this document. I have only 1 thought and 1 comment:

1. The regional planning section does not discuss current organizations as a potential partnership. Perhaps the feedback you received nixed this as part of the recommendation, but I thought you were going to include the COG as a potential partner, convener, and/or host. We are open to that still.

2. I am not included on the laundry list of participants starting on page 58. Perhaps folks from the Perry event only are not listed here?

Thanks for the opportunity to comment.
Rick

Sent from my U.S. Cellular BlackBerry® smartphone

Comments from Chris Jones, Iowa Soybean Association
Received 5/18/2011

From: Christopher Jones
To: Jamie Ridgely; Ehm, William [DNR]; Tom Buman
Cc: Schilling, Keith [DNR]; Roger Wolf; Randy Beavers (beavers@dmww.com); Kinman, Linda
Subject: RR Master Plan--CSJ edits
Date: Wednesday, May 18, 2011 12:48:51 PM
Attachments: RRMP csj edits.pdf

I've spent less time with this than I should, but I did make some comments. These should appear as text "balloons" in the file. Many of my comments might be more properly termed "observations", but you can think about them and act, or not, as you see fit. Some general observations:

- The document is well written and well organized, with remarkably few spelling and grammatical errors.
- Maps and graphs are excellent
- There is a lot of discussion in various places of human capital, without directly using that term. Perhaps this merits its own section/recommendation, or just more in-depth discussion. The problem of human capital is a big one, no doubt about it.
- You have two short paragraphs under the subheading of "Subsurface tile drainage". Tile is just one component of the hydrological modification that has occurred over the last ~140 years that is the root of nearly all the problems. This includes loss of wetlands and perennial vegetation, the evapotranspiration patterns of the corn-soy system, stream (ditch) creation, rip rap, divorce of the streams from their floodplain, stream straightening, down-cutting, and so forth. People are really focused on tile right now, but I think it is important that they see tile in the context of the complete hydrological modification that has occurred..
- I do think the creation of the watershed "authority" or whatever you want to call it is necessary, and I for one feel that this potentially could be the most positive result of the process.

Anyway, you can see my comments in the document. If my comments didn't show up, let me know.

Chris Jones
Iowa Soybean Association
1255 SW Prairie Trail Parkway
Ankeny, IA 50023
515-334-1038 Direct to desk
515-250-0368 Cell
Email: cjones@iasoybeans.com

Environmental
Programs & Services
IOWA SOYBEAN ASSOCIATION

Summary of Comments on Raccoon River Water Quality Master Plan

Page: 8

Author: Christopher Subject: Sticky Note Date: 5/18/2011 11:28:36 AM

Technically you should cite Des Moines Water Works, and not the City of Des Moines. The City of Des Moines is one user of the water, along with ~30-40 other political entities that buy water from DMWW. My point here is there many more cities than just DM and Panora that are using the water, i.e. Ankeny, Urbandale WDM, etc etc.

Author: Christopher Subject: Sticky Note Date: 5/18/2011 11:29:16 AM

comprises might be a word to use here.

Page: 11

Author: Christopher Subject: Sticky Note Date: 5/18/2011 11:37:40 AM

Are there peer-reviewed papers that demonstrate that tile reduces runoff? This is clearly the "conventional wisdom" that many in Ag promote; however, I know there are credible people who dispute this. We know that peak flows in tilesheds are no different now than before they were tiled; this implies tile is not reducing runoff, especially during the wet season. There is a concerted effort right now to promote the idea that there is an environmental benefit to tile. Yes, these lands could not be farmed (and maybe would be un-inhabitable) without tile. But I encourage you to stay away from the idea that tile produces environmental benefits--it does, for Homo sapiens, Zea maize, and Glycine Max, but no other species I am aware of.

Page: 15

Author: Christopher Subject: Sticky Note Date: 5/18/2011 12:41:34 PM

Knowing what i know now, I have to believe cattle are a far larger source than hogs. i just don't think that the organisms survive for very long once the manure is applied to the field. High E coli numbers are most likely due to runoff of fresh manure. i dont have much information that can be used to present in the document, however.

Page: 19

Author: Christopher Subject: Sticky Note Date: 5/18/2011 11:44:31 AM

Can we just call wetlands, wetlands? Why do they have to be a "nitrate-removal wetland". No one really knows if a wetland will successfully mitigate high nitrate until after the fact.

Author: Christopher Subject: Sticky Note Date: 5/18/2011 11:46:08 AM

yes, good.

Author: Christopher Subject: Sticky Note Date: 5/18/2011 11:45:58 AM

Notropis topeka should be italicized

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Author: Christopher Subject: Sticky Note Date: 5/18/2011 11:48:20 AM

My own personal feeling is that in few years we will be talking about the large N loads coming from the South RR watershed. As tile goes in on the hillsides and Loess soils in watersheds like Brushy, the N will follow.

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Author: Christopher Subject: Sticky Note Date: 5/18/2011 11:53:40 AM

A lot of this discussion, along with the practices themselves, falls under the category of "water management". So many of these problems are the direct manifestation of modified hydrology. This isnt necessarily a comment that needs further discussion, although maybe it is

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Author: Christopher Subject: Sticky Note Date: 5/18/2011 11:54:10 AM

extra space between o and f.

Page: 33

Author: Christopher Subject: Sticky Note Date: 5/18/2011 11:57:00 AM

i do not buy the concept that the urban dwellers dont understand the problems and issues that farmers must cope with, or that they are "removed" from it all. There are 1000s of people in the DM area that work at IFBF, John Deere, Pioneer, Monsanto, etc etc that know full well the situation. I live in Ankeny, and 3/4 of the town moved there from rural Iowa. I dont see this as a barrier; rather i see it as an opportunity.

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Author: Christopher Subject: Sticky Note Date: 5/18/2011 12:00:05 PM

DMWW is to be commended for its efforts at public awareness. i agree with most or all of your discussion of communication needs; however, i do feel that many have deliberately ignored and or dismissed the efforts at communication that have been implemented.

Author: Christopher Subject: Sticky Note Date: 5/18/2011 12:00:51 PM

maybe we need to explicitly state who we believe shares in the responsibility.

Page: 35

Author: Christopher Subject: Sticky Note Date: 5/18/2011 12:01:52 PM

A lot of this discussion here might merit a subheading of "human capital" necessary to achieve our objectives, and how we are going to create that.

Author: Christopher Subject: Sticky Note Date: 5/18/2011 12:02:14 PM

reinvent

Page: 37

Author: Christopher Subject: Sticky Note Date: 5/18/2011 12:08:50 PM

What you are basically articulating here is where "conservation" lies in the list of priorities. These things aren't barriers in my mind; they just hold a higher priority. Why not just say it? And why are we so afraid to say that the need to achieve a certain income level is a priority? It's a priority for me and almost every other person i know. It should be a priority for farmers too. They cant do conservation if they are not prosperous. But if they are prosperous, then there should be societal expectations for conservation. In my view, this is a point that should be articulated, and one that farmers should hear.

Author: Christopher Subject: Sticky Note Date: 5/18/2011 12:11:24 PM

human capital again

Author: Christopher Subject: Sticky Note Date: 5/18/2011 12:10:54 PM

Again, human capital, where and how are we going to get it. You touch on this throughout. Maybe this deserves its own specific recognition.

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Author: Christopher Subject: Sticky Note Date: 5/18/2011 12:11:46 PM

consultants instead of consults?

Author: Christopher Subject: Sticky Note Date: 5/18/2011 12:14:12 PM

Now this is what i would call a barrier. How do we make "value added" profitable?

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Author: Christopher Subject: Sticky Note Date: 5/18/2011 12:15:15 PM

i know we look to Rathbun as an example. it would be nice to see some data about whether or not what they have done has resulted in improved WQ.

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Author: Christopher Subject: Sticky Note Date: 5/18/2011 12:16:39 PM

of course if people/organizations are going to invest, then they will want a mechanism to demonstrate success or failure.

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Author: Christopher Subject: Sticky Note Date: 5/18/2011 12:17:29 PM

in my view they are not very limited; i think methods and systems exist

Author: Christopher Subject: Sticky Note Date: 5/18/2011 12:17:00 PM

yes, costly

Author: Christopher Subject: Sticky Note Date: 5/18/2011 12:17:51 PM

little or no mention of dmww monitoring at the mouth.

Author: Christopher Subject: Sticky Note Date: 5/18/2011 12:18:19 PM

yes, important

Comments from Katherine Koskovich, Iowa Department of Natural Resources
Received 5/20/2011

From:	Koskovich, Katherine [DNR]
To:	Jamie Ridgely
Date:	Friday, May 20, 2011 2:08:08 PM
Attachments:	UpperRaccoonRiverWHIPSP.doc PL_Staff_Dec10.jpg

Hi Jamie:

I am emailing with regard to the Raccoon River Master Plan, which Adam Kiel just sent out for review and comments.

I didn't know if you were aware of the **Topeka Shiner Special WHIP** project in Sac, Calhoun, and Carroll counties. I have attached the proposal. We are in the second year of the project. So, you will notice that the NRCS local DC names have changed (Carroll County is now Clint Miller, and Sac and Calhoun is now Denis Schulte). We have four nice projects presently. This project targets *oxbow wetlands* along the Raccoon River and it's tribs where FWS have designated as Topeka shiner critical habitat. We have one more year of funding, so we are looking for more landowners who want to restore or enhance oxbows for Topeka shiners.

I looked over the Recommendations for management practices that are listed in the Master Plan for the various programs or targeted practices. Do you include WRP wetlands (I did see Floodplain wetlands so perhaps that would include the WRP program wetlands) and "oxbow restoration" as targeted practices?

Also, you might want to add or include The IDNR's Private Lands Program under the section for Recommendation #6 Opportunities for Private Landowner Conservation Planning efforts. I have attached a map showing the staff we have statewide. Many of the counties within the Raccoon Watershed are covered by either myself or my counterpart in SW Iowa (Matt Dollison). The PLP also includes AmeriCorps staff in various counties, as well as the new Pheasants Forever (Reload Iowa) Farm Bill Biologists! All of us promote and market conservation programs to private landowners and should be a resource listed in this section. There is a strong partnership with NRCS, whether it is with our DNR PLP, AmeriCorps, or Pheasants Forever. Most watershed initiatives include these partner agencies as a resource for regional and local private landowners.

If I can be of assistance with this Master Plan for the Raccoon River Watershed, please contact me. I am available to promote conservation programs to private landowners, and assist NRCS staff in promoting programs for target efforts, in many of the counties within the watershed.

Thanks for the opportunity to provide comments to this Draft Plan!

Kathy Koskovich

Katherine Koskovich, Private Lands Biologist
Iowa Department of Natural Resources
Area 1 NRCS
3539 Southern Hills Dr, Suite #3

Sioux City, Iowa 51106
Office:712-276-2774 Ext: 108
Cell: 712-330-6932
FAX: 712-276-3272
Email: Katherine.Koskovich@dnr.iowa.gov

From: Barney, Lindsey [DNR]
Sent: Monday, May 23, 2011 1:46 PM
To: Kiel, Adam [DNR]
Subject: RE: Raccoon River Master Plan

Good Afternoon Adam,
This Raccoon River Master Plan Draft was very informative and very good. As a Forester I face a lot of the same challenges promoting conservation as were highlighted in this plan in the rest of my district. This draft happened to give me some ideas for dealing with these challenges in other situations. As this project continues, please let me know if there is anything I can do or help promote on my end. Carroll and Audubon counties are in my district. Thanks-

Lindsey Barney
District 9 Forester
712 South HWY 6
BOX 189
Oakland, IA 51560
Office: 712-482-6245
Cell: 712-350-0013

Comments from William Smith
Received 5/26/2011

From: FHD101@aol.com [mailto:FHD101@aol.com]
Sent: Thursday, May 26, 2011 2:38 AM
To: raccoon@agreninc.com
Subject: Raccon River Water Management Plan

I write today to express to you and all members of the planning commission to consider technology implementation that would resolve Raccoon River Non Point Source problems.

We are talking about a watershed here and Closed Loop Sub-Irrigation technology is point critical in resolving and controlling non point source problems with in the watershed.

Please review the technology and utilize it to solve the problems of the Raccoon River.

Sincerely,
William J. Smith
fhd101@aol.com
712-253-0362

Comments from Mike Murphy
Received 6/1/2011

From: Michael Murphy [mailto:anglermurphy@msn.com]
Sent: Wednesday, June 01, 2011 2:40 PM
To: raccoon@agreninc.com
Subject: Draft Plan Comments

I have a few minor comments at this time, and two questions. The RRWA Board will be meeting soon to discuss the draft plan and I expect will be making comments.

Typos, etc. -
p. 33, first paragraph: "Without this, public officials, nor watershed resident, can be expected...." It seems like the word "neither" should be inserted before public officials, or it should read "Without this, public officials or watershed residents cannot be expected ...."

p. 36, first full paragraph, seventh line: The word "Media" appears out of place before "Furthermore"

p. 40, last paragraph: The phrase "education residents" doesn't seem right. Maybe "educate residents"?

p. 53 Two citations under Agren refer to "Mater Plan" rather than "Master Plan"

p. 57 The Zohrer citation should be "Securing..." rather than "Securating..."

1. Is the list/assessment for pathogens, page 15, available yet?

2. What is the source of the numbering system for subwatersheds in Figures 4-10? I have two HUC12 maps but neither uses that numbering system. I had trouble finding the names of the subwatersheds in the priority geographic areas lists. I believe that I have them now, but it took a lot of time. I think it would be more user-friendly to include the names in the lists.

Thank you. Nice job on the plan.

Mike Murphy

Comments from Steve Roe, Raccoon River Watershed Association
Received 6/10/2011

Raccoon River Watershed Association
712 45th Place, Des Moines, IA 50312
515-229-1669
sroe16@mchsi.com
www.northraccoon.org

June 10, 2011

Agren, Inc., Attn: RRWQMP
1238 Heires Ave.
Carroll, Iowa 51401

RE: Comments to Raccoon River Draft Master Plan

Dear Agren:

We commend Agren and M&M Divide for their efforts in drafting a Master Plan for water quality improvements in the Raccoon River basin. We particularly endorse the inclusive and open methodology used to develop this plan and appreciate the inclusion of members of our organization in the expert panels. We look forward to advising and assisting in implementation of the plan.

With respect to the "Current Watershed Conditions" (pp.6-12) portion of the plan, we feel that you have provided a succinct and useful discussion of the factual background and issues. We suggest that in the Water Uses paragraph that you add "fishing" in the recreational use portion. We also appreciate the discussion of Water Quality aspects, not only as they relate to matters within the watershed, but beyond.

Regarding the recommendations, we strongly support your presentation of the findings and consensus of the expert panels, with, we think, minor comment. We fully support recommendation #1, strategic targeting of priority sub watersheds and use of BMPs, in order to efficiently direct resources to the most problematic sources of pollution. We understand the need to use both actual water quality monitoring and computer modeling to establish geographic priorities, but have some question whether modelling has too much influence. For example, Elk Run-North Raccoon River [071000060804], which has been consistently shown by ACWA monitoring to be the highest contributor of nitrate, did not make the top 20. We also note that the pathogen discussion is yet to be included. Finally, we feel that naming, by HUC 12 designation, of the sub watersheds on the priority lists would be useful. We understand that this may be difficult because the hydrologic units modeled by SWAT do not match the HUC 12 boundaries in some cases.

We also feel that Recommendation #7, creation and maintenance of an implementing organization and/or advisory body, is crucial, strongly followed by monitoring (#8) and assessment(#9). This is not to say that the other recommendations are not important.

As to organization, we feel that you have adequately laid out the options for an implementation entity. You have presented the spectrum as consulting vs. decision-making bodies. Given the large geographical area and number of political subdivisions in the watershed, we think that advisory would be a better model. We do feel that there should be a strong administrative (staff) component. For example, the Rathbun Land and Water Alliance, cited in your report, has several technical staff and a strong board for an area smaller than the Raccoon River watershed. We feel that the Des Moines Water Works, due to their interest, expertise, and ongoing dedication to this process, should be a source of administrative expertise and assistance. The Iowa Soybean Association, as the prime mover in the Agriculture Clean Water Alliance, has a cadre of staff and volunteers whose expertise and dedication will hopefully continue to be utilized.

An overarching board (commission, etc.[1]) should include SWCDs, counties and cities that wish to participate, and major interest groups, such as Des Moines Water Works and Iowa Soybean Association. Given that the problems are going to have to be solved mostly by agricultural interests, representation of other agricultural organizations seems appropriate. Given the number of entities involved, we agree that a tiered (voting and advisory) structure is appropriate. Our organization would like to be involved on an advisory basis.

Regarding the monitoring and assessment discussions (pp. 42-44), we strongly agree with these presentations. In particular, we think that preparation of a guidance document for sub watershed monitoring by local groups is important. We feel that biological assessments also should be included in local monitoring efforts. Participation in local monitoring projects is something that we encourage for our membership, and having a guidance document would be helpful and assure consistency.

Overall, the plan is excellent, and we appreciate the opportunity to comment on the draft.

Sincerely,

Steve Roe, President
Raccoon River Watershed Association

[1] The term “alliance” could also be used, as the Rathbun group did. We like the positive connotation of this term.

Comments from Michael Coffey,
U.S. Fish & Wildlife Service
Received 6/1/2011

From: Michael_Coffey@fws.gov
To: raccoon@agreninc.com
Subject: Comments Sought on Raccoon River Plan - June 10 deadline
Date: Wednesday, June 01, 2011 4:15:58 PM

Attn: RRWQMP

Thank you for the opportunity to comment on the draft plan. We have three comments for your consideration (outlined below). Please let us know if you have any questions.

Comment #1. Well done. We found the report to be nicely organized and contain useful information.

Comment #2. Please reference page 19. The exact listing of Critical Habitat for the federally listed endangered Topeka shiner only includes the off channel and side channel pools adjacent to the North Raccoon River, and ten other tributaries and their qualifying floodplain habitats of the North Raccoon River. These designations may have a specific or regulatory impact on land management in this watershed if the action resulted in the harm or harassment to the Topeka shiner; and if the action resulted in adverse modification to the Critical Habitat where the project involves a Federal permit or a Federal funding source.

Comment #3. Please reference Recommendations 1 & 2. Our water quality studies suggest that streamside buffers would not necessarily reduce nitrate loading to the streams if the primary transport pathway and loading comes from the tile drainage system which would allow flow under the buffer strip. Also, it appears that some parts of Iowa can leach selenium from the naturally selenium rich soils resulting in the accumulation of selenium in the sediments of treatment wetlands. Selenium may can reach thresholds that become toxic to aquatic life and birds in these kinds of treatment wetlands.

Mike Coffey
U.S. Fish and Wildlife Service
Greater Illinois and Iowa Ecological Services Field Office
Environmental Contaminants Program
1511 47th Avenue
Moline, Illinois 61265
office 309-757-5800 x206
fax 309-757-5807
michael_coffey@fws.gov
http://www.fws.gov/contaminants

Midwest Region Contaminants Program Mission Statement:
Prevent contaminant impacts to fish, wildlife, plants, and their habitats; and restore those resources that have been impacted by environmental contaminants, consistent with the mission and priorities of the U.S. Fish and Wildlife Service.

Comments from Mark Tomer,
United States Department of Agriculture/Agricultural Research Service
Received 6/6/2011

From: Tomer, Mark
To: raccoon@agreninc.com
Cc: AGREN, INC.
Subject: comments
Date: Monday, June 06, 2011 12:17:31 PM
Attachments: Raccoon_River_Master_Plan_Draft_5_11_13.pdf
Raccoon_River_Master_Plan_Draft_5_11_20.pdf

Amy,

I thought it read quite well and only had a couple comments that are given on the two files – these are pages extracted from the plan where my comments came up.

Thanks, I enjoyed participating on the panel.

Mark Tomer
Research Soil Scientist
USDA/ARS - National Laboratory for Agriculture and the Environment
2110 University Blvd.
Ames IA 50011-3120

515-294-0213

Comments from Mark Tomer,
United States Department of Agriculture/Agricultural Research Service
Received 6/6/2011

Summary of Comments on Raccoon River Water Quality Master Plan

Page: 13

Author: Mark Tomer Subject: Inserted Text Date: 6/2/2011 3:02:49 PM

As shown below, modeling and watershed assessments indicate that different parts of the watershed need to be prioritized for different contaminants and that different suites of practices are needed to address each contaminant and address watershed issues in a comprehensive manner.

Page: 20

Author: Mark Tomer Subject: Inserted Text Date: 6/2/2011 2:57:37 PM

Reconstruction, restoration, and reconnection of oxbows is being encouraged as a practice and has been shown successful in increasing Topeka shiner numbers.

From: Brad Riphagen [mailto:riphagen@netins.net]
Sent: Tuesday, June 07, 2011 3:50 PM
To: raccoon@agreninc.com
Subject: Comments

Thanks for allowing for comments, I found the information to be clear and hope we are able to implement many of the recommendations. I only have one comment concerning formatting, in the first section of recommendations where subwatersheds are referenced, it would work better for me if the two maps that correspond to the nitrate discussion follow directly after that discussion, and so on with the other issues, rather than all lumped together at the end.

Thanks again,
Brad Riphagen

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briphagen@treesforever.org

Comments from Linda Kinman,
Des Moines Water Works
Received 6/9/2011

Des Moines Water Works
Water You Can Trust for Life

CIRDWC
Central Iowa Regional Drinking Water Commission

June 9, 2011

Jamie Ridgely
Tom Buman
Agren, Inc.
1917 N US Hwy 71, Ste 3
Carroll, IA 51401

Bill Ehm
Alan Bonini
IA Department of Natural Resources
Wallace Bldg.
502 E. 9th Street
Des Moines, IA 50319

RE: Draft Raccoon River Master Plan

The Central Iowa Regional Drinking Water Commission (CIRDWC) and Des Moines Water Works (DMWW) submit the enclosed comments to Agren, Inc. in response to their request for input on the *Draft, Raccoon River Master Plan*. Both CIRDWC and DMWW understand the challenges in the Raccoon River Watershed. They are committed to participating in the development of a watershed authority and in implementation of projects and practices in the watershed that will improve and protect water resources for many generations to come.

We look forward to continuing to work with AGREN, Inc., IA Department of Natural Resources and all other Raccoon River watershed stakeholders. And, we are extremely hopeful that through this planning effort additional resources and commitments will ensure an opportunity to holistically resolve the challenges in the Raccoon River watershed. Resolutions that will protect and preserve the source of drinking water for 500,000 Central Iowans, the natural beauty and function of the river system, and a vibrant economy. Thank you for the opportunity to comment. We look forward to beginning the next stage in this planning process.

Sincerely,

Linda Kinman

Linda Kinman
Public Policy Analyst/Watershed Advocate

2201 George Flagg Parkway, Des Moines, IA 50321
515-283-8706 kinman@dmww.com

Comments from Linda Kinman,
Des Moines Water Works
Received 6/9/2011

Des Moines Water Works
Water You Can Trust for Life

CIRWDC
Central Iowa Regional Drinking Water Commission

Comment Document

Draft Raccoon River Master Plan
June 9, 2011

Central Iowa Regional Drinking Water Commission (CIRDWC)* and Des Moines Water Works (DMWW)** would like to first thank the Iowa Department of Natural Resources (IDNR) for funding the Raccoon River Master Plan (Plan) project. Secondly we would like to thank M & M Divide-Resource, Conservation and Development (RC & D) and Agren, Inc. for their diligent work on the project.

CIRDWC and DMWW provide drinking water to more than 500,000 citizens in Central Iowa. These same citizens own the utilities and entrust us with their operation and infrastructure. Source waters treated for drinking water include groundwater, an infiltration gallery (under the influence of the Raccoon River), and the Des Moines and Raccoon Rivers. The DNR has declared both rivers impaired for coliform bacteria and nitrates (Total Maximum Daily Load (TMDL) – Raccoon River - 2007 and the Des Moines River - 2009). In addition both rivers appear on Iowa's 303(d) list of impaired waters.

For more than 20 years the utilities have treated increasing levels of nitrates in both surface and groundwater sources. The largest nitrate removal facility in the world was installed at DMWW in 1993. In the last 4-5 years the utilities have experienced algal and cyanobacteria blooms, increasing microbial counts, and high levels of ammonia in the Raccoon River. Because of its importance as a drinking water source we are pleased that the Raccoon River watershed was selected for this project.

Due to the high price of corn and soybeans conservation practices are disappearing from the Raccoon River watershed landscape. Subsurface tile drainage installation has increased. Both of which only exacerbate water quality and quantity issues in the watershed. We understand that agricultural production is critical to Iowa's economy and that production is enhanced through tile drained systems. We understand the need for producers to earn a living and provide their families with a good quality of life. This is the American dream for all Iowans. But as Iowans, we also understand the value and ethic that reaching our dream should not come at the expense of our water and soil resources. Resources our families, friends, neighbors, and future generations should have the benefit of.

Water quality and quantity and land use issues will only improve when we can engage in open and honest conversations, digress from a piecemeal approach to conservation, target our resources and holistically manage Iowa's watersheds. It is our hope and desire that the Plan will be the impetus to generate change in the Raccoon River watershed. And, that it will place an emphasis on an institutionalized process for planning, implementing, and funding restoration and protection priorities in the watershed.

To follow are our general comments on the Plan and to follow those are comments specific to the nine recommendations. DMWW and CIRDWC value each and every contribution toward improving Iowa's water resources. We look forward to working with project partners to pursue an overarching watershed organization and further development of the recommendations outlined in the Plan.

Sincerely,

Randy Beavers, DMWW-CEO and General Manager

E.J. Giovannetti, CIRDWC-Chair

2201 George Flagg Parkway, Des Moines, IA 50321
515-283-8706 kinman@dmww.com

Comments from Linda Kinman,
Des Moines Water Works
Received 6/9/2011

General Comments – Draft Raccoon River Watershed Master Plan

Pg. 5 – Methodology: As we have expressed in the past we would like to have seen additional public involvement in the project. That said we do appreciate the opportunity to submit comments during this public comment period.

Pg. 8 – Water Uses: The first sentence should read …is used by the Des Moines Water Works and the City of Panora for drinking water. In addition, 23 CIRDWC utilities receive treated drinking water from DMWW and have a vested interest in improving and protecting the Raccoon River watershed.

Pgs. 8-11 – The description of Water quality, Land use, Geology and soils, Subsurface tile drainage, Demographics, and Climate accurately depict conditions in the Raccoon River watershed.

Subsurface tile drainage has not always been recognized as a contributing factor in the water quality or quantity discussion. As an engineered system there are benefits and consequences. Accepting and understanding both can provide the dialogue needed to guard the benefits and mitigate the consequences. Management of water resources must include management of subsurface tile drainage systems. Thank you for including it in the recommendations.

None of the recommendations specifically address the issues of mitigating subsurface tile drainage or demographic concerns. Did the expert panels address these issues? Were recommendations considered, but consensus not reached? If so, could a minority report accompany the final Plan document?

While the recommendations have merit they appear as a reiteration of desired deliverables in the IDNR, Request for Proposal, Purpose Statement. The recommendations recognize and support the understanding and connection of people, places, behaviors, and practices that support and/or set-up barriers to progress in the Raccoon River watershed. Our expectation of the plan was that it would identify and direct changes to break down the barriers and put in place a process that will improve water resource management in the watershed. A recommended road map for getting there and who best can drive the effort.

We anticipated the comprehensive plan would identify real issues and real work that would mobilize and empower partners to address water resource management issues. However, the Plan failed to address the following needs:

- Human and financial capital
    - Are changes to current organizations and/or agencies needed for improved delivery of programs and funding or increased efficiencies
    - Do programs and/or funding mechanisms need to change – i.e.: more flexibility, the ability to target, the ability to use multiple sources of funding for “stacking” practices
    - How do you engage stakeholders
- State and Federal Policy changes
    - What are the policy barriers to improve watershed management
    - What incentives are needed to improve watershed management
    - What regulations would better support watershed management
    - How do you generate the political will to move from complacency to action
- Engagement of the private sector – Retailers, Associations, Industries

  - What is their role
  - What is their accountability
- Engagement of our state colleges and universities
  - What is their role
  - What is their accountability
- The recommendations are narrowly focused on conservation practices. There needs to be a focus on holistic management of Iowa's water resources. Watershed management must address both water quantity and quality. Raising the focus on a holistic approach to watershed management will help to prioritize the needs.
- The Plan reiterates much of what has been included in prior watershed reports. There was nothing new or innovative.
- The Plan does not identify what the teams of experts considered their vision in which they based their recommendations
  - The recommendation focus on conservation practices. What is the worth of water to the state?
  - What are the measures that will indicate watershed management improvement
  - How did they define an environmentally and economically sustainable landscape
  - How would they institutionalize the vision

Comments on Specific Recommendations – Draft Raccoon River Watershed Master Plan

Recommendation #1 - <u>Target implementation of agricultural best management practices (BMPs) to priority sub watersheds by primary impairment and priority practices for that impairment.</u>

Pg. 17 – third sentence from the end – "practices identified as having the most potential for pathogen reduction (should this be sediment reduction) in the Raccoon…"

Voluntary agricultural best management practices and conservation programs have been around for 20-30 years and we continue to see soil loss, increased water quality degradation, and increased water flow and velocity in our rivers and streams. Did the expert panels address why BMPs are not the norm? Did they offer recommendations as to how to garner additional acceptance and implementation of BMPs? Without a recommendation for change, how will things be different?

Recommendation #2 - <u>Enhance effectiveness of nutrient control and removal practices by encouraging "stacked" approach to nutrient management such as reduce, trap and treat.</u>

Again, individual or "stacked" voluntary agricultural best management practices and conservation programs have been around for 20-30 years and we continue to see soil loss, increased water quality degradation, and increased water flow and velocity in our rivers and streams. Without a recommendation for change, how will things be different?

Pg. 29 – last sentence – "Moreover, new strategies and technologies are needed that can achieve measurable reductions in the export of nutrients from tile-drained landscapes." This statement seems significant to the ability to mitigate nutrients and should be a major recommendation in and of itself.

Recommendation #3 - Take full advantage of emerging technologies and LiDAR elevation sets in Iowa to identify areas of concern and target practices based on landscape characteristics at the field level.

Precision conservation technology and practices are available today. "The purpose of precision conservation is to maintain the increases in crop productivity made possible through precision agriculture, while reducing unnecessary inputs and losses of sediment, nutrients, and other chemicals to the environment (Delgado, Berry and Khosla 2008)" (Pg. 30 - ¶) 3). This sounds like precision conservation is the win/win we have all been searching for. Did the expert panel consider how precision conservation becomes the norm?

There is no discussion of engaging the private sector in overcoming the barriers and challenges of implementing conservation technology. Was this discussed? If not, why was the private sector not a consideration? How can the industry assist with the discussion of making conservation practices "convenient"?

Historically farmers have been some of the most innovative people. The development of steel plows, hydraulic couplers, or spring tooth harrow came from farmers. Innovators often came from peripheral producers who defied common sense or government advice. How can we successfully foster innovation and acceptance of conservation technology in the agricultural community? All too often the mentality today is to wait until the government gives it to us.

Barriers and challenges – Includes statements that,

> "…precision conservation will require a fundamental shift in the way conservation programming is administered." This too seems like it should be a primary recommendation in the plan. Were there discussions as to how this fundamental shift should occur? Was consensus not reached?
>
> There is a need to target (programs and funds), and that, "the responsibility for targeting should shift from local decision makers to a more regional scale" and that, "precision conservation will require a fundamental shift in the way conservation programming is administered" (Pg. 32-¶ 3). Was there discussion as to what this would look like and/or how it could happen? Who should decide? Is this reorganization within an existing entity or instituting another level of bureaucracy? This entity should occur at what scale (watershed)?

Recommendation #4 - Conduct public education to improve awareness of water quality and instill a personal commitment to water quality improvement among all watershed residents.

Pg. 33 – "A significant first step towards water quality improvement must be increasing the general awareness of water quality within the Raccoon River watershed."

As noted in "Current efforts," recommendations have been made in multiple reports by multiple taskforces, but never implemented:

- 2001 Iowa Watershed Taskforce
- 2003 Iowa Water Summit
- 2007 Watershed Quality Planning Task Force Final Report
- 2009 Sub-committee of the Water Resources Coordinating Council

- 2010 Watershed Planning Advisory Council Interim Report
- (2010 The Raccoon River Master Plan)

While each report identifies some level of water quality success, overall water quality in the Raccoon River and across the state has not improved. How is this recommendation more strategic? There is no discussion of engaging the private sector or industry groups? Was this discussed? If not, why was the private sector not a consideration? Does private industry have a role – a responsibility?

Recommendation #5 – Focus outreach and education efforts to farm operators and agricultural landowners on nutrient and drainage management strategies.

Pg. 34 – "If significant progress is to be made towards meeting water quality standards in the Raccoon River watershed, farmers and agricultural landowners must fully understand and accept the impact of subsurface drainage on nitrate loading and the need for system-based or "stacked" approaches to nutrient management."

The statement above and the results of the Conservation District of Iowa and Iowa State University survey that indicated a "high level of unawareness and lack of acceptance regarding the impacts of row crop production in the drained landscapes," raises a lot of questions as to what approach will lead to the greatest potential for change. Who should provide the information, how will it be delivered and who will lead the change?

Pg. 37 – Engagement of absentee landowners and renters is also a critical factor in addressing land and water quality resource issues. Did the expert team discuss? Were there suggestions? Was there lack of consensus?

Was there discussion as to what the message should be, who should deliver it, or how should it be delivered? Again, there is no discussion of engaging the private sector or industry groups. Was this discussed? If not, why was the private sector not a consideration? How can the industry assist?

Recommendation #6 - Aggressively pursue opportunities to facilitate private-sector conservation planning services.

We very much agree that a public-private partnership could capitalize on relationships already established between producers and retailer/service providers. However, the delivery system will need to change. Currently producers ask for assistance. To ensure practices and funding are targeted to high priority sites, service providers will need to approach producers.

A strategic organized public/private effort could accelerate the application of conservation practices in high priority watersheds. Overarching planning and implementation goals and strategies will require some tough decisions to ensure that priority watersheds and sub-watersheds are targeted, practices are "stacked", and results are measureable. Who will drive this?

Pg. 39 – It was disappointing to read the comment, "It is likely unrealistic that the financial rewards for conservation planning services can be elevated to match those of ag product sales." Regularly it is touted that farmers (producers) are the true stewards of the land, water and air. Therefore, it would seem that the agricultural ethic used to approach financial decisions should come from the perspective of balance between cost and sustainability? Did the expert panels address the economic and social implications of conservation planning and practices? Did the expert panel discuss the financial ramifications of nutrients lost to rivers and streams or the cost of duplicative application of manure and commercial fertilizer to the same field? Is the cost of water quality degradation a part of the equation when determining financial rewards?

Recommendation #7 - Develop a regional planning organization to guide implementation of the Raccoon River Water Quality Master Plan.

Your example of the Tennessee Valley River Authority is very appropriate. President Roosevelt's ideal was to create "a corporation clothed with the power of government but possessed of the flexibility and initiative of a private enterprise," (http://www.tva.com/abouttva/history.htm). A structure similar to his "ideal" is needed in the Raccoon River Watershed for coordinating project, program and funding efforts, raising awareness, and generating accountability for all stakeholders. This approach was supported by the Implementation Expert Panel, "A watershed management organization should be formed to serve the entire watershed…" (Pg. 41-¶ 2)

Recommendation #7 of the Plan recommends developing a planning organization to guide implementation of the Plan. It is confusing as to whether the plan or the entity comes first? We understood the planning project RFP was for the purpose of planning. The purpose statement is:

> "This Master Plan is intended to identify and recommend institutional structure(s), funding mechanisms, and overarching actions needed to address the identified primary water quality-based concerns within the Raccoon River Basin."

The Plan recommendation does not identify or recommend an institutional structure. And, even before the 2010 legislation outlining a process for establishing watershed management authorities, there were structural mechanisms that allowed organizing of watershed groups. What needs to change to ensure the formation of an entity? What should the structure look like, based on strengths and weaknesses-who should participate, and how will they institutionalize the plan and guarantee implementation? Should this be an existing entity, reorganization of existing entities or newly created?

Recommendation #8 - Monitor water quality at the sub-watershed scale to characterize existing conditions and evaluate effectiveness of watershed projects and conservation.

There are resources for site specific water quality monitoring that requires minimal cost to purchase. For example, HACH test strips for measuring nitrates come 25 strips per bottle at a cost of $16.99. These are easy to use and easy to read. They allow for immediate evaluations on-site. They can be used for preliminary examination of water quality, followed-up with in laboratory analysis if the producer wants confirmation of the results.

We agree that monitoring is critical to watershed management. Monitoring programs create the data necessary to determine water quality status and help analyze the effectiveness and benefits once conservation practices are in place.

The partnership between DMWW and Agricultures Clean Water Alliance has been invaluable in evaluating water quality in the Raccoon River and now in the Des Moines River. Having this data readily available to the public accelerates the ability of watershed groups to immediately prioritize and site conservation practices. Through the expertise within the partnership, monitoring protocols, sites, and analysis procedures can be coordinated for watershed and sub-watersheds. Voluntary monitoring maximizes people and funding resources. The success of the relationship should serve as a model.

Recommendation #9 – Continue to assess long-term water quality status and trends in the Raccoon River and enhance these efforts as resources allow.

We support continued monitoring and the expansion of monitoring for additional parameters which will further qualify and quantify the performance and health of the Raccoon River.

While we agree with continuing to the monitor the Raccoon River at some point there has to be actions taken to support improvement and protection. The Raccoon River is probably one of the most monitored rivers in the country. Local, state and federal agency's fiduciary accountability is compromised when we continue to monitor without taking action to mitigate the findings. We have known for more than 20 years and continue to see the upward trend of nitrates in the Raccoon River. How much additional data is needed for it to become a high enough priority to receive funding and focus that will reduce nitrates.

We support an annual watershed meeting to "better coordinate monitoring efforts, prioritize monitoring needs, and identify and coordinate funding sources." We have pursued this endeavor for more than 10 years without much success. Hopefully inclusion in the Plan and dwindling state and federal funding will elevate the relevance of coordination.

It appears modeling has its benefits but also has its drawbacks. Pursuit to improve modeling data and the robustness of its capabilities should continue.

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* Central Iowa Regional Drinking Water Commission (CIRDWC) is a group of public water suppliers throughout Central Iowa, formed by 28E Agreement to improve Central Iowa through coordinated planning and cooperation in an effort to promote the wise use of resources. The Commission's goal is to provide efficient, effective infrastructure and operations to deliver adequate, safe, and affordable drinking water to the region. Members include:

Board of Directors for the Warren Water District
Board of Directors for the Xenia Rural Water District
Board of Supervisors for Polk County, Iowa
Board of Water Works Trustees of the City of Des Moines, Iowa
Board of Water Works Trustees of the City of Indianola, Iowa
Board of Water Works Trustees of the City of Urbandale, Iowa
Board of Water Works Trustees of the City of West Des Moines, Iowa
City of Altoona, Iowa
City of Ankeny, Iowa
City of Bondurant, Iowa
City of Carlisle, Iowa
City of Clive, Iowa
City of Cumming, Iowa
City of Johnston, Iowa
City of Mitchellville, Iowa
City of New Virginia, Iowa
City of Norwalk, Iowa
City of Pleasant Hill, Iowa
City of Polk City, Iowa
City of St. Charles, Iowa
City of Waukee, Iowa
City of Windsor Heights, Iowa

Comments from Doug Karlen,
United States Department of Agriculture/Agricultural Research Service
Received 6/9/2011

From: Karlen, Doug [mailto:Doug.Karlen@ARS.USDA.GOV]
Sent: Thursday, June 09, 2011 3:25 PM
To: amy@agreninc.com
Subject: RE: Comments Sought on Raccoon River Plan - June 10 deadline

Amy,

I have scanned through the report and it looks very good. The primary addition that I would suggest would be a short (2 page) executive summary that briefly summarized the recommendations and perhaps how they were reached. It felt like I had to swim a long way before I learned what the recommendations were going to be. Other than that – a good job, well done.

Cheers,
Doug

IDNR Comments on Draft Raccoon River Water Quality Master Plan
June 10, 2011

General Comments:

- The document lacks an executive summary; this was specifically mentioned in the contract and should be added.
- The document lacks a conclusion; it seems to stop abruptly after the water quality modeling section. A conclusion could be used to discuss what is left to do and what should happen next, etc.
- The modeling report (p 44-52) seems out of place, it could be an appendix or used as reference material like the Ag BMP expert panel report.
- No where in the report does it make mention of the Iowa Stormwater Management Manual or Low Impact Development. These topics could be briefly discussed within recommendation #4.
- Please update Environmental Regulated Facilities information (p. 9 and appendix 4) to only show the following facility types: Public Water Supply, Wastewater NPDES, Wastewater Industrial, Storm Water General Permit 1, 2 & 3. Also, please ensure data is current.
- Please carry same format of current efforts, potential opportunities and barriers and challenges through all recommendations. This will require revisions to recommendations 1, 2, 8 and 9.
- Please consider reordering the recommendations the flow of events should the plan be adopted. This is one possible order for the existing recommendations: 7, 4, 5, 6, 3, 1, 2, 8, 9.

Page Specific Comments:

Cover page:

- Should we call this a "watershed plan" rather than a "water quality plan"?

Page 5:

- The Iowa Department of Natural Resources (DNR) ~~contracted~~ awarded a grant to the Missouri & Mississippi (M&M) Divide RC&D and Agren to develop a Water Quality Master Plan for the Raccoon River Watershed in January 2010. A copy of the final plan ~~will be~~ was submitted to Iowa DNR in June 2011 to satisfactorily complete the obligations of the grant agreement.
- Please add some sort of acknowledgement of the source of funding for this grant – EPA-ARRA 604(b) funds and Section 319 funds)

Page 6

- I can't find where Table 1 is cited in the text of the report.

Page 8:

- Paragraph 4: need to note that the pathogen standard is for recreational use
- Paragraph 5: line 4, is it nitrate or total nitrogen…just checking
- In text, the report skips from referencing Appendix 1 to Appendix 3. What happened to a reference to Appendix 2? Do you need to reorder sequencing of appendices? The first reference to Appendix 2 is on page 11.

Page 11:

- Paragraph 3: It is too simplistic to say that tile decreases runoff. Under what conditions? At what scale? There needs to be some mention that the creation of the ditch/main network exacerbates many of the drainage problems by moving the water more quickly. Tile isn't necessarily the "boogie man", but the hydrologic *system* that has evolved may be causing challenges.

- Last paragraph: It may be useful to compare the % of land rented to the average of Iowa
- Third paragraph – references Figure 5 but Figure 4 isn't referenced until page 14 for the first time. Do you need to reorder the sequencing of the figures to match the text?
- Last paragraph – It would be useful to also report data on non-operator owners that still live in Iowa. This would give the reader a relative perspective as to the magnitude of out-of-state absentee landowners versus those that still live in state.

Page 12:

- Recommendation #1 is rather confusing…can it be simplified and not lose its meaning?
- Last paragraph – strike: "The Ag BMP Expert Panel provided an opportunity for in-depth analysis of several best management practices identified as having the most promise for restoring water quality in the Raccoon River Watershed (Table 2. ~~Agricultural best management practices evaluated~~)."

Page 13:

- Last paragraph: Can we make it more clear that golf courses are not the problem?
- Can we indicate that urban best management practices are included in the Iowa Stormwater Management Manual, or does that take away from the necessary focus on ag?

Page 14:

- Should we say that Outlet Creek is the only effluent dominated sub-watershed?
- Second paragraph – this is the first reference to Figure 4. (See edit for page 11)
- Last paragraph – text fails to mention "adaptive nutrient management with verification" even though it is listed in Table 3 as a High Priority BMP.

Page 15:

- First paragraph: There should be mention that point sources are required to disinfect.
- First paragraph – strike: "Sources of *E. coli* bacteria (the pathogen indicator ~~for bacteria~~) include municipal and industrial wastewater treatment plants, stormwater runoff, animal manure, septic systems, and wildlife. Manure from hogs and cattle are by far the two largest sources of bacteria."
- Subsection titled "Priority geographic areas for pathogen reduction" has no text associated with it.

Page 16

- Second paragraph – the order of Figures 6 and 7 on pages 23 and 24 does not follow the order of the reference to the figures in the text of this paragraph.

Reconcile this difference. Also, in this paragraph the text refers to Figure 8 when it should read Figure 6.

Page 17

- First paragraph – in the text, the first reference to Figure 9 should actually be referencing Figure 10. Also, as in the comment on page 16, the order of Figures 9 and 10 on pages 23 and 24 does not follow the order of the reference to the figures in the text of this paragraph. Reconcile this difference.
- Last paragraph – revise last sentence as follows:
    - As shown in Table 5, practices identified as having the most potential for ~~pathogen~~ phosphorus and sediment reduction in the Raccoon River include no/reduced tillage, cover crops, farm ponds, addition of perennial vegetation in crop rotation, and strategically-placed vegetation including streamside buffers.

Page 19

- First paragraph – the text describing the High Priority BMPs for wildlife habitat listed in Table 6 are in reverse order to the way they appear in the table. This seems awkward.
- Last paragraph – correct second sentence as follows:
    - The U.S. Fish and Wildlife Service designated the North Raccoon River as critical habitat for the Topeka shiner (~~see~~ Table ~~9~~7.).
- Please make note that the Topeka shiner is the only federally listed animal species found in the watershed therefore it is the only one highlighted in the report. Also, it is the only species with federally designated critical habitat in Iowa and the Raccoon River watershed. There was some concern that other species were not discussed.

Page 28

- In title for Recommendation #2 – add an "a" after the word "encouraging".
- First paragraph – would it be better to refer to a "suite" of nutrient control practices, rather than a "set" of nutrient control practices?

Page 29:

- Chart: cover crops should be listed under source reduction. NRCS lists cover crops as an "avoiding core practice" in the MRBI as opposed to "controlling" and "trapping".
- First paragraph: Should we include the fact that NRCS refers to combinations of practices as a conservation system and has promoted a systems approach for years. Farms that incorporated systems (stacked practices) for soil conservation have faired far better in high rainfall events of recent years than those farms with only one practice.
- Last paragraph: insert "altered" before "hydrology".

Page 31:

- Under current efforts, need to include extensive GIS layers maintained by DNR, models developed by DNR utilizing GIS that prioritize sediment and phosphorus delivery, models developed by DNR and IDALS to calculate sediment and P reductions for various practices, RASCAL, watershed planning, etc.

- Second paragraph of Potential Opportunities: second line: insert “width” after “variable”.
- Neil Smith should be spelled Neal Smith
- “Potential opportunities” offers some very good information, but we don’t want to leave people with the impression that they should wait for new technologies as if the precision conservation will *solve* the problem. Some agronomists believe that variable rate application of nutrients will solve the problem of nutrients in our streams…it won’t.
- Second and third full paragraph – combine text, attempt to mention tools in more general terms and remove mention of any particular software/tool provider:
    - Iowans are coming up with new uses for LiDAR data all of the time. Some of the conservation-related uses for LiDAR within the state include flood plain mapping, watershed modeling, runoff modeling, wetland restoration, forestry management, and mapping recreational trails (Iowa Department of Natural Resources 2011). When combined with software packages designed for conservation planning, the LiDAR data can be even more powerful.

Page 32

- Top of page – revise first line:
    - ~~Agren, Inc. to develop SoilLossCalculator,~~ a private vendor to develop a geographic information system (GIS)-based soil loss
- First paragraph – Revise last sentence:
    - ~~SoilLossCalculator~~ This tool will also allow planners to evaluate different combinations and placement of conservation practices based on effectiveness for erosion control.
- Last paragraph – Claiming “ease of use” as being a “barrier” seems pretty thin to me.

Page 33:

- Second paragraph: last sentence: I am not so sure that this is biased at all. The I-Will campaign received 63% of the vote in the polls. That seems to me to be the ultimate poll.
- Last paragraph: The Iowa Watershed Task Force report is actually the oldest of the reports listed. It is dated 2001. You could also add that the 2009 Water Resource Coordinating Council Flood Plain Management Recommendations corroborates the findings of the other reports as well.
- Add some reference to the need to encourage cities and towns to the SWM Manual and implement LID practices.

Page 34:

- Paragraph 5: any way to strengthen “shared responsibility”?

Page 36

- First full paragraph – revise following sentence:
  - ~~Media~~ Furthermore, media campaigns must be designed to intentionally bring each audience from a level of awareness, through interest, desire, and finally to action (practice implementation).

Page 37:

- Last paragraph: should there be some mention of conservation/nutrient plans developed by NRCS in the MRBI watersheds and DNR manure management plans. Mike Sexton and his wife have made a business of this.

Page 40:

- Last paragraph: fourth line: change "education" to "educate".
- Should we indicate that regional org should tie other beneficial efforts on the Raccoon even though they may not be mentioned in the plan? I am thinking of the Greenways project. It may not be a watershed, but may be able to have a big influence on water quality and public perceptions.

Page 41:

- Third paragraph: third line: they should prioritize geographies as well as issues.
- Third paragraph – The last sentence states "Education and outreach should be an important part of the organization's mission." – shouldn't this be discussed first in the context of the mission since earlier you note how it is a "first key step toward water quality improvement…"?

Page 42:

- Current efforts: should we include IOWATER volunteer monitoring as well. We could probably identify how many volunteer monitors are active in the basin. There needs to be a caveat about what their data can be used for.

Page 44:

- Fourth paragraph: are the terms "space and time" and "fluxes" too techie?
- First full paragraph – at end of paragraph change "Geological Survey" to Geological and Water Survey Bureau".

Page 47

- In Table 9, in the description under "ID 2" it talks about the "effects incorporated in all remaining scenarios starting with 3a". Should this refer to 4a instead (there does not appear to be a scenario 3a)?
- In Table 9, in the description under "ID 3" it talks about the "effects incorporated in all remaining scenarios starting with 3b". Should this refer to 4b instead (there does not appear to be a scenario 3b)?

Page 48:

- First paragraph: third line: delete one of the "reflects".
- Last paragraph – edit last sentence as follows:
  - The main characteristic of these eight scenarios was the elimination of all fall applications of anhydrous ammonia by shifting ~~the~~ 50 percent of the

applications that were applied in the fall (as simulated in the calibrated baseline and scenarios 2 and 3) to spring…

Page 51:

- Second paragraph: I am surprised that the model shows only 13% reduction in nitrate for cover crops. The field level data I have seen is much greater than that.

Page 58:

- Charlie Van Meter instead of VanMetz

Page 60:

- Should Jean Pottroff be Jean Pottorff? Just checking…I do not know.

Page 61:

- Margaret Becker: should be Veolia Water rather than Violia Water

Comments from Rick Robinson, Iowa Farm Bureau Federation
Received 6/9/2011

From: RRobinson@ifbf.org [mailto:RRobinson@ifbf.org]
Sent: Thursday, June 09, 2011 6:14 PM
To: raccoon@agreninc.com
Cc: Fed_Government_Relations@ifbf.net
Subject: IFBF Comments on Draft Raccoon River Water Quality Master Plan

June 9, 2011

Agren, Inc.
1238 Heires Ave.
Carroll, IA 51401

RE: Draft Raccoon River Water Quality Master Plan Comments

The Iowa Farm Bureau Federation (IFBF), the state's largest general farm organization with more than 154,000 members, appreciates the opportunity to comment on the Draft Raccoon River Water Quality Master Plan. We trust these comments will help improve the final document, which should be intended to be a guide and planning resource for local landowners, citizens and natural resource professionals to help them target limited resources, prioritize subwatersheds and continue to make soil and water quality improvements.

Farm Bureau supports development of local voluntary watershed plans, such as this master plan, to address the resource concerns, including agricultural nonpoint sources. We believe the plan's goals and objectives can best be administered at the local level through soil and water conservation districts, commodity and farm groups. Any watershed plans or polices made must be backed by sound scientific research and give proper consideration to impacts on agriculture production.

General Comments

The final plan should have an executive summary that includes the basic background and recommendations. You should also give consideration to prioritizing the recommendations based on available science and professional experiences. It may be more useful to watershed residents.

The final plan should continue to not include numeric targets for nitrogen, phosphorus or sediment or state or local regulatory actions affecting fertilizer applications, tillage or other land use management decisions. The science we've seen from the Iowa Governors' Water Summit (2003), the Gulf Hypoxia and Local Water Quality Concerns Workshop in Ames (September 2005), and the Hypoxia in the Northern Gulf of Mexico: Assessing the State of the Science meeting in New Orleans (April 2006),points to variability in weather as the dominate short- and long-term water quality nutrient influence. Variability in weather, and in volumes of surface run-off and subsurface drainage, may lead to highly variable nutrient exports at times. Science suggests that current nutrient impairment problems are not mainly due to mismanagement of fertilizers and manures, but more to historic changes in land use and hydrology that came with the conversion of prairie and wetlands to cropland. The final plan needs to be clear about this fact.

It would help if the final plan better explains that the watershed has fertile soils and generally ample precipitation. Whenever excess water moves over/through the soil, nutrient losses can occur. The science indicates the factors influencing losses are mainly changes in land use over time, hydrology and weather.

It is also important for the public to understand that for optimal crop production, adequate amounts of N and P must be present in the soil. It is important that the plan explain that to obtain economically viable crop yields in the watershed, nitrate from farm field groundwater can still be above the drinking water standard of 10 mg/L or a TMDL of 9.5 mg/l.

Also, precipitation sometimes results in surface run-off and/or subsurface drainage. When that happens, some nutrients can move through the soil profile. Citizens, watershed residents and farmers need better information regarding the potential for reducing nitrate leaching losses with N management, and to understand that its success is highly dependent on many complicated factors.

The complexity of managing these factors need to be better explained to the public in the report. We suggest these scientific findings be made more clearly in an executive summary at the beginning of the plan.

Challenges of Best Management Practice Adoption

The executive summary or background section should include more information detailing the challenges of the dynamic nature of best management practice consideration and deployment. For example, Iowa State University recommends fertilizer rate for corn after soybeans is 100-150 pounds of nitrogen per acre, depending on the price of fertilizer, the expected price for grain produced and the supply of subsoil moisture. This amount of fertilizer is necessary to produce economically viable corn yields and can result in soil water nitrate concentrations of as high as 22-45 milligrams per liter. If applied N or mineralized organic matter N (conversion from organic to ammonium) would stay in the ammonium form, then losses would not occur.

Unfortunately, that isn't the way it works. Ammonium is converted to nitrate via nitrification. Nitrate is the form that can be moved out of the soil profile by leaching or lost by denitrification. Potential N loss is dependent upon factors that influence each--for nitrification, soil temperature is very important, and for denitrification soil temperature and soil moisture are important. Conversion to nitrate does not equal loss; it just means the N is susceptible to loss. Clearly, these relationships are complex and largely dependent on weather. And while farmers take steps to manage these factors and minimize the potential for N loss, the cost for available management practices and their effectiveness varies. These are important distinctions for the public to understand. The master plan is an opportunity to communicate this information.

Soil quality and soil sustainability are also important issues related to nutrient management decisions. Mass balance calculations based on zero or low N rates on corn have shown soil organic matter content decreases over time. The plan's scenarios and options should give consideration to both water and soil quality when making nutrient management recommendations.

According to information from the hypoxia science assessments and the Gulf Hypoxia and Local Water Quality Concerns Workshop in Ames, some improvement in in-field nutrient management may be possible in certain cases, but within limits. Off-site practices are also likely needed. There are no easy answers and any improvements will be incremental. Targeting of current best management practices and site-specific design of treatment technologies is critical in this and other Iowa watershed plans.

The potential for relative reductions in nitrate leaching in Raccoon River watershed, Iowa and the Corn Belt for specific corn-soybean management changes shows that while switching from row crops to perennials may theoretically yield the largest relative reduction in N losses compared with reductions in fertilizer rates, improved timing of applications and tillage management, limited economic returns and management gaps inhibit the adoption of perennials.

Therefore, care must be taken in the final master plan to avoid premature economic and policy recommendations that may promote the wrong practices (e.g., shifting from fall to spring anhydrous ammonia, shifting to crop rotations that are economically limiting (C-S-A-A-A) or shifting to perennials). Some of those options may need to include creation of economic incentives for specific technologies, but these must be considered in the context of the available peer-reviewed science, social structures and political and financial realities.

Watershed Planning & Implementation Principles

The IFBF suggests including these watershed planning and implementation principles in the executive summary and report. They are based in part on recommendations of the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force:

- Cost-effective measures are different across different watersheds and subwatersheds. Watershed residents should gain a good amount of knowledge about their watersheds before adopting any control policies that have been promising elsewhere;
- Targeting different pollutants will mean different land use options, so it is important watersheds identify their needs before any policy discussions;
- Programs must target N & P reductions to be the most effective;
- The plan should create a reasonable baseline to evaluate the value of the work already completed by watershed residents, and the optimal combinations of practices to address future needs;
- The plan should give watershed residents an idea of the magnitude of the work remaining and the challenges of implementation within the confines of limited financial resources;
- These practices and options will likely need to be accompanied by significant resources and given adequate time for implementation; and,
- Significant investment in monitoring and evaluation would enable watershed residents to be more strategic with program implementation.

Comments from Rick Robinson, Iowa Farm Bureau Federation
Received 6/9/2011

Specific Draft Plan Comments

Page 9 – Land Uses. This section would be improved with discussion of the economic impacts of land use changes.

Page 11 - Subsurface Tile Drainage, paragraph no. 2: “Although subsurface tile decreases <u>soil and phosphorus</u> runoff from the surface of a field….”

Page 13 – Nitrates. This would be an excellent opportunity to better explain soil mineralization and its role more clearly for watershed residents.

Page 14 - Priority Best Management Practices for Nitrate Reduction. Compare and contrast the “expert panel” results with modeling results in each section, including economic costs and returns of the options.

Page 16 – Phosphorus and Sediment. What percent of the P load is stream resuspension? What does the literature tell us about that? What is the likelihood of load reductions in addressing P targets?

Page 29 – Recommendation No. 2. What does the modeling show in terms of effectiveness of staking of practices (or was this technique modeled)?

Page 32 – Paragraph 2. “Where it was once only practical for a local Soil and Water Conservation District field office to <u>work with landowners to voluntarily site</u> conservation practices at the field level….”

Page 32 – Barriers and Challenges. This statement needs more explanation: “Whether the responsibility for targeting is handled at a more regional scale, or left to the local field office, precision conservation will require a fundamental shift in the way conservation programming is administered.”

Page 33 – Recommendation No. 4, first paragraph, last sentence edit. “Water quality should be positioned as a ~~concern and~~ responsibility of all residents~~, not just those who consider themselves “environmentalists”~~.

Page 33 – Recommendation No. 4, paragraph no. 2. An explanation of the difference between loading and concentration is needed, and its impacts.

Page 33-37 - Recommendation No. 4. Good discussion about the need for public education.

Page 36 - Recommendation No. 5, last paragraph, last sentence edit. “The message must be stated in a way that <u>recognizes economics and</u> is not preachy or threatening and does not alienate the farming community.”

Page 37 - Recommendation No. 5. More discussion about the opportunities for partnering with private agribusiness is needed in this section.

Page 39 – Barriers and Challenges. Do the plan facilitators have any recommendations for the option of crop consultant incentives and training, especially in working directly with landowners and farmers outside of government programs to achieve the same outcomes?

Page 42 – Recommendation No. 8. What is the RRW's rank in the MRBI program? What is it's ranking in the context of resource concerns of other watersheds? What recommendations do the report facilitators have to be able for Iowa to better rank the needs of the RRW relative to other watersheds facing nutrient and sediment issues? Funds and staff are limited, so who do we prioritize the RRW relative to other areas of the state in a fair and effective way? What other methods exit to document progress? How can we use surveys, aerial photography or development of an Iowa NRI system to help us establish baselines or measure future progress? How can we do a better job of giving farmers credit for the work that they've done (and accounting for that work)?

Page 44 – Water Quality Modeling. This section needs clarification that the modeling results are not intended for public policy decisions, but for local watershed residents and natural resource professionals to use as a guide in ranking priority subwatersheds and targeting of BMPS or limited financial resources.

Page 45 - Couple with Stakeholder Input and Expert Judgment. This is another opportunity to discuss alternatives for use of farmer surveys, aerial photography or development of an Iowa NRI system to help establish baselines, credit work already completed or measure future progress.

Thanks again for the opportunity to comment. With this information in mind, the IFBF asks the final master plan focus on implementation options that recognize right of watersheds to develop a voluntary plan of action to address the agricultural nonpoint source issues, that support ongoing water monitoring and science development, and avoids numeric targets for nitrogen, phosphorus and sediment or regulatory actions affecting fertilizer applications or other farmer management decisions.

Sincerely,

Rick Robinson

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People. Progress. Pride.
"Friend Me" On Facebook
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Comments from James Eliason
Received 6/9/2011

From:	Jim Eliason
To:	raccoon@agreninc.com
Cc:	Gautsch, Jackie [DNR]
Subject:	Raccoon River Water Quality Master Plan
Date:	Thursday, June 09, 2011 10:17:16 AM

Ladies and Gentlemen:

I read the draft master plan available on line. I'm interested in water quality and am an IOWater volunteer water sampler.

Recommendation #8 was to monitor water quality at a subwatershed scale. I think a great way to do this would be to increase participation in IOWater volunteer monitoring and by increasing coordination of monitors with an overall water quality plan.

Currently IOWater monitors are encouraged to monitor sites of personal interest, and may not coordinate their activities with anyone else, including other IOWater monitors. I think many monitors would change their monitoring site and/or add additional site(s) to their monitoring activities if they knew that other sites were of broad interest/importance. Recruiting monitors to subwatersheds listed as "very high priority" would be helpful, and improve monitor motivation. Getting schools involved in the program would also increase public awareness and amount of data.

Concerns over accuracy of the data could be addressed by having professional samplers recheck data that indicate a significant water quality problem.

Sincerely,
James L. Eliason, Ph.D.

Comments from Randy Holl,
Lake Panorama Association
Received 6/9/2011

From:	Randy Holl
To:	raccoon@agreninc.com
Subject:	comments on the Raccoon River Water Quality Master Plan draft
Date:	Thursday, June 09, 2011 10:16:05 AM

The Lake Panorama Association is supportive of the recommendations and findings of the Raccoon River Water Quality Master Plan draft. We were disappointed additional modeling is not yet available for pathogen source identification as pathogen reduction is recommended to be one of the priorities of any organization that develops to assist in the implementation of the Water Quality Plan. Sediment reduction is the Association's priority with pathogen reduction being a strong second priority. We do encourage every effort that would result in improvement of the plan's priority of nitrate reduction however, as the related benefits of some of the best management practices would give some assistance in sediment and pathogen reduction in the Middle Raccoon watershed above Lake Panorama.

Since implementation of best management practices within the watershed is dependent upon the development of leadership and organizational performance, it would be difficult to evaluate the plan for its efficacy in the recommendations for the type of organizations that might best serve the purposes of the plan. These recommendations seem sound in theory, however, but leave implementation and level of involvement in the entire watershed up to the mix of political and financial priorities. Hopefully, cooperation at a high level will enable funding and information promotion that will advance the water quality plan.

Lastly, the plan does not address the philosophical notion of whether agricultural producers should be required to use best management practices but assumes that voluntary practices will be adequate under the right organizational and funding scenarios. We suggest that an increase in promotion of these practices at a high level –whether in providing a funding source or making high level priority BMP's mandatory, are needed if the goals in reductions in watershed problems are to be seriously met.

I would like to thank Agren and the other participants for the opportunity for input into the plan process and express my hope for the continued improvement of water quality in the Raccoon River watershed as well as throughout the Midwest.

Randy Holl

Senior Administrative Assistant
Lake Panorama Association
P.O. Box 157
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Panora, IA 50216

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641 755-3810 FAX

Http://www.lakepanorama.org

Comments from Marty Adkins,
United States Department of Agriculture/Natural Resources Conservation Service
Received 6/9/2011

From: Adkins, Martin - Des Moines, IA [mailto:Martin.Adkins@ia.usda.gov]
Sent: Thursday, June 09, 2011 12:52 PM
To: raccoon@agreninc.com
Subject: Raccoon Plan comments

My comments are attached. Please let me know if you have any questions.

Marty Adkins

Martin W. Adkins
Assistant State Conservationist for Water Resources
210 Walnut Street, Room 693
Des Moines, IA 50309-2180
Phone: 515/284-4769
Fax: 515/284-4394

Follow Iowa NRCS on Twitter!

Comments from Marty Adkins,
United States Department of Agriculture/Natural Resources Conservation Service
Received 6/9/2011

Raccoon_River_Master_Plan_Draft_5_11 NRCS comments (Read-Only) [Compatibility Mode]

Main document changes and comments

Page 2: Comment [mwa1]	martin.adkins	5/25/2011 11:23:00 AM

Cropland data layers from more recent years are available through NASS.

Page 36: Comment [mwa2]	martin.adkins	5/25/2011 11:23:00 AM

The DMWW also provides water to many suburban communities and to the Xenia Rural Water System.

Page 36: Deleted	martin.adkins	5/25/2011 8:24:00 AM

considered to be

Page 36: Deleted	martin.adkins	5/25/2011 8:24:00 AM

water

Page 36: Inserted	martin.adkins	5/25/2011 8:24:00 AM

resource

Page 36: Comment [mwa3]	martin.adkins	5/25/2011 11:23:00 AM

See comment mwa2 above.

Page 36: Inserted	martin.adkins	5/25/2011 8:31:00 AM

Page 36: Comment [mwa4]	martin.adkins	5/25/2011 11:23:00 AM

Given wildlife contributions a 99% reduction is impossible to achieve.

Page 40: Comment [mwa5]	martin.adkins	5/31/2011 1:24:00 PM

At which goal or goals are these recommendations aimed? TMDL targets are included in earlier parts of the narrative; are those targets being adopted for this plan too?

Page 41: Comment [mwa6]	martin.adkins	5/31/2011 1:41:00 PM

These two priorities are true for the North and Middle Raccoon basins. Sediment and phosphorus reductions are very significant concerns in the South Raccoon basin.

Page 44: Deleted	martin.adkins	5/31/2011 1:45:00 PM

compromises

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contributes

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comprise

Page 44: Inserted	martin.adkins	5/31/2011 1:45:00 PM

manure contributes about

Page 44: Comment [mwa7]	martin.adkins	5/31/2011 2:07:00 PM

Based on my reading of the referenced report, this statement seems overly simplified. The report stated on page 13: “Larger stream N-loads are related to watersheds with greater inputs of fertilizer, ag-fertilizer, and total N inputs. For phosphorus, this preliminary analysis showed little in the way of clear relationships. As previously described, the picture for phosphorus is clouded by the considerable natural concentrations of P in Iowa sediments, the fact that P from manure and fertilizer tends to attach to soil and sediment particles, and the variable nature of P concentrations in streams under variable runoff conditions. The preliminary analysis does suggest a trend towards higher dissolved phosphorus concentrations in watersheds with greater P inputs. Further analysis of the relationships between nutrient inputs and stream quality are warranted, particularly for phosphorus."

Page 44: Inserted	martin.adkins	5/31/2011 2:07:00 PM

and phosphorus

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also can

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are also

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eroding

Page 46: Deleted	martin.adkins	5/31/2011 2:08:00 PM

Page 48: Inserted	martin.adkins	5/31/2011 2:09:00 PM

and/or trapping sediment

Page 48: Deleted	martin.adkins	5/31/2011 2:22:00 PM

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pathogen

Page 48: Inserted	martin.adkins	5/31/2011 1:33:00 PM

phosphorus

Page 48: Inserted	martin.adkins	5/31/2011 2:21:00 PM

terraces, grassed waterways, sediment and water control basins, grade stabilization structures,

Page 50: Deleted	martin.adkins	5/31/2011 2:26:00 PM

nitrate-removal

Page 50: Comment [mwa8]	martin.adkins	6/1/2011 9:14:00 AM

Non-nitrate-removal wetlands seem to be an afterthought in this section. It would be better to include them in the overall list of BMPs benefitting wildlife, and then note that nitrate removal wetlands provide water quality benefits with some habitat quality trade-offs.

Page 59: Inserted	martin.adkins	5/31/2011 2:36:00 PM

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set

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system

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nutrient control

Page 67: Inserted	martin.adkins	5/31/2011 2:48:00 PM

resource management

Page 67: Comment [mwa9]	martin.adkins	5/31/2011 2:51:00 PM

There is a sole emphasis on nutrients here, even though pathogens are targeted in other parts of the report and there is earlier acknowledgment of the importance of sediment, both as a water quality impairment itself and as a carrier of P.

Page 67: Deleted	martin.adkins	5/31/2011 2:52:00 PM

Page 67: Comment [mwa10]	martin.adkins	6/1/2011 9:23:00 AM

Terraces, sediment and water control basins, grassed waterways and grade stabilization structures should be added to this table given their utility for source reduction and trapping of sediment-bound phosphorus.

Page 67: Comment [mwa11]	martin.adkins	5/31/2011 2:56:00 PM

This paragraph might either substitute for or be somehow combined with the text at the top of this page. As it is this paragraph is repetitive.

Page 70: Comment [mwa12]	martin.adkins	6/1/2011 9:27:00 AM

Lack of targeting of cost-share funding and/or inadequate targeting of conservation planning assistance (or lack of planning period) seems to be what you're getting at here. Is that correct? A more specific discussion of the problem would be helpful here.

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Page 70: Comment [mwa13]	martin.adkins	5/31/2011 3:07:00 PM

High labor requirements due to the limitations of current tools?

Page 70: Comment [mwa14]	martin.adkins	5/31/2011 3:09:00 PM

Time requirements might be excessive? (See comment mwa13.)

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general

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of the general public about

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of

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small

Page 71: Comment [mwa15]	martin.adkins	5/31/2011 3:12:00 PM

Was this an expert panel assumption or is there survey data available?

Page 71: Comment [mwa16]	martin.adkins	5/31/2011 3:13:00 PM

This statement doesn't seem to square with the second sentence in this paragraph.

Page 72: Comment [mwa17]	martin.adkins	5/31/2011 3:14:00 PM

Why?

Page 72: Comment [mwa18]	martin.adkins	5/31/2011 3:19:00 PM

Are Iowa Learning Farm events drawing non-farm audience members in significant enough numbers to plan on this as a significant strategy?

Page 72: Comment [mwa19]	martin.adkins	5/31/2011 3:20:00 PM

Agribusinesses? Local and absentee landlords? Lenders?

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n effective,

Page 72: Comment [mwa20]	martin.adkins	5/31/2011 3:24:00 PM

I disagree, especially if we insert the word "effective" in this sentence. There might need to be several iterations of trial message development, delivery and evaluation of results before a message is shown to really work. The use of focus groups might be a really good idea to help manage costs and to avoid a series of starts and stops with ineffective messages.

Page 72: Comment [mwa21]	martin.adkins	5/31/2011 3:29:00 PM

How about foundation or corporate sponsorship?

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high level of un

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lack of

Page 73: Inserted	martin.adkins	5/31/2011 3:38:00 PM

on the part of farmers and landowners

Page 74: Comment [mwa22]	martin.adkins	5/31/2011 3:51:00 PM

See comment mwa20. It applies here too.

Page 77: Inserted martin.adkins 5/31/2011 3:56:00 PM

Agronomists will also need to understand the limits of their expertise and when to engage other specialists including NRCS and IDALS-DSC conservationists and engineers.

Page 77: Deleted martin.adkins 6/1/2011 8:37:00 AM

Finally, a

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Page 77: Inserted martin.adkins 6/1/2011 8:37:00 AM

. Finally, adherence to the existing NRCS TSP quality assurance framework will be needed to ensure that conservation planning assistance provided by both public and private sector providers is technically sound.

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phosphorus, sediment

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Page 82: Comment [mwa23] martin.adkins 6/1/2011 8:29:00 AM

This section would fit better in an appendix rather than in the main document.

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Header and footer changes

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Text Box changes

Page 49: Inserted martin.adkins 5/31/2011 2:23:00 PM

Terraces
Grassed waterways
Sediment and water control basins
Grade stabilization structures

Page 50: Deleted	martin.adkins	5/31/2011 2:26:00 PM

Nitrate-removal

Header and footer text box changes

Footnote changes

Endnote changes

Comments from Harry Ahrenholtz,
Agriculture's Clean Water Alliance
Received 6/10/2011

From:	Harry Ahrenholtz
To:	raccoon@agreninc.com
Subject:	FW: Draft Racoon River Water Quality Master Plan Comments
Date:	Friday, June 10, 2011 3:35:50 PM
Attachments:	Ahrenholtz ltr2.doc

From: Harry Ahrenholtz
Sent: Friday, June 10, 2011 3:16 PM
To: racoon@agreninc.com
Cc: Roger Wolf
Subject: Draft Racoon River Water Quality Master Plan Comments

We are pleased to comment on the Master Plan Draft. A hard copy is being sent via regular mail also. Thank you for the opportunity.

Comments from Harry Ahrenholtz,
Agriculture's Clean Water Alliance
Received 6/10/2011

June 9, 2011

Agren Inc.
Att: RRWQMP
1238 Heires Ave.
Carroll, IA 51401

RE: Draft Raccoon River Water Quality Master Plan Comments

On behalf of the Agriculture's Clean Water Alliance (ACWA), we appreciate the opportunity to comment on the Draft Raccoon River Water Quality Master Plan. The ACWA is an association of 13 ag retailers operating in the Des Moines and Raccoon River basins. Many of us are direct competitors. As ag retailers, we are aware of our dual mission to help farmers improve agronomic performance in the field while supporting environmental performance beyond the field's edge. Because of their role as drinking water sources, sport fisheries, and paddling destinations, the Raccoon and Des Moines Rivers are important indicator streams for Iowa. Also, because their course takes them through one of the world's most fertile agricultural regions, they are important environmental indicators for agriculture.

People from every link in Iowa's environmental chain — farmers, agronomists, environmentalists, agencies and policy makers — are seeking scientific data, workable solutions, and leadership in an attempt to get water quality improvements. The first step is to gain a better understanding of the complex land-water interface and how agricultural management practices actually impact surface waters.

In 1999, ten of us doing business in West Central Iowa joined together to initiate a cooperative project that would establish a comprehensive database of water quality information for the state's largest source of municipal drinking water: the Raccoon River. Volunteers were recruited and trained as Certified Samplers to help collect samples, and delivery to the Des Moines Water Works testing laboratory was coordinated through project leaders. Thus was born the Agriculture's Clean Water Alliance (ACWA), a 501(c)(3) non-profit organization funded, to date, entirely by member dues taken from a percentage of their annual nitrogen fertilizer sales.

The organization began with the simple premise of collecting data through a certified water sampling effort. Just as we use agronomic data to predict agronomic performance, ACWA and

Comments from Harry Ahrenholtz,
Agriculture's Clean Water Alliance
Received 6/10/2011

its partners believe we need good environmental data to understand the nature of the problems we face, identify solutions for those problems, and evaluate the effectiveness of those solutions. Consistently collected data along these waters draining agricultural lands was lacking, and these agribusinesses stepped up to the plate. Neither they nor their farmer customers wanted the products intended for improving crops to end up instead in their local and downstream waters.

Since 1999, ACWA members have invested over $1 million funding water quality monitoring in the Raccoon, and since 2008, in the Des Moines, and their largest tributaries. Well over 10,000 samples have been collected by over 200 Certified Samplers (some sites using automated samplers) and analyzed for nitrate-nitrogen, and over 1000 for *E. coli* bacteria. In addition, ACWA funded the first successful real-time nitrate analyzer in Iowa, a device installed in the Raccoon River at Van Meter. This remote monitor has been providing minute-to-minute nitrate data to the general public via the internet since 2008. The success of this project led researchers at the University of Iowa and the U.S. Geological Survey to implement similar projects of their own on the Mississippi and Iowa Rivers. ACWA continued with this theme by helping fund another remote monitoring device on the Middle Raccoon River at Panora in 2010.

All ACWA members follow a Code of Practice for fall application of nitrogen, perhaps the only one of its kind in the nation. This is a formal agreement among the retailers that they will not distribute anhydrous ammonia for fall application until soil temperatures reach 50 degrees F at a depth of four inches (60 degrees F with use of a nitrification inhibitor) with a forecast of cooling soil temperatures. This is a Best Management Practice designed to reduce nitrogen loss to streams from row crop agriculture.

In 2008, ACWA doubled its scope by recruiting members from the Des Moines River Watershed, in North Central Iowa and South Central Minnesota, and extending its water monitoring network to cover the Des Moines River, which the Raccoon River joins in Des Moines, and its tributaries. Now made up of 13 member retailers, ACWA's expanded mission is to reduce nitrogen and phosphorous loss from farm fields and keep them from entering the Raccoon and Des Moines Rivers and their tributaries. ACWA intends to continue building membership in the Des Moines Basin with offers of membership to other organizations that support its mission.

Through monitoring, ACWA has been able to change some individual operator management practices upstream. The water quality data has helped farmers understand the importance of nutrient management, and how this is manifested in improved water quality for Iowa.

Monitoring helps estimate the locations of possible impairment sources within the basin. This enables the project team to target specific things that can be addressed and resolved quickly, manifesting a real impact. ACWA is focused on the Raccoon and Des Moines River watersheds, where farmers are experimenting with management practices. ACWA can monitor and compare performance above and below these practices, and contrast them with a non-treated area to determine if changes in management can be part of the solution to water quality impairments. As the local watershed community figures out what are the most cost effective strategies for addressing their concerns, credible data, and the ability to interpret it, become imperative.

Comments from Harry Ahrenholtz,
Agriculture's Clean Water Alliance
Received 6/10/2011

Characterization of nitrate-nitrogen throughout the watershed has helped Des Moines Water Works (DMWW) more effectively manage their systems for nitrate removal, and the remote Van Meter device provides DMWW advance warning of high-nitrate episodes. The Van Meter data has also been integral to stream research conducted at Iowa State University and the University of Iowa.

ACWA Certified Samplers helped characterize two acute water quality events: the elevated ammonia episode observed in Iowa rivers during the spring of 2008, and the cyanobacteria bloom in Black Hawk Lake, which caused a deterioration of water quality in the Raccoon River, in 2009.

ACWA's monitoring data directly led to the following watershed projects: a WIRB-funded project conducted by DMWW in the Upper Brushy Creek Watershed, resulting in a 50% reduction in *E. coli* bacteria measured at Dedham, IA; Watershed Development and Planning Assistance Grants for the Elk Run and Lyons Creek Watersheds and a 319 IDNR/EPA grant for implementation in Lyons Creek; and targeting of West Buttrick (in the Raccoon) and Lyons Creek, Lower Eagle, and Buck Creek watersheds (in the Boone) as locations for USDA Mississippi River Basin Initiative (MRBI) grant applications, which were successful, resulting in four years of focused, additional funding support and partnership effort to apply priority conservation practices that avoid, control or trap nutrients in these watersheds.

The ACWA water monitoring project has positively linked users of the resource and institutions in a way that is enhancing water quality while recognizing farmers' needs to remain profitable and meet growing demands for their crops. The project has demonstrated the importance of partnerships, and how water quality needs and issues can be addressed in a non-adversarial way by focusing on facts and identifying and promoting multiple solutions that deliver results and are sustainable over time.

The 2012 ACWA Work Plan includes objectives and actions that will continue support in being a leading supplier of watershed, water quality and nutrient management information. ACWA continues to consider ways to provide our network of around 200 Certified Crop Advisors (CCA) water quality training and to work on developing sub watershed plans as a way to encourage targeted programming that may include strategies such as enhanced nutrient management, wetland restorations and bioreactors. Our objectives include design, development, and execution of communications tactics that meet the needs of members and informs broader audiences about activities of ACWA.

Our objectives include the following:

- Support base programs that continue the water monitoring program.
- Continue to respond to opportunities to secure resources to support focused special projects consistent with ACWA mission.
- Continue coordination with ACWA partners like Des Moines Water Works, USDA Lab for Agriculture and the Environment, Iowa State University, Iowa Department of Natural Resources, Iowa Division of Soil Conservation and USDA –NRCS.
- Continue working with partners on targeted projects and implementation strategies including providing leadership on Raccoon River master plan implementation.

Recommendations and comments specific to the draft Raccoon River Master Plan dated May 9, 2011:

- Recommend that stakeholder and public comments like this one need to become published as part of the record of the Master Plan
- Recognize that Agren did a good job of delivering what they original proposed to do
- Recognize that Agren did not have a specific definition provided to them on what constitutes a Master Plan
- Recognize the importance of the private sector delivery of technical assistance; however more elaboration of how this could work should be included and supported.
- The Master Plan document falls short of actually being a "plan" in our view as it simply does not establish goals, objectives, timelines, responsibilities etc… It essentially is a guidance document of stakeholder input coupled with expert assessment and analysis with primary recommendations for the watershed community to select in what could be considered a Master Plan.
- The document does not address the financial implications of what it will take to meet the recommendations. This information will be important consideration for the watershed stakeholders. In addition this plan will compete for resources at the state and federal level and there is no discussion how the plan might relate with those opportunities. The reality is a significant amount of work will be needed for projects to compete for funding – e.g. defined goals, targets and specific implementation strategies. An enhancement to the current document might highlight current examples already underway.
- The document does recommend the formation of a regional watershed planning organization to guide future implementation and includes the rationale for establishing it, however; there should be more specific information detailing who should or could be involved, its potential structure and how it will be sustainably funded.

In closing, the ACWA remains committed to helping the farmers and watershed community to be productive while improving water management. We appreciate the opportunity to participate, support and engage in these discussions. We hope you find these comments useful. If you have questions or comments do not hesitate to contact me.

Sincerely,

Harry Ahrenholtz
President
Agriculture's Clean Water Alliance
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406 First Street
Ralston, Iowa 51459
712-667-3200
harrya@westcentral.net

Comments from Tom Shipley,
Iowa Cattlemen's Association
Received 6/10/2011

From: Tom Shipley
To: raccoon@agreninc.com
Subject: comments
Date: Friday, June 10, 2011 3:36:38 PM

Comments regarding the Raccoon River Water Quality Master Plan-

As we at Iowa Cattlemen's Association only recently received a copy of this report (2 days prior to comment deadline) we will only address an issue that is most visible- fencing of streams to keep cattle out.

First we would like to say that we had no input on this plan. I attended the "meeting" at Auburn on June 7th. Stakeholders and representatives of ag groups were present but there was nothing that was part of developing a plan.

We strongly object to the portion of the plan that suggests that restricting access to streams by fencing will improve water quality- specifically pathogen reduction.
This has been refuted by Dr. Jim Russell in a current study funded by the Leopold Center at Iowa State University. He says that the research indicates that it is NOT necessary to deny cows access to water in a stream.

Dr. Russell states-

" What our research refutes is the belief that the only solution of sediment, phosphorous, and PATHOGEN loading of pasture streams is exclusion fencing.

Instead, our research shows that the risks of sediment, phosphorous, and pathogen pollution associated with grazing may be significantly reduced by

management practices that reduce the amount of time cattle congregate in and near pasture streams- the larger and wider the pasture, the less the need for

these practices.

Aside from this research, the lack of density of the animals on pasture makes one wonder why this is given as such a big concern. If 4% of the acres in the watershed are grazing lands this means there are 92,000 acres. If that can sustain 40,000 cows that means there are 11 cows per square mile. Where is the logic that this is an environmental hazard?

The state of Iowa has lost almost half of the cows that were here 25-30 years ago. This has severely impacted the economy and environment of rural Iowa. The proposals in this plan would only make the situation worse and drive more fragile acres into cultivation which only makes the problems worse.

Thank you.

Tom Shipley
Dir. of Issues Management and Policy Implementation
Iowa Cattlemen's Association
515-296-2266
712-621-3276-cell

From: Jim Patrick [mailto:Patrick@stormlake.org]
Sent: Monday, June 13, 2011 9:30 AM
To: 'raccoon@agreninc.com'
Subject: Comments on Raccoon River Basin

Response to Request for Comments to the Raccoon River Water Quality Master Plan
(Developed by AGREN, M&M Divide RC&D)

Municipalities are faced with limited funding for infrastructure projects. Point source discharges from municipalities are not identified as significant contributors to the water quality issues addressed in this report. The majority of current treatment plants are doing a good job and more stringent limits will have limited benefits to the watershed compared to investments in storm water management and agriculture runoff improvements.

Therefore, we would request that the report add a statement or full recommendation that the mandated future programs be evaluated for overall environmental effectiveness in an effort to determine if the dollars spent will have a significant impact on water quality within this watershed. The DNR should prioritize municipal projects so that storm water management projects are given priority over advanced treatment NPDES requirements. Dollars spent to manage these types of initiatives will have a greater impact than further nutrient removal from source point dischargers.
Municipalities should be given encouragement and their discharge permits should reflect the importance of serving non-sewered housing developments.

I was not on the list of panel members.

Thank you for your efforts on this plan.

James Patrick
City Manager
City of Storm Lake

Comments from Jay Ritchie, AGREM
Received 6/20/2011

From: Jay Ritchie
To: Jamie Ridgely
Subject: Raccoon River Water Quality
Date: Monday, June 20, 2011 8:04:33 AM

Jamie Ridgely,

We were forwarded an e-mail concerning the project underway to improve the water quality of the Raccoon River Watershed. I just wanted to let you know about our contoured and controlled drainage and irrigation systems that both help farmers grow better, more consistent yields, and help protect the environment from agricultural runoff. The systems we design are affordable and effective, allowing the farmer to start by installing controlled drainage at first, and upgrade later, if desired, to a full subirrigation system with reservoirs , and even artificial wetlands. Our subirrigation system can be used to apply processed effluent from cattle or hog operations to the field in a controlled manner that minimizes the risk of contaminating nearby streams and rivers, even when the crops are in. We would be happy to speak with you to explain our contoured and controlled drainage and irrigation design services and how these systems could benefit the Raccoon River Water Shed, the people who use the waters, and the farmers that grow crops and raise livestock in your area.

More information can be found at www.agrem.com

Jay Ritchie,
AGREM, LLC.
309 530-9271

Comments from Jim Gillespie,
Iowa Department of Agriculture and Land Stewardship
Received 7/6/2011

From: Gillespie, Jim [mailto:Jim.Gillespie@Iowaagriculture.gov]
Sent: Wednesday, July 06, 2011 4:17 PM
To: Jamie Ridgely
Cc: Kiel, Adam [DNR]; william.ehm@dnr.state.ia.us; tom@agreninc.com; Gipp, Chuck
Subject: RE: Raccoon River Master Plan wrap-up

Jamie:
First of all, I am sorry for the late comments, and thank you for letting me share some final thoughts.

I still have a problem calling this a "MASTER PLAN" like it addresses all environmental issues. It tends to concentrate on the impairment, that being nutrients and bacteria and what practices might be used to address these. When there are a lot of issues in the Raccoon River from top to bottom, land-use to landscape. And the impairment can always change, not to mention flooding and other environmental issues.

It is fine to recommend the best known approaches to try and address the current impairments, but we should not limit ourselves to just a certain few, as if these were silver bullets. We don't have enough resources, such as financial and technical, to deal with the whole Raccoon River Watershed, so concentrating on critical issue "IS" important. But this is really a plan to address the current impairments.

I remember brining these topics up in the group sessions and I have not changed my mind yet. You can take my comments for what they are worth and do what you like with them.
Gillespie