Lake Sinissippi-Rock River Nonpoint Source Watershed Implementation Plan

Prepared by:

Dodge County Land and Water Conservation Department

2019

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127 East Oak Street

Juneau, WI 53039

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Table of Contents

List of Figures

List of Tables

List of Appendices

Acknowledgements

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Lake Sinissippi-Rock River Watershed Implementation Plan

Executive Summary

The Lake Sinissippi-Rock River Watershed is a sub watershed of the Upper Rock River Basin and is located in southeast Wisconsin in Dodge County. Lake Sinissippi-Rock River is in the Towns of Hubbard, Hustisford, Oak Grove, and the village of Hustisford. The Lake Sinissippi-Rock River Watershed drains approximately 22,540 acres.

Historically, the land in this area was covered with forests, wetlands, prairies, and oak savannas. The Upper Rock River Basin was home to many Native American cultures before Europeans began to settle in the area in the early 1800's. Farming in the area has led to clearing of forests and natural areas and draining of wetlands in the Upper Rock River Basin. Farming, industry, and urban development in the Lake Sinissippi-Rock River Watershed has led to poor water quality in the Upper Rock River.

Agriculture is the dominant land use in the Lake Sinissippi-Rock River watershed and is the main contributor of the watershed to poor water quality. There is also 303,860 acres that drain into the Rock River flowing through Lake Sinissippi. The Dead Creek Watershed has 19,584 acres that also drains into Lake Sinissippi that is not part of the Lake Sinissippi-Rock River Watershed. An inventory of the stream banks indicates that streambank erosion is not a major contributor of sediment or nutrients. The extent of tile drainage in this watershed area may also play a factor into the amount of nutrient and sediment loading.

The Lake Sinissippi-Rock River Watershed Plan Provides a Framework to Accomplish the Following Goals:

Goal #1: Improve surface water quality to meet TMDL limits for total phosphorus and sediment.

Goal #2: Increase citizens' awareness of water quality issues and active participation in stewardship of the watershed.

Goal #3: Reduce runoff volume and flood levels during peak storm events.

Challenges and Sources in the Watershed:

Lake Sinissippi-Rock River Watershed is 22,540 acres. However, an additional 326,400 acres drain into the lake through the Rock River and Dead Creek. According to the "Water Quality Monitoring and Assessment-Rock River, Dead Creek and Lake Sinissippi-2015", the Rock River contributes 65.0% water inflow, 89.7% of the TP and 90.0% of the TSS loadings. Dead Creek contributes 4.0% water inflow, 4.4% of the TP and 3.9% of the TSS. The HUC12 watershed itself contributes 3.3% water inflow, 3.6% TP and 3.2% TSS. Within the watershed itself, the dominant land use in the watershed is agriculture and is responsible for 96.7% of the phosphorus and 97.7% of the sediment loading in the watershed. Agricultural runoff and erosion as well as subsurface drainage are likely the main contributors to nutrient and sediment loading in the watershed.

Watershed Implementation Plan:

The TMDL goals for the Lake Sinissippi- Rock River Watershed can not be met by working only in the HUC12 watershed as there are 326,400 acres that drain into the watershed via the Rock River and the Dead Creek HUC12. The watershed will be split into 4 areas, (NW, NE, SW, and SE), and a 10-year implementation plan will be developed based on stream goals. The action plan recommends best management practices, information and education activities, and needed restoration to achieve the goals of the watershed project. The plan includes estimated costs, potential funding sources, agencies responsible for implementation, and a measure of success.

Recommended Management Practices:

- Reduced Tillage Methods (Strip/Zone till, No till, Mulch till)
- Cover Crops
- Harvestable Vegetated Buffers
- Wetland Restoration
- Grassed Waterways
- Nutrient Management
- Vertical Manure Injection
- Streambank or Shoreline Protection
- Exploring new technologies/practices (soil amendments, tile drainage water management, phosphorus removal structures, etc.)

Education and Information Recommendations:

- Provide educational workshops and tours on how to implement best management practices.
- Engage landowners in planning and implementing conservation on their land and ensuring they know what technical tools and financial support is available to them.
- Provide information on water quality and conservation practices to landowners in the watershed area.
- Newsletters and/or webpage with watershed project updates and other pertinent conservation related information.

Conclusion

Meeting the goals for the Lake Sinissippi-Rock River watershed will be challenging. Watershed planning and implementation is primarily a voluntary effort with limited enforcement for “non-compliant” sites that will need to be supported by focused technical and financial assistance. It will require widespread cooperation and commitment of the watershed community to improve the water quality and condition of the watershed. This plan needs to be adaptable to the many challenges, changes, and lessons that will be found in this watershed area.

List of Acronyms

AM- Adaptive Management

BMP- Best Management Practice

CAFO- Concentrated Animal Feeding Operation

CLU- Common Land Unit

GIS- Geographic Information System

HSG-Hydrologic Soil Group

URRB- Upper Rock River Basin

LWCD- Land and Water Conservation Department

MS4- Municipal Separate Storm Sewer System

NRCS-Natural Resource Conservation Service

PI- Phosphorus Index

SNAP-Soil Nutrient Application Planner

SSURGO- Soil Survey Geographic Database

USEPA- United States Environmental Protection Agency

UWEX- University of Wisconsin Extension

USDA- United States Department of Agriculture

USGS-United States Geologic Service

WDNR-Wisconsin Department of Natural Resources

WPDES- Wisconsin Pollutant Discharge Elimination System

WWTF- Waste Water Treatment Facility

TMDL-Total Maximum Daily Load

TP- Total Phosphorus xiv

TSS- Total Suspended Solids

WQT- Water Quality Trading

1.0 Introduction

1.1 Lake Sinissippi-Rock River Watershed Setting

The Lake Sinissippi-Rock River Watershed is a sub watershed of the Upper Rock River Watershed in Wisconsin and is represented in figure 1.1. The Lake Sinissippi-Rock River watershed is located entirely in Dodge County. The Lake Sinissippi-Rock River watershed is a total area of 22,540 acres. Lake Sinissippi is approximately 2,855 acres. Thus, 19,685 acres drain into Lake Sinissippi and the Rock River. The Rock River flows through the Lake Sinissippi-Rock River Watershed. The watershed is 51.4% agricultural land and 48.6% non-agricultural land. The watershed includes portions of the Towns of Hubbard, Hustisford, Oak Grove, part of the cities of Horicon and Juneau as well as part of the village of Hustisford.

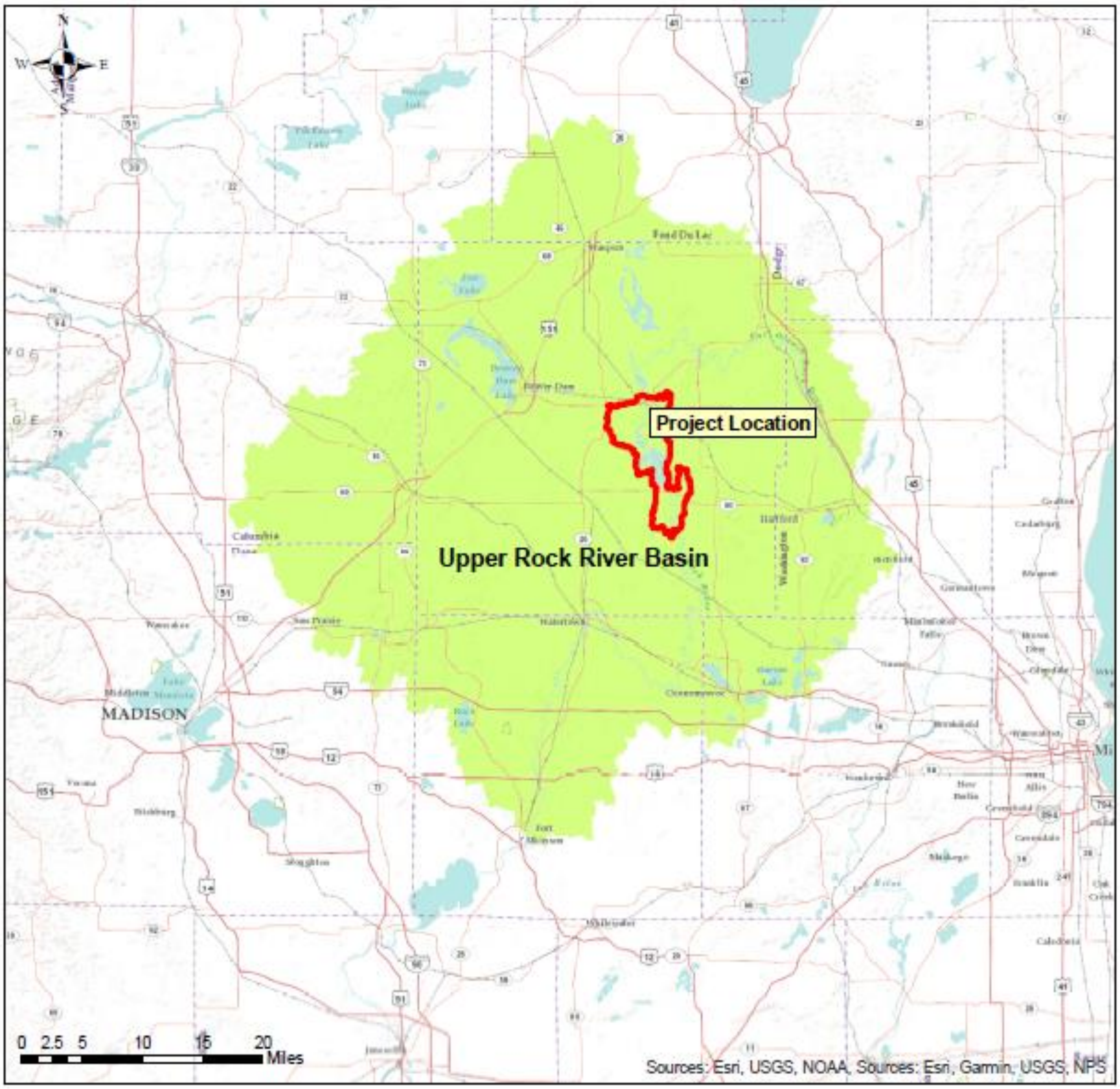


Figure 1.1: **Lake Sinissippi-Rock River Watershed**

1.2 Purpose

Excessive sediment and nutrient loading to the Rock River basin has led to increased algal blooms, oxygen depletion, water clarity issues, and degraded habitat. Algal blooms can be toxic to humans and costly to a local economy. Due to the impairments of the Rock River Basin, a TMDL (Total Maximum Daily Load) was developed for the Rock River basin and its tributaries that was approved in 1995. The purpose of this project is to develop an implementation plan for the Lake Sinissippi-Rock River sub watershed to meet the requirements of the TMDL. The Rock River TMDL requires that any tributaries to the Rock River meet a median summer total phosphorus limit of 0.075 mg/l or less.

1.3 US EPA Watershed Plan Requirements

In 1987, Congress enacted Section 319 of the Clean Water Act, which established a national program to control nonpoint sources of water pollution. Section 319 grant funding is available to states, tribes, and territories for the restoration of impaired waters and to protect unimpaired/high quality waters. Watershed plans funded by Clean Water Act section 319 funds must address nine key elements that the EPA has identified as critical for achieving improvements in water quality (USEPA, 2008). The nine elements from the USEPA Nonpoint Source Program and Grants Guidelines for States and Territories are as follows:

1. Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan. Sources that need to be controlled should be identified at the significant subcategory level along with estimates of the extent to which they are present in the watershed

2. An estimate of the load reductions expected from management measures.

3. A description of the nonpoint source management measures that will need to be implemented to achieve load reductions in element 2, and a description of the critical areas in which those measures will be needed to implement this plan.

4. Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.

5. An information and education component used to enhance public understanding of the plan and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.

6. Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.

7. A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.

8. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.

9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under element 8.

1.4 Prior Studies, Projects, and Existing Resource Management and Comprehensive Plans

Various studies have been completed in the Upper Rock River Basin describing and analyzing conditions in the area. Management and Comprehensive plans as well as monitoring programs have already been developed for the Upper Rock River Basin. A list of known studies, plans, and monitoring programs are listed below:

Water Quality Monitoring and Assessment-Rock River, Dead Creek and Lake Sinissippi Dodge County-2015

This is an assessment of water inflow volume and loading of pollutants to Lake Sinissippi

Total Maximum Daily Loads for Total Phosphorus and Total Suspended Solids in the Upper Rock River Basin -2011

The *TMDL for Total Phosphorus and Total Suspended Solids in the Upper Rock River Basin* was prepared by the Cadmus Group for the EPA and WDNR and was approved in 2011. This plan set a TMDL for the Upper Rock River and its tributaries as well as estimated current pollutant loading and loading reductions needed to meet the TMDL for each sub watershed in the Upper Rock River Basin.

The State of the Rock River Basin-2002

The State of the Rock River Basin Plan report is an overview of the state of the natural resources of the Rock River Basin. It is an educational document.

Upper Rock River Watershed Management Plan-2002

The Upper Rock River Watershed Management Plan is an appendix to the State of the Rock River Basin publication. Most of the information was obtained from the Upper Rock River Basin Water Quality Management Plan-1995

Upper Rock River Basin Water Quality Management Plan-1995

The Wisconsin Department of Natural Resources developed the Upper Rock River Basin Water Quality Management Plan with assistance from the Bureaus of Water Resources, Fisheries, and Wastewater Management. The plan focuses on water quality issues and problems as they relate to surface waters in the Basin, including the Horicon Marsh.

1.5 Wisconsin Ecoregion

Ecoregions are based on biotic and abiotic factors such as climate, geology, vegetation, wildlife, and hydrology. The mapping of ecoregions is beneficial in the management of ecosystems and has been derived from the work of James M. Omerik of the USGS. The Lake Sinissippi-Rock River watershed is located in the Southeastern Wisconsin Savannah and Till Plains ecoregion. The Southeastern Wisconsin Till Plains supports a variety of vegetation-types from hardwood forests to tall grass prairies. Land used in this region is mostly used for cropland and has a higher plant hardiness value than in ecoregions to the north and west (Figure 1.2).

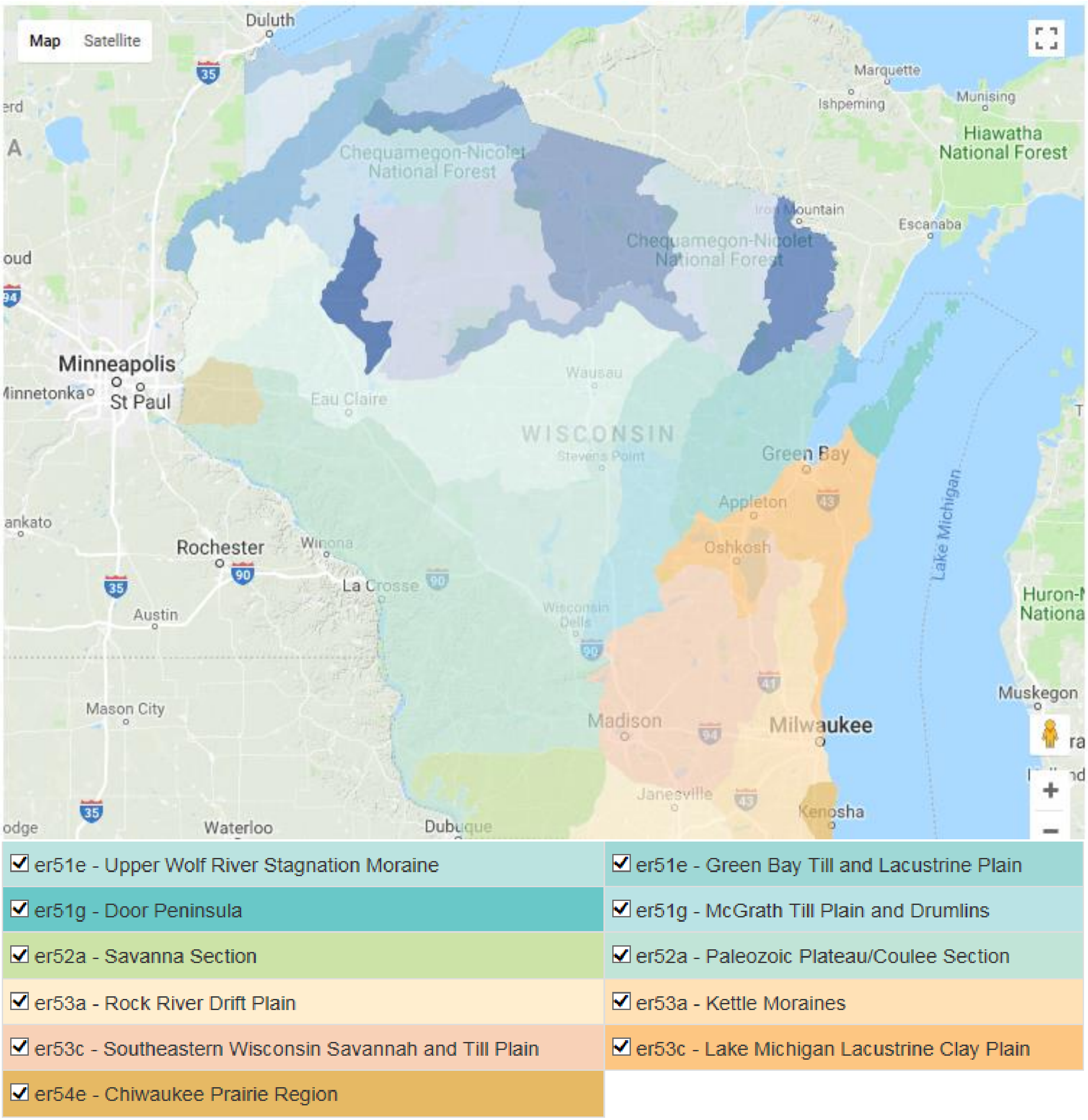


Figure 1.2: Wisconsin Ecoregions

1.6 Climate

Wisconsin has a continental climate that is affected by Lake Michigan and Lake Superior. Wisconsin typically has cold, snowy winters and warm summers. The average annual temperature ranges from a low of 35.8°F to 56°F. Temperatures can reach minus 30°F or colder in the winter and above 90°F in the summer. Average annual precipitation is about 35.1 inches a year in the watershed area. The climate in central and southern Wisconsin is favorable for dairy farming, where corn, small grains, hay, and vegetables are the primary crops.

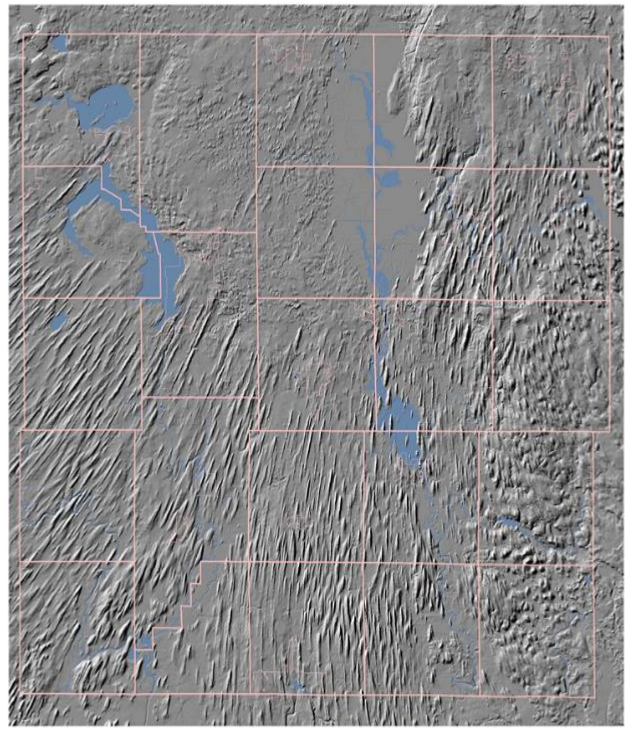


Figure 1.3: Dodge County Drumlin Fields

Dodge County
Land Resources and Parks
Department

1.7 Topology and Geology

The Lake Sinissippi-Rock River watershed area was part of the glaciated portion of Wisconsin. During the last Ice Age the Laurentide Ice Sheet began to advance into Wisconsin where it expanded for 10,000 years before it began to melt back after another 6,500 years. Glaciers have greatly impacted the geology of the area. During the Ice Age, a massive ice sheet covered all of Dodge County. The county's present day topography was shaped by the advance and retreat of this ice mass. Glacial debris was deposited as ground moraine and other glacial formations, varying in thickness from 100 to 300 feet in depth. One of the most unique glacial formations are the glacial drumlin (elongated hills). Figure 1.3 shows the orientation of these drumlin hills while Figure 1.4 shows the ice geology for the state of Wisconsin. There is approximately 400 feet of elevation change in the Lake Sinissippi-Rock River Watershed, with the highest points reaching 948 feet above sea level in the western side, to 846 feet above sea level in the southern portions of the county. Figure 1.5. The two most prominent topographic features in the county include the very flat, marsh areas such as the Horicon Marsh, and the Niagara Escarpment, which rises 190 feet in some areas.

Figure 1.4: Ice Age Geology of Wisconsin
©Mountain Press, 2004

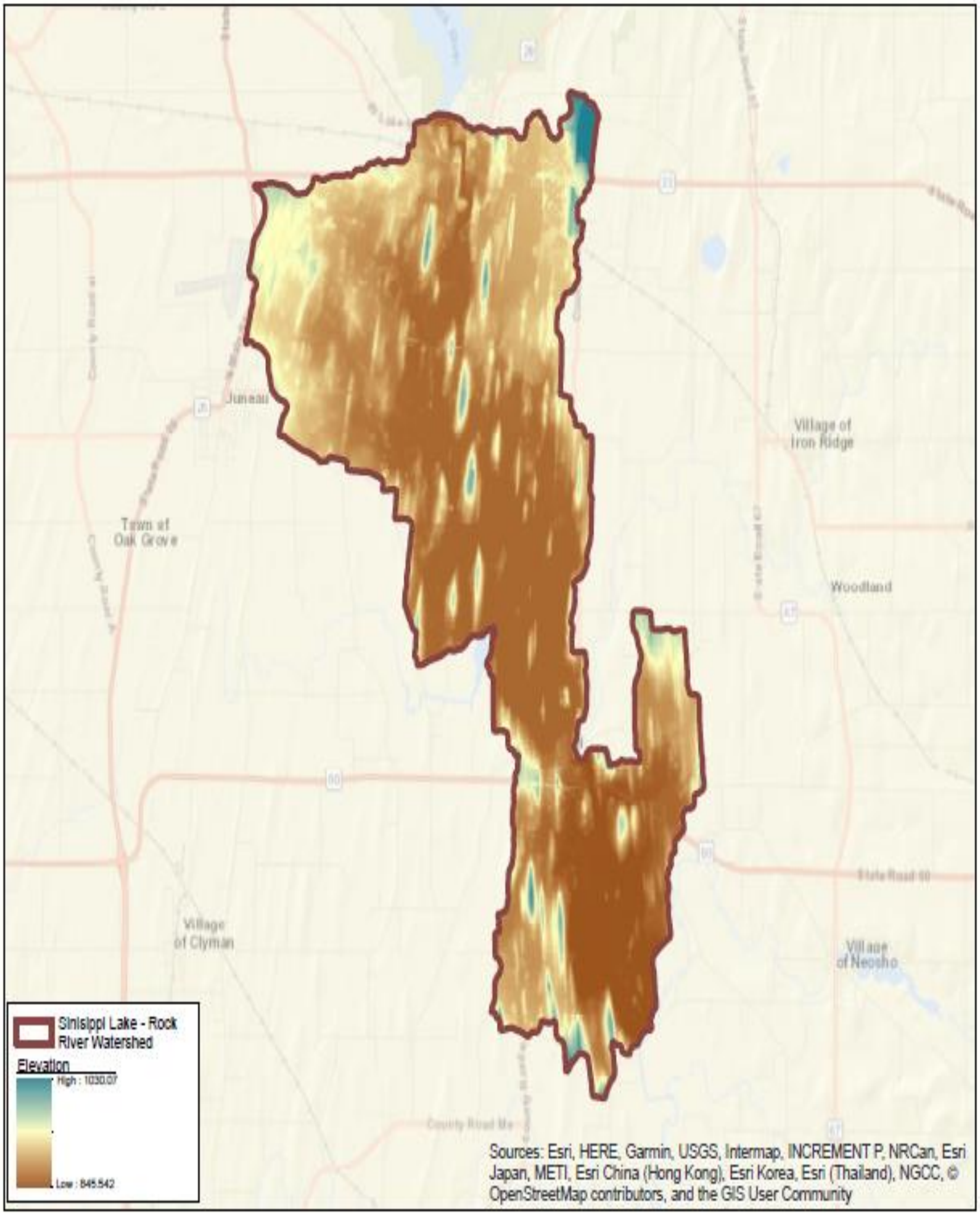


Figure 1.5: Lake Sinissippi-Rock River Elevation

1.8 Soil Characteristics

Soil data for the watershed was obtained from the Natural Resources Conservation Service Soil Survey Geographic (SSURGO) database. The type of soil and its characteristics are important for planning management practices in a watershed. Factors such as erodibility, hydric group, hydric rating, and slope are important in estimating erosion and runoff in a watershed.

The dominant soil types in the watershed are Pella Silty Clay Loam (20.4%), Elburn Silt Loam (9.9 %), and Miami Silt Loam (9.8%).

Hydrologic Soil Group

Soils are classified into hydrologic soil groups based on soil infiltration and transmission rate (permeability). Hydrologic soil groups, along with land use, management practices, and hydrologic conditions determine a soil's runoff curve number. Runoff curve numbers are used to estimate direct runoff from rainfall. There are four hydrologic soil groups: A, B, C, and D. Descriptions of Runoff Potential, Infiltration Rate, and Transmission Rate of each group are shown in Table 1.1. Some soils fall into a dual hydrologic soil group (A/D, B/D, and C/D) based on their saturated hydraulic conductivity and water table depth when drained. The first letter applies to the drained condition and the second letter applies to the undrained condition. Table 1.2 summarizes the acreage and percent of each group present in the watershed and Figure 1.6: shows the location of each hydrologic soil group. The dominant hydrologic soil group in the watershed is Group B (40.1%). Group D soils have the highest runoff potential followed by group C. Soils with high runoff potentials account for 39.2% of the soils in the watershed.

Table 1.1: Hydrologic Soil Group Description

HSG	Runoff Potential	Infiltration Rate	Transmission Rate
A	Low	High	High
B	Moderately Low	Moderate	Moderate
C	Moderately High	Low	Low
D	High	Very Low	Very Low

Soil Erodibility

The susceptibility of a soil to wind and water erosion depends on soil type and slope. Course textured soils, such as sand, are more susceptible to erosion than fine textured soils such as clay. The soil erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. It is one of the six factors used in the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons/acre/year. Values of K range from 0.27 to 0.37. The majority of the soils in the Lake Sinissippi-Rock River watershed have moderate to high values for Erodibility (K) (Figure 1.7).

Table 1.2: Hydrologic Soil Groups in Lake Sinissippi

Hydrologic Soil Group	Acres	Percent
A	331.6	1.7
A/D	973.7	5.0
B	7793.9	40.1
B/D	2711.9	14.0
C	3141.0	16.2
C/D	3515.9	18.1
D	953.6	4.9
Total	**19421.6**	**100.0**

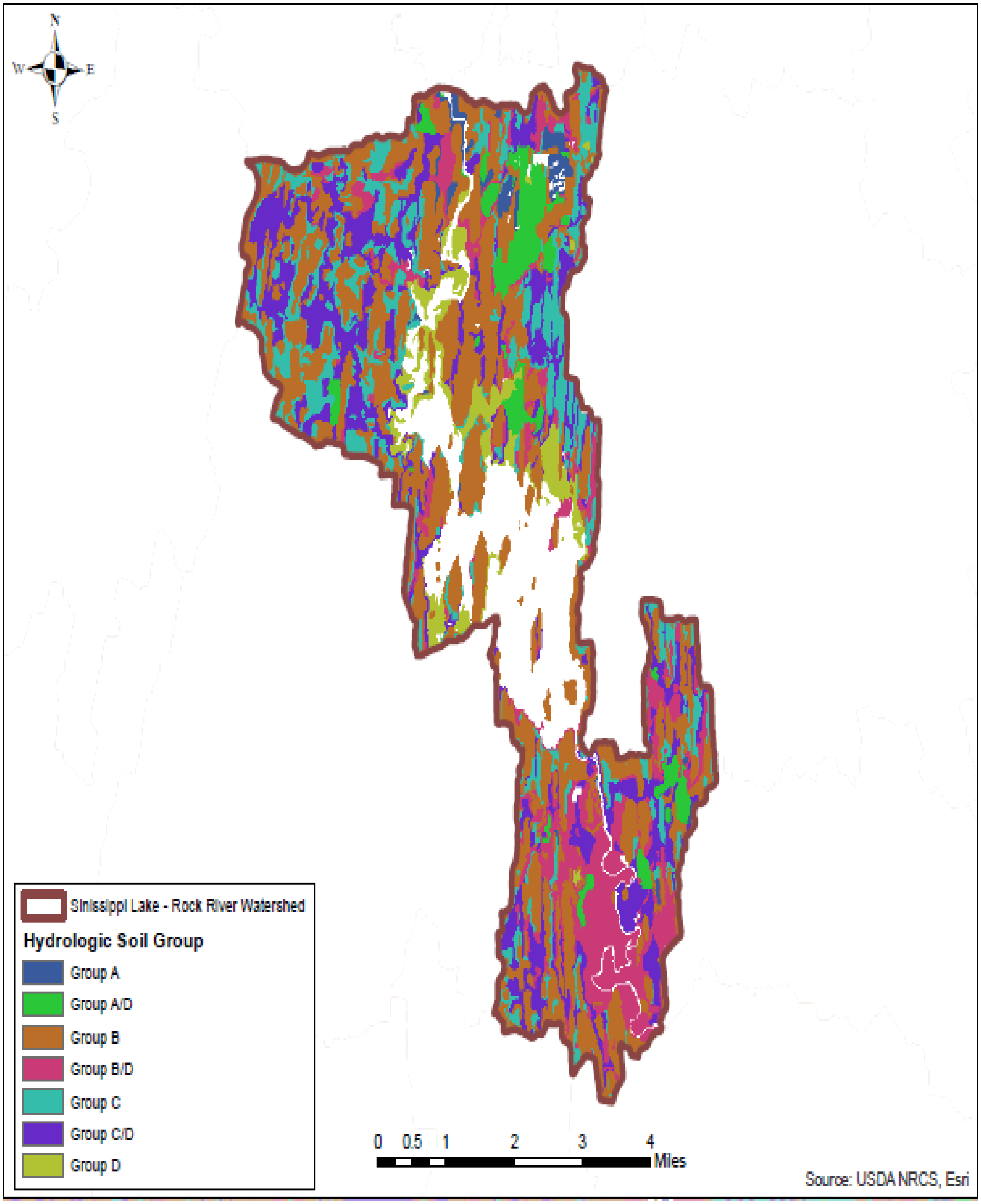


Figure 1.6: Hydrologic Soil Groups in Lake Sinissippi-Rock River

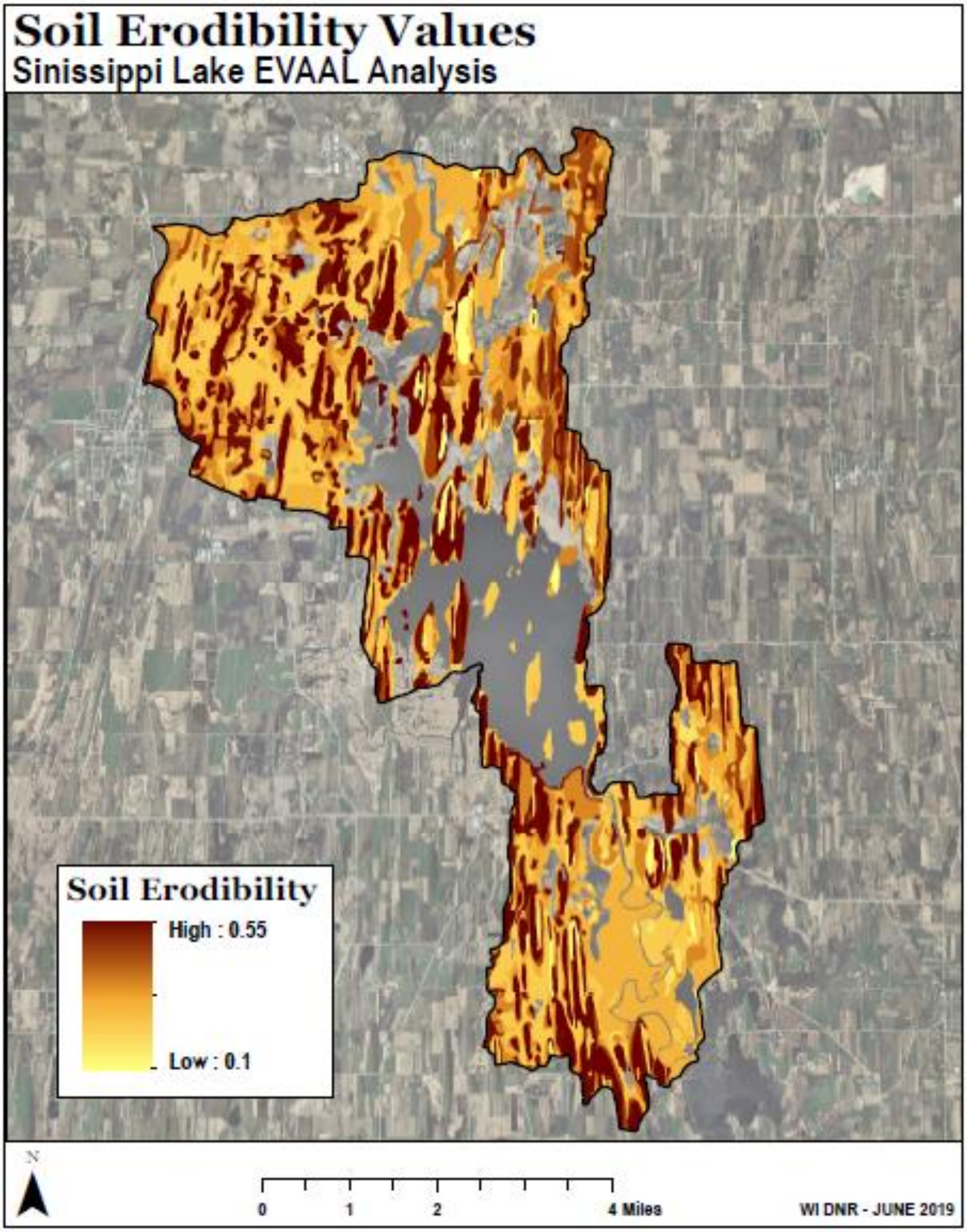


Figure 1.7: Soil Erodibility Map

2.0 Watershed Jurisdictions, Demographics, and Transportation Network

2.1 Watershed Jurisdictions

The Lake Sinissippi-Rock River Watershed is located entirely in Dodge County. The Watershed includes part of the Townships of Hubbard, Hustisford, Oak Grove, the village of Hustisford, part of the city of Horicon, and part of the city of Juneau. The breakdown of jurisdictions is located in table 2.1 and represented by Figure 2.1.

2.2 Jurisdictional Roles and Responsibilities

Natural resources in the United States are protected to some extent under federal, state, and local law. The Clean Water Act is the strongest regulating tool at the national level. In Wisconsin, the Wisconsin Department of Natural Resources has the authority to administer the provisions of the Clean Water Act. The U.S. Fish and Wildlife Service and U.S. Army Corps of Engineers work with the WDNR to protect natural areas, wetlands, as well as threatened and endangered species. The Safe Drinking Water Act also protects surface and groundwater resources.

Table 2.1: Watershed Jurisdictions

Jurisdiction	Acres	Percent
County		
Dodge County	22,540	100.0
Municipality		
Town of Hubbard	8,076.2	35.8
Town of Hustisford	7443.8	33.0
Town of Oak Grove	5,294.1	23.5
Village of Hustisford	547.1	2.4
City of Horicon	1142.2	5.1
City of Juneau	36.6	0.2

Dodge County and other local municipalities in the watershed area have already established ordinances regulating land development and protecting surface waters. Dodge County has ordinances relating to Animal Waste Storage and Nutrient Utilization, Floodplain, Shoreland Protection and Storm water. In addition to county-level regulations, each municipality has their own regulations. Municipalities may or may not provide additional watershed protection above and beyond existing watershed ordinances under local municipal codes.

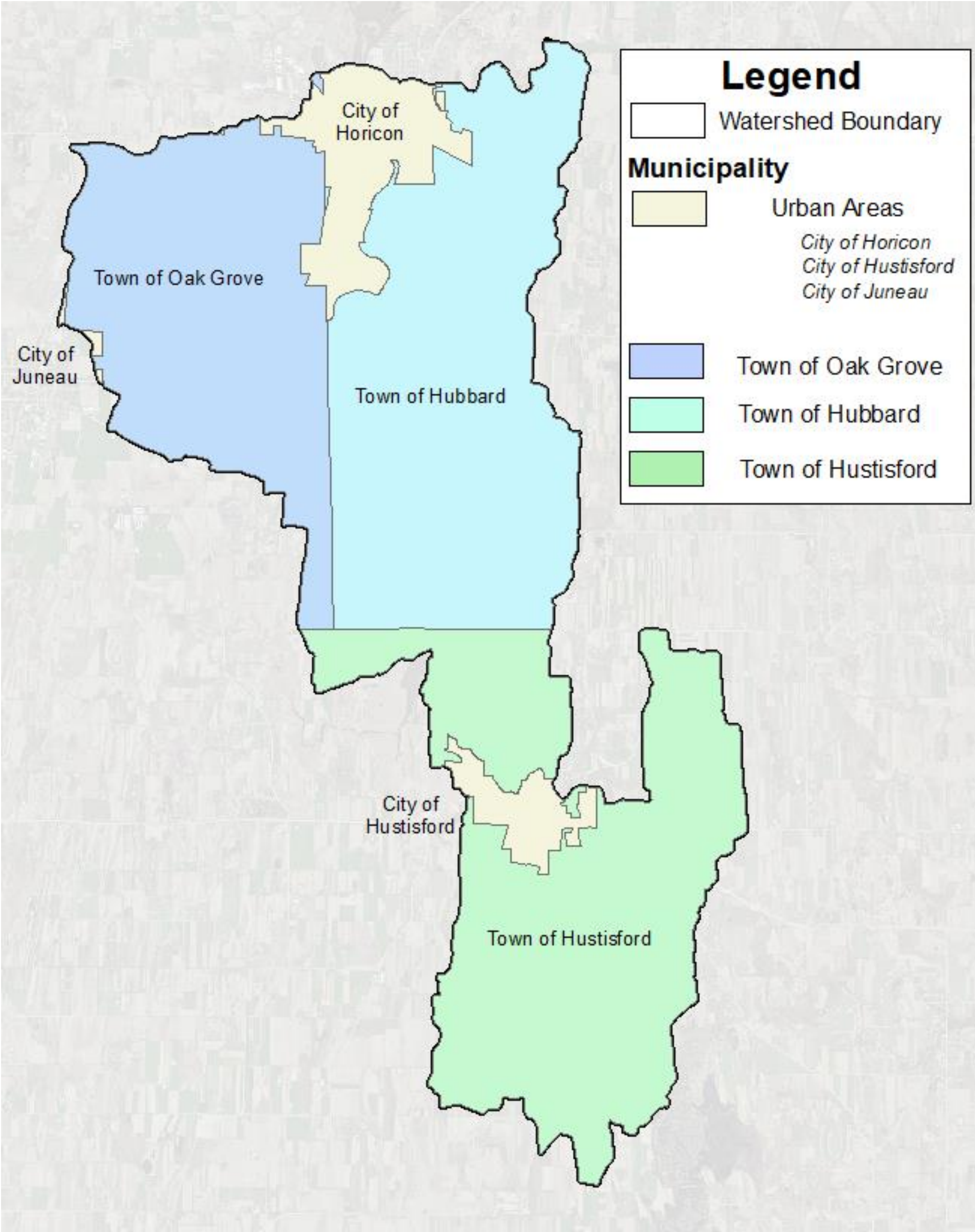


Figure 2.1: Watershed Jurisdictions

2.3 Transportation

The major roads that run through the Lake Sinissippi-Rock River watershed include State Highways 33 and 60 (Figure 2.3). County Roads include E, S, R, and TW. State Hwy. 33 runs east-west across the northern part of the watershed. State Hwy. 60 runs east-west through the southern part of the watershed. County Hwy S runs east-west through the middle of the watershed. County Hwy. E and TW runs north-south on the eastern side of Lake Sinissippi. County Hwy. R runs east and west through the southern part of the

2.4 Population Demographics

The Lake Sinissippi-Rock River Watershed is a rural, low-density populated area. It is located 6.4 miles southeast of Beaver Dam, 7.4 miles northwest of Hartford, and 4.5 miles south of Mayville. Wisconsin population projections were developed by the Wisconsin Department of Administration's Demographic Services Center in 2013 and were based on the 2010 Census. Dodge County's population is predicted to increase 8.5% from 2010 to the year 2030 (Table 2.3).

Median annual income data was collected from 2012-2017 by the American Community Survey. Population data for municipalities and counties are from the 2010 US Census. Median annual income in the municipalities in the watershed is above the county averages for the area (Table 2.2).

Table 2.2: Population Projections

Municipality	Population	Median Income
Town of Hubbard	1,774	$74,250
Town of Hustisford	1,373	$67,589
Town of Oak Grove	1,080	$59,091
Village of Hustisford	1,123	$74,118
City of Horicon	3,655	$61,943
County		
Dodge	88759	$54,485

Source: U.S. Census Bureau (US Census Bureau 2012-2016 US Census Bureau American Community Survey 5 Year Estimates)

Table 2.3: Population and Median House Hold Income

County Name	April 2010 Census	April 2020 Projection	April 2030 Projection	Total Change
Dodge	88,759	92,024	97,020	8,261

Source: Wisconsin Department of Administration Demographic Services Center (Eagan-Robertson 2013)

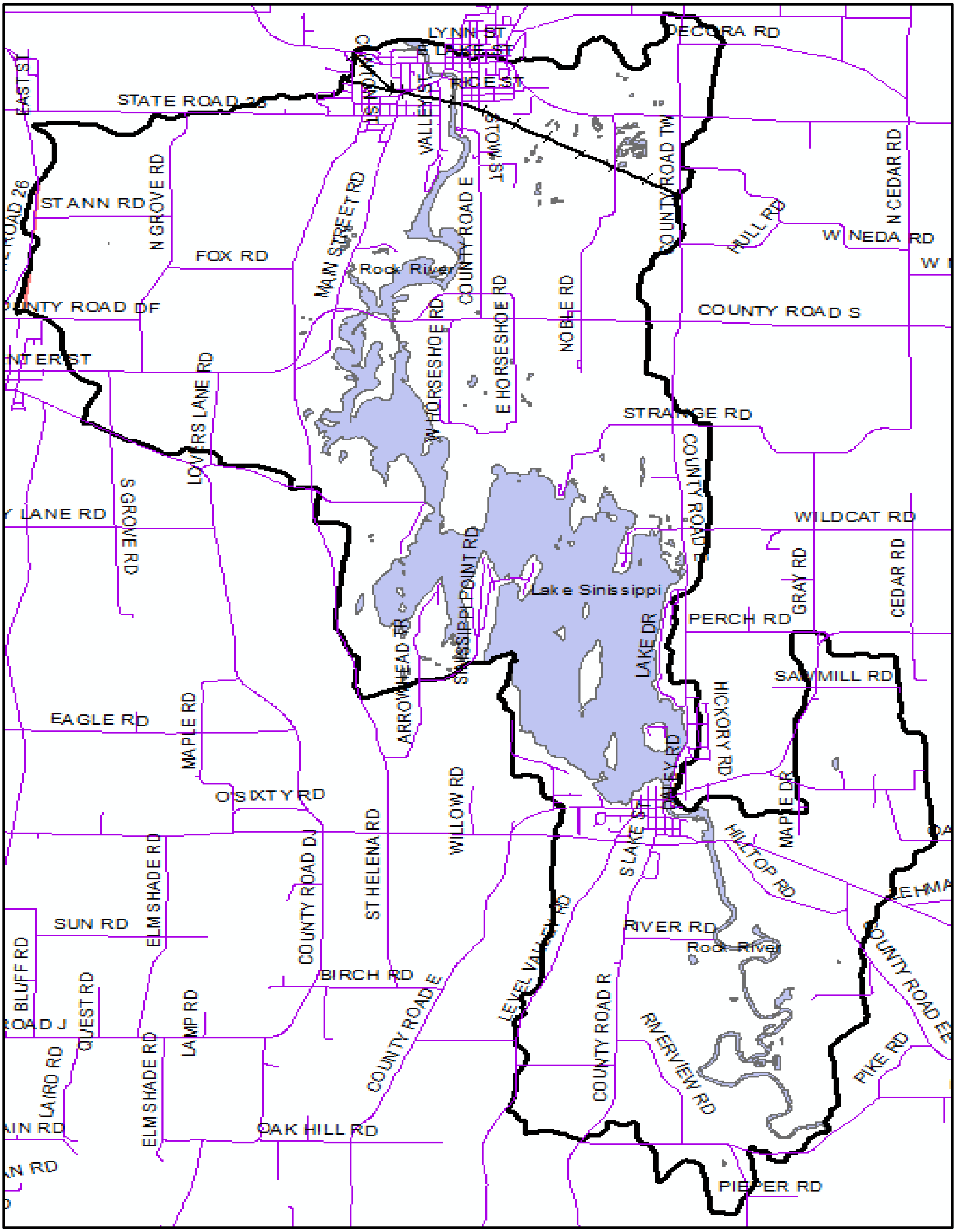


Figure 2.2: Watershed Transportation

3.0 Land Use/Land Cover

3.1 Existing Land Use/Land Cover

Land cover and land use data for the watershed area was obtained from the Raster GIS Data provided by USDA/NRCS. Land cover and land use for the watershed is shown in Figures 3.1 & 3.2.

The dominant land use in the watershed is agriculture at 54.1% including cultivated crops (37.0%) and pasture (17.1%). Developed land accounts for just 5.7% of the land in the watershed. Natural areas such as wetlands, forest, grassland, and open water make up the remaining 45.9% of the watershed area.

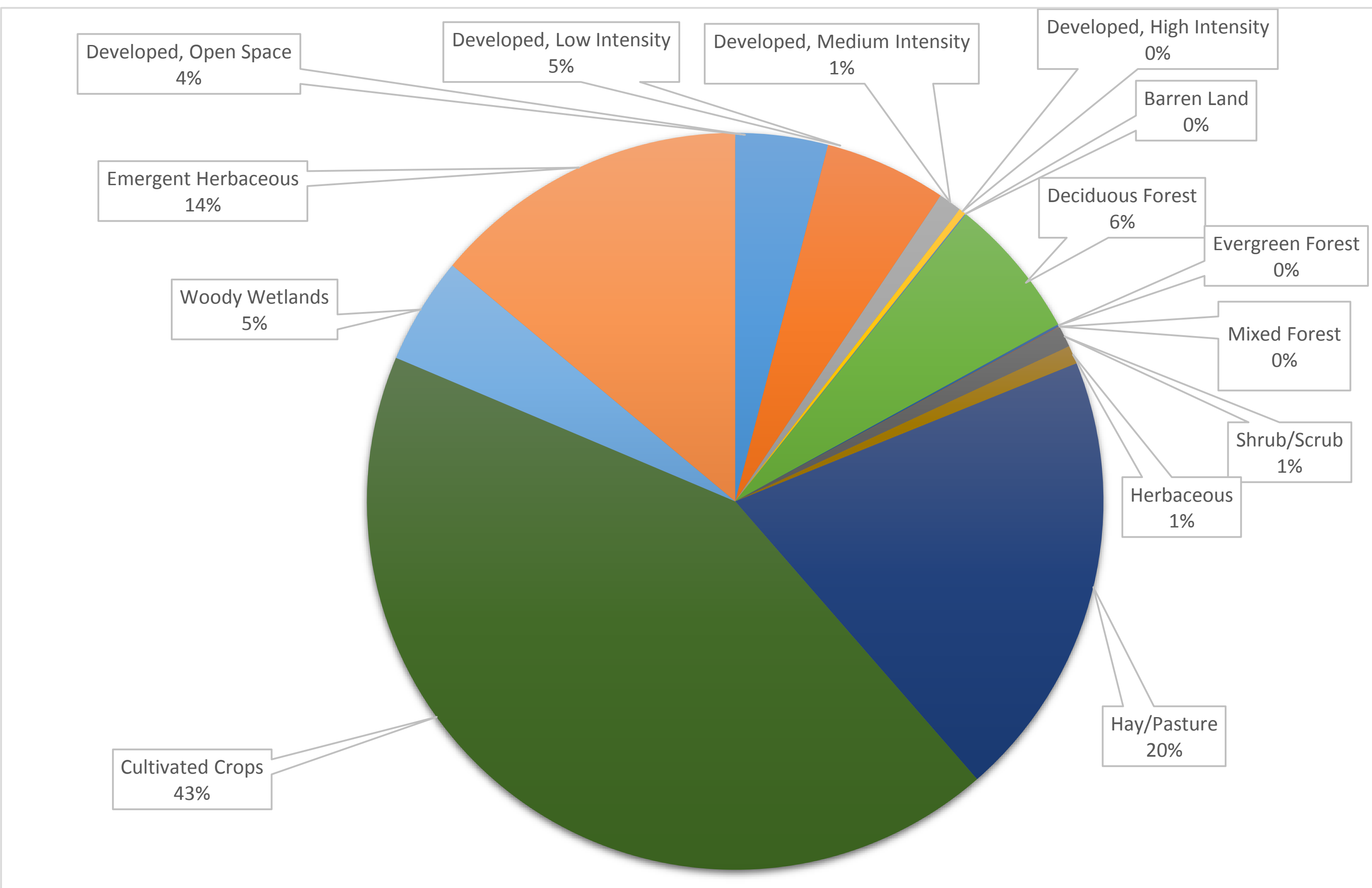


Figure 3.1: Land Use/Land Cover

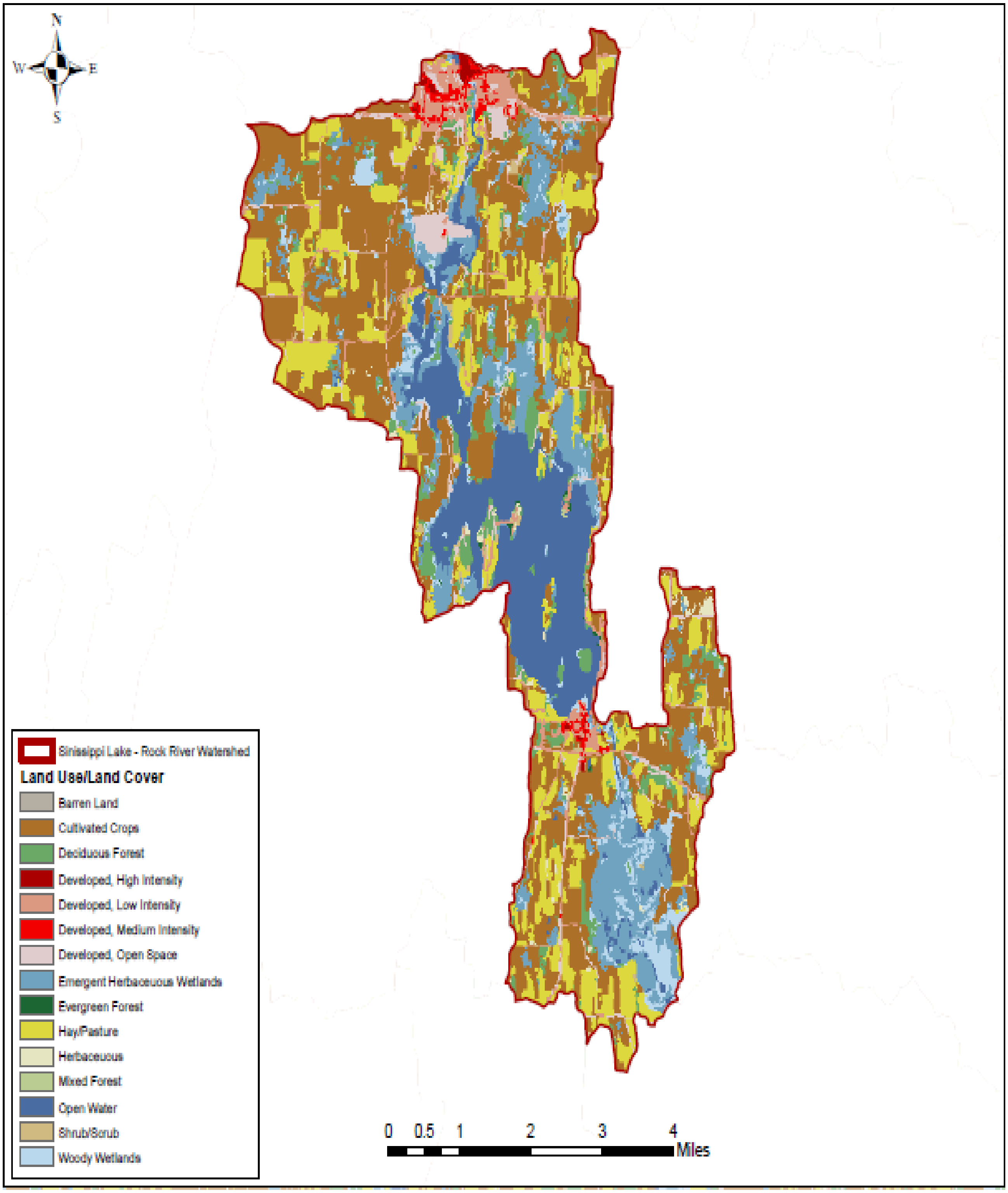


Figure 3.2: Land Use Map

3.2 Crop Rotation

Cropland data was obtained from the USDA National Agriculture Statistics Service (NASS). NASS produced the Cropland Data Layer using satellite images at 30 meter observations, Resourcesat-1 Advanced Wide Field Sensor, and Landsat Thematic mapper. Data from 2013 to 2018 was analyzed to obtain a crop rotation. Crop rotations for the watershed are shown in Table 3.1 and Figure 3.3-3.7.

No Agriculture is the dominant rotation in the watershed at 48.6%. Cash Grain and Dairy follow with 20.0% and 17.5% respectively. Different crop rotations can affect the amount of erosion and runoff that is likely to occur on a field. Corn is often grown in dairy rotations and harvested for corn silage; harvesting corn silage leaves very little residue left on the field making the field more susceptible to soil erosion and nutrient loss. Changing intensive row cropping rotations to a conservation crop rotation can decrease the amount of soil and nutrients lost from a field. Increasing the conservation level of crop rotation can be done by adding years of grass and/or legumes, adding diversity of crops grown, or adding annual crops with cover crops.

Table 3.1: Agricultural Land Use

Sinissippi Crop Rotation Totals					
	Northwest	Northeast	Southwest	Southeast	**TOTALS**
No agriculture	4218.8	4227.9	1202.6	1308.8	10958.1
Dairy	1648.4	1060.0	492.8	744.8	3946.0
Cash Grain	2064.6	1002.2	1013.2	414.7	4494.7
Continuous Corn	151.5	117.2	52.2	35.1	356.1
Pasture/Hay/Grassland	885.4	882.5	562.5	383.6	2714.0
Vegetable/Grain	70.7	0.4	0.0	0.0	71.1
TOTALS	9039.4	7290.2	3323.3	2887.1	22540.0

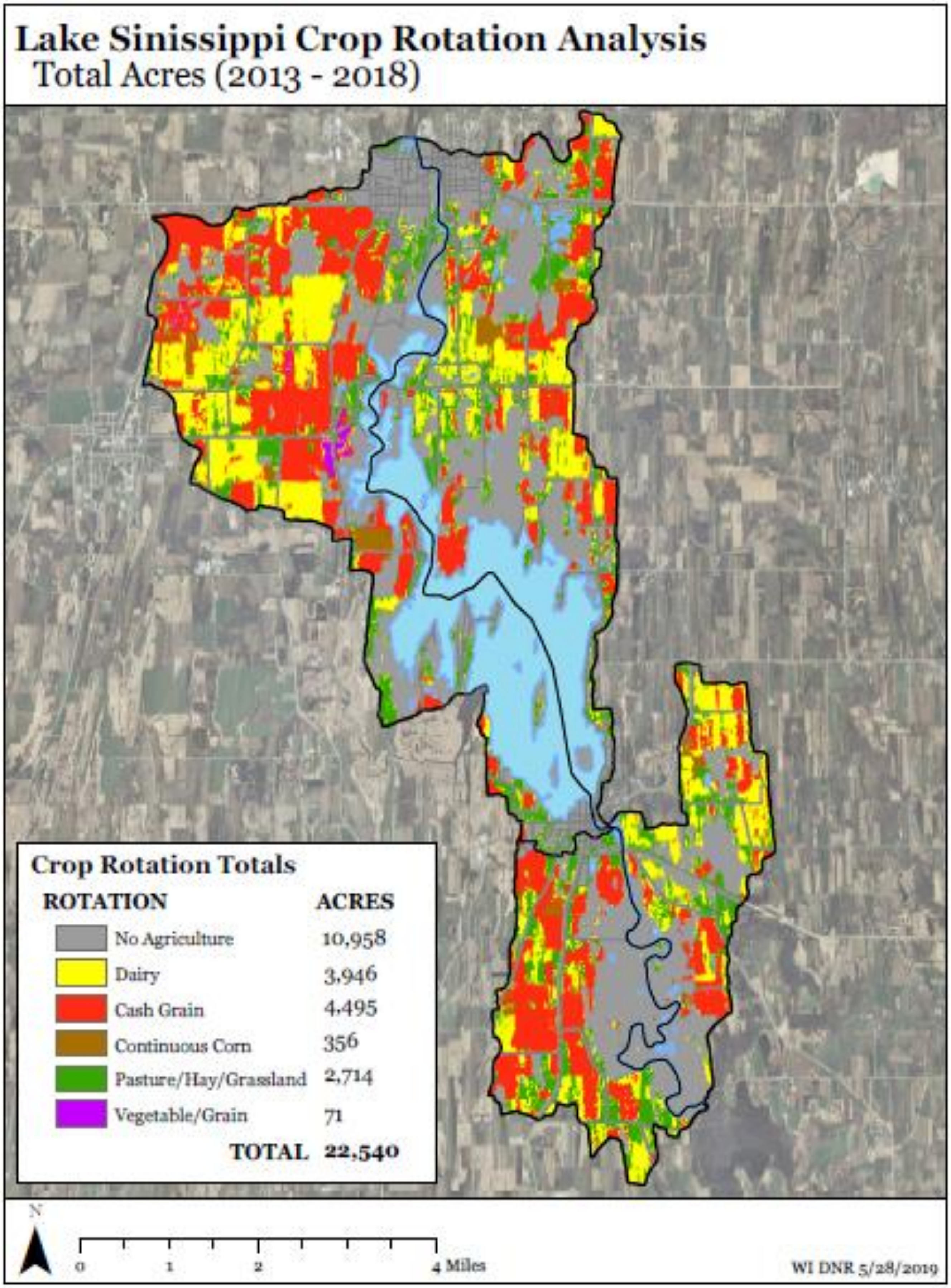


Figure 3.3: Crop Rotation Analysis

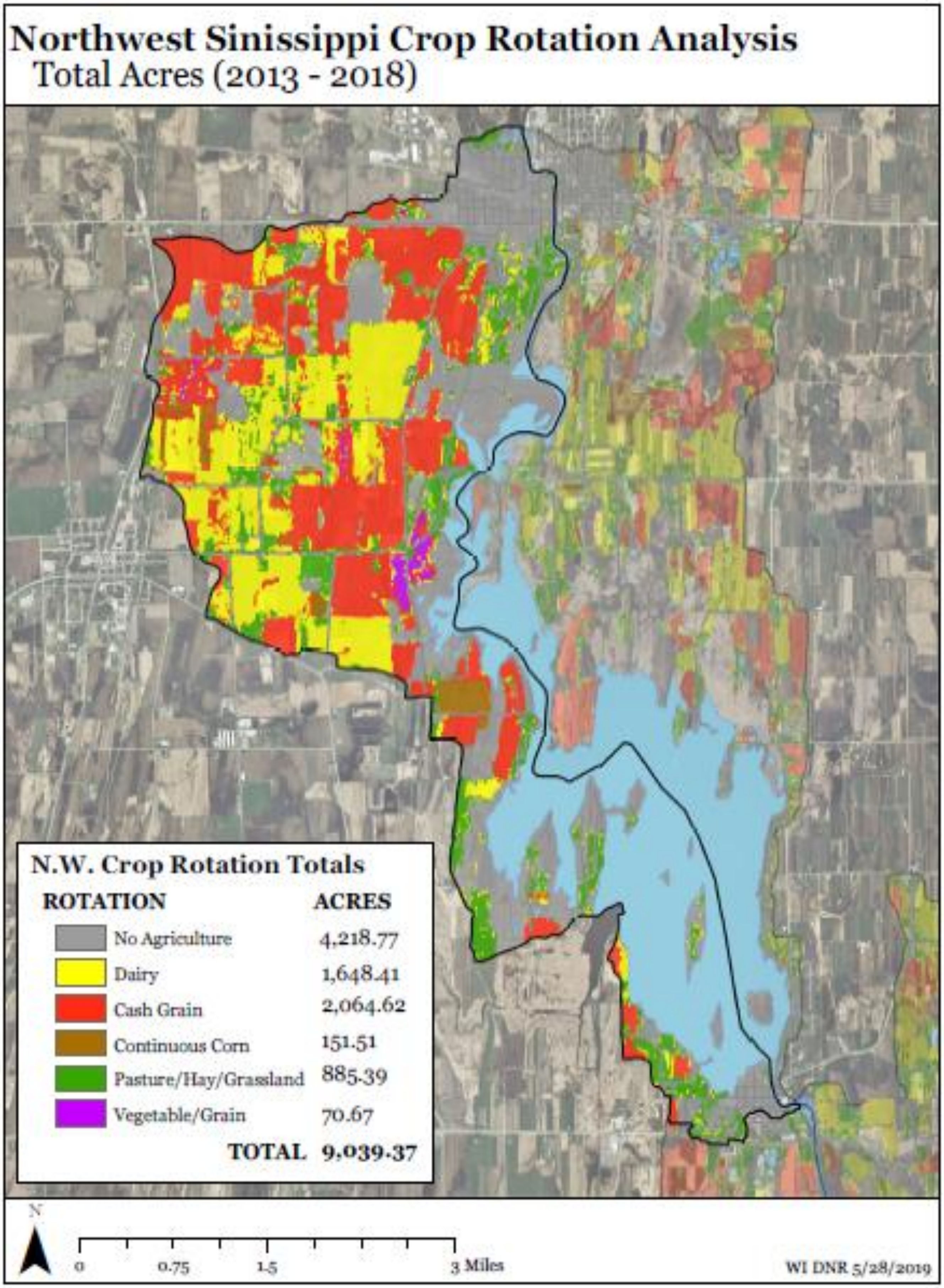


Figure 3.4: Crop Rotation Analysis for the NW Region

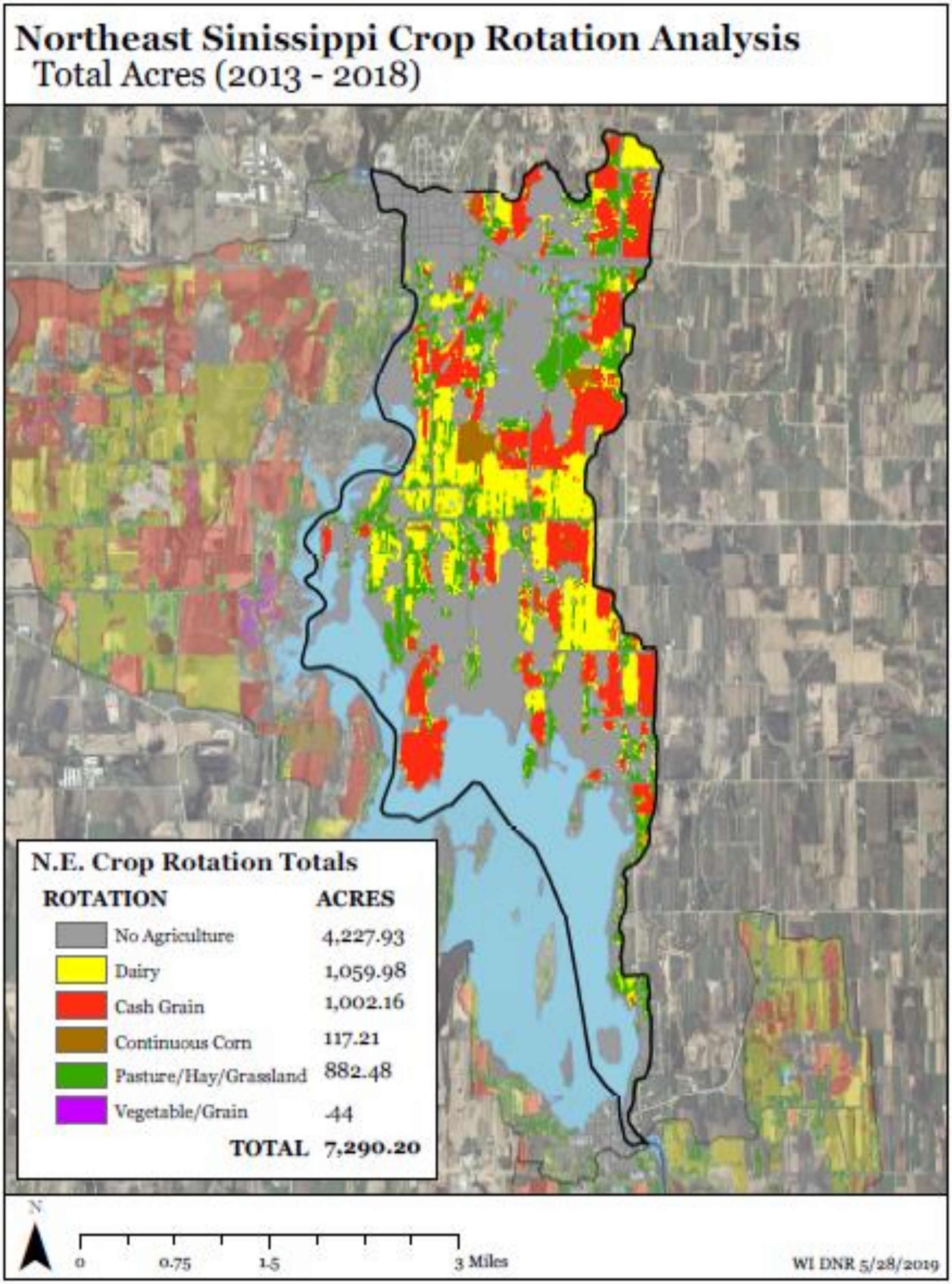


Figure 3.5: Crop Rotation Analysis for the NE Region

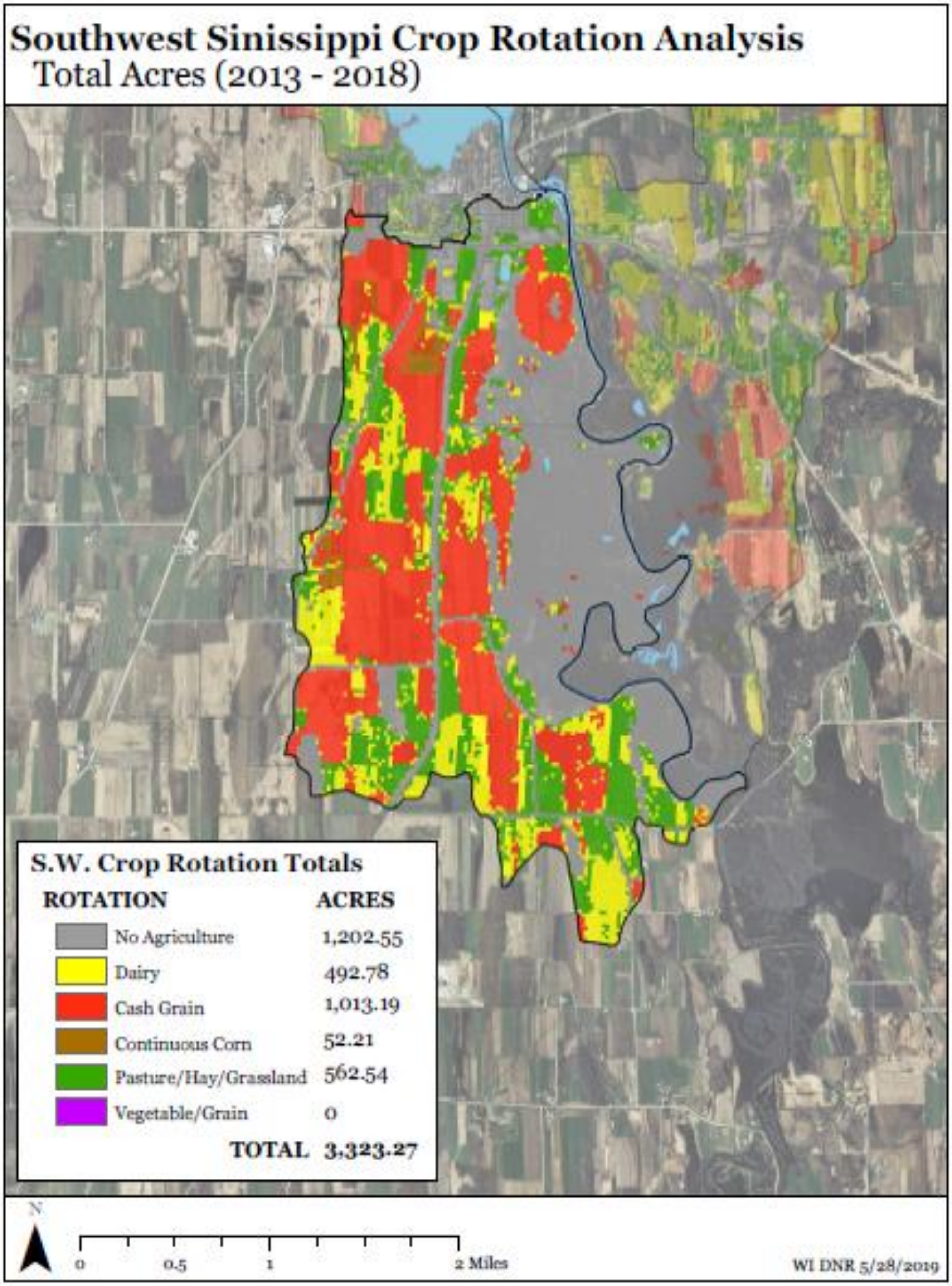


Figure 3.6: Crop Rotation Analysis for the SW Region

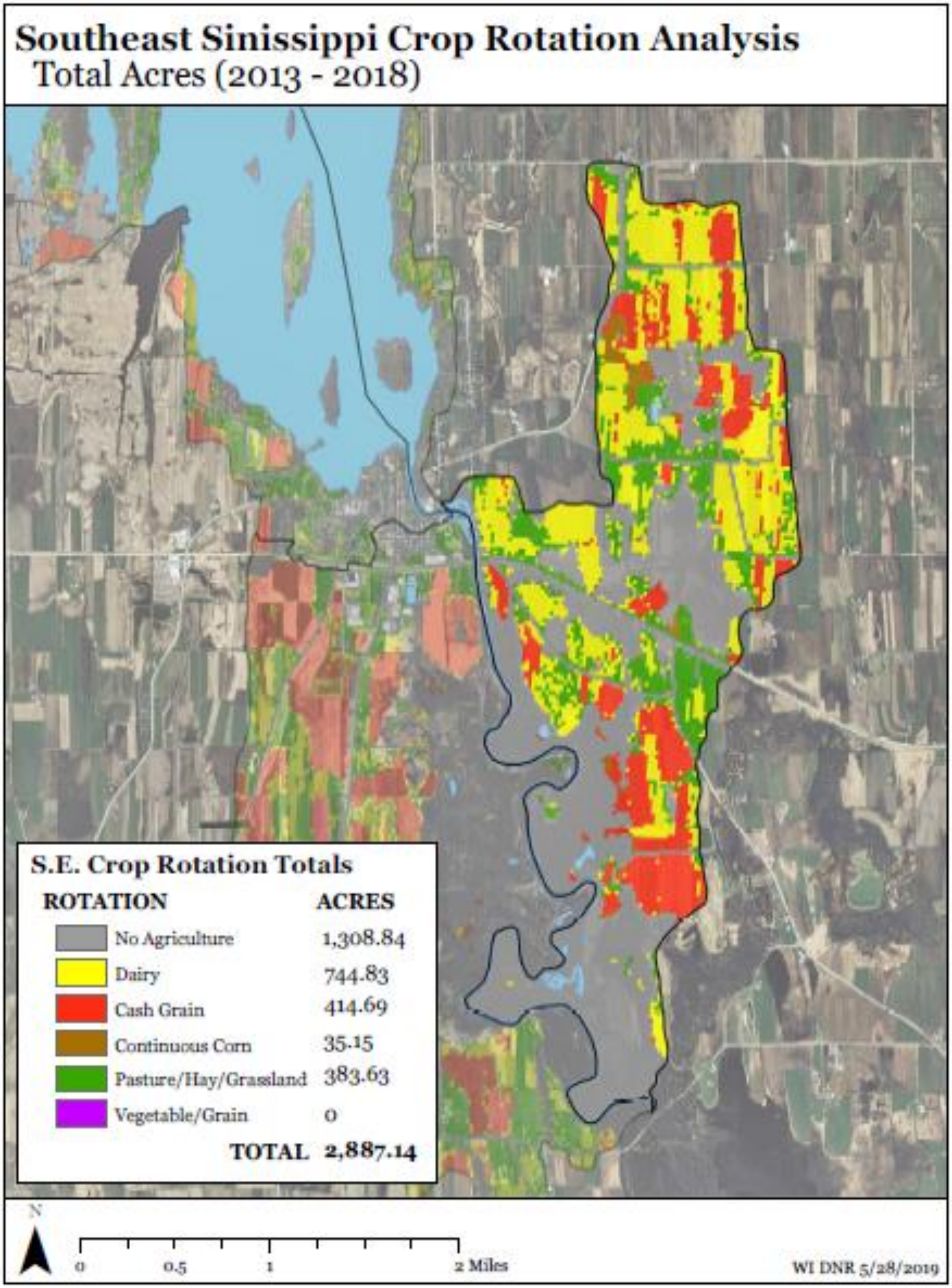


Figure 3.7: Crop Rotation Analysis for the SE Region

4.0 Water Quality

The federal Clean Water Act requires states to adopt water quality criteria that the EPA publishes under 304 (a) of the Clean Water Act, modify 304 (a) criteria to reflect site-specific conditions, or adopt criteria based on other scientifically defensible methods. Water quality standards require assigning a designated use to the water body.

4.1 Designated Use and Impairments

A 303 (d) list is comprised of waters impaired or threatened by a pollutant, and needing a TMDL. States submit a separate 303 (b) report on conditions of all waters. EPA recommends that the states combine the threatened and impaired waters list, 303(d) report, with the 303(b) report to create an "integrated report". Lake Sinissippi and the Rock River, (Figure 4.1) are listed as impaired waterways. The impairment indicator both is, "Degraded Habitat." The pollutant is listed as Sediment/Total Suspended Solids and Total Phosphorus.

Sinissippi Lake-Sinissippi Lake Watershed (UR08)	
Sinissippi Lake (859900)	
Size	2,855 acres
Segment	
Natural Community	
Year Last Monitored	2011
General Condition	Poor
	This Lake is impaired
Impairments include	Degraded Habitat, Eutrophication, Excess Algal Growth
Pollutants include	Total Phosphorus, Sediment/ Total Suspended Solids

Rock River-Sinissippi Lake Watershed (UR08)	
Rock River (788800)	
Size	8 miles
Segment	296-305
Natural Community	
Year Last Monitored	2019
General Condition	Poor
	This River is impaired
Impairments include	Degraded Habitat
Pollutants include	Total Phosphorus, Sediment/ Total Suspended Solids

Figure 4.1: Lake Sinissippi and Rock River Impaired Waterway Report

Streams and rivers in Wisconsin are assessed for the following use designations: Fish and Aquatic Life, Recreational Use, Fish Consumption (Public Health and Welfare), and General Uses.

The Lake Sinissippi-Rock River Watershed has a large portion of its area in water, primarily from its namesake's lake. However beyond this, the watershed has a number of smaller tributaries spaced out across the area. The surface waters for Lake Sinissippi-Rock River are shown in figure 4.2.

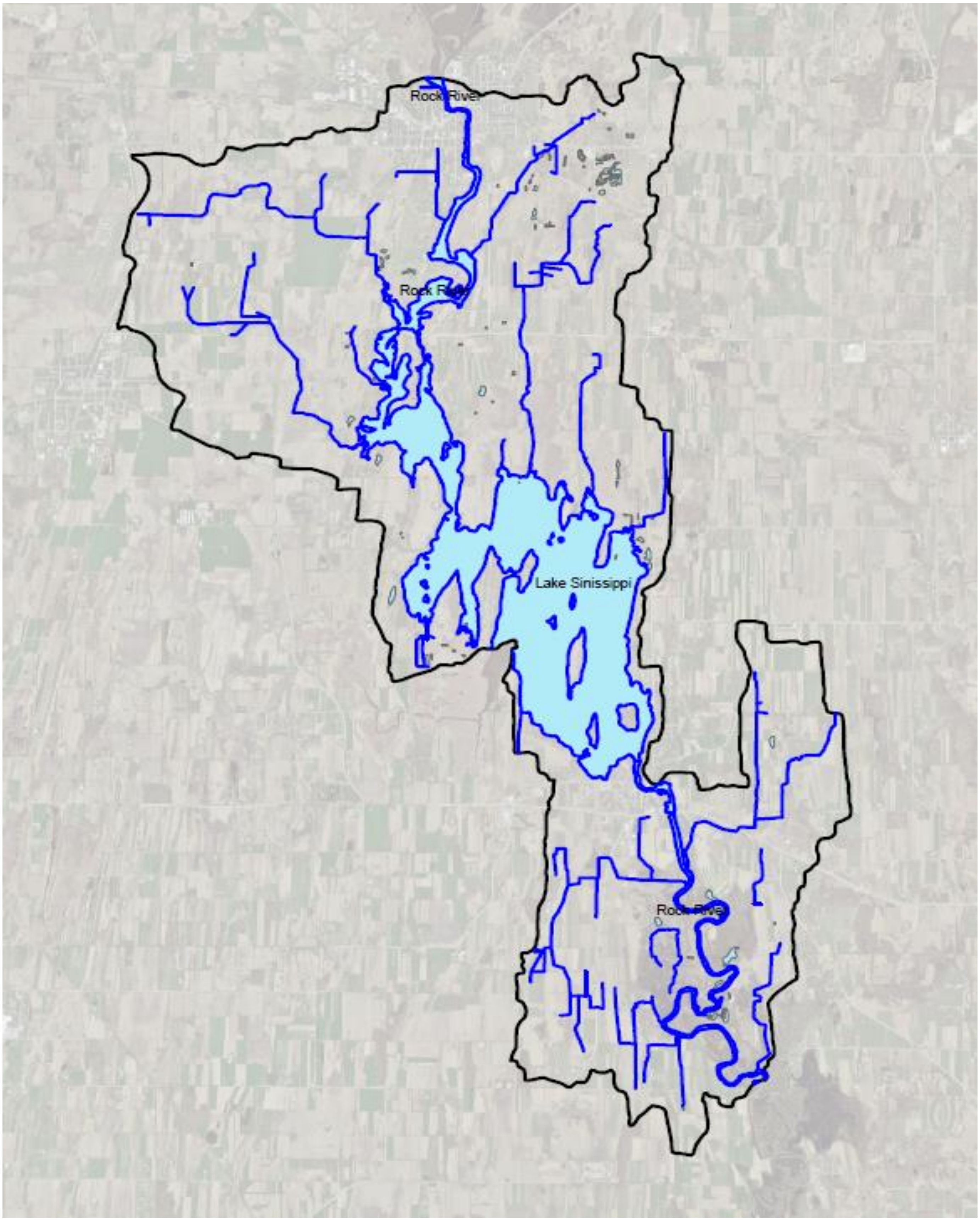


Figure 4.2: Watershed Surface Waters

4.2 Point Sources

Point sources of pollution are discharges that come from a pipe or point of discharge that can be attributed to a specific source. In Wisconsin, the Wisconsin Pollutant Discharge Elimination System (WPDES) regulates and enforces water pollution control measures. The WI DNR Bureau of Water Quality issues the permits with oversight of the US EPA. There are four types of WPDES permits: Individual, General, Storm water, and Agricultural permits.

Individual permits are issued to municipal and industrial wastewater treatment facilities that discharge to surface and/or groundwater. WPDES permits include limits that are consistent with the approved TMDL Waste Load Allocations. The cities/villages of Brownsville, Burnett, Horicon, Kekoskee, Leroy, Lomira, Mayville, Theresa, and Waupun are municipal permit holders that drain into the Rock River. There is one Agricultural WPDES permit holders in the Lake Sinissippi-Rock River Watershed.

4.3 Nonpoint Sources

The majority of pollutants in the Lake Sinissippi-Rock River watershed come from nonpoint sources. A nonpoint source cannot be traced back to a point of discharge. Runoff from agricultural and urban areas is an example of nonpoint source. Agriculture is the dominant land use in the Lake Sinissippi-Rock River watershed and accounts for approximately 96.7% of the total phosphorus loading and 97.7% of total suspended sediment loading. Other nonpoint sources in the watershed include erosion from stream banks and construction sites as well as runoff from lawns and impervious surfaces.

In 2010, new state regulations in Wisconsin went into effect that restricts the use, sale, and display of turf fertilizer that is labeled as containing phosphorus or available phosphate (Wis.Stats.94.643)**.** The law states that turf fertilizer that is labeled containing phosphorus or available phosphate cannot be applied to residential properties, golf courses, or publicly owned land that is planted in closely mowed or managed grass. The exceptions to the rule are as follows:

- Fertilizer that is labeled as containing phosphorus or available phosphate can be used for new lawns during the growing season in which the grass is established.
- Fertilizer that is labeled as containing phosphorus or available phosphate can be used if the soil is deficient in phosphorus, as shown by a soil test performed no more than 36 months before the fertilizer is applied. The soil test must be done by a soil testing laboratory.

Wisconsin also has state standards pertaining to agricultural runoff. Wisconsin State Standards, Chapter NR 151 subchapter II describes Agricultural Performance Standards and Prohibitions. This chapter describes regulations relating to phosphorus index, manure storage & management, nutrient management, soil erosion, tillage setback as well as implementation and enforcement procedures for the regulations.

4.4 Water Quality Monitoring

Water samples have not been taken in the Lake Sinissippi-Rock River Watershed, except for the Rock River and Lake Sinissippi itself.

5.0 Pollutant Loading Model

The developers of the Rock River TMDL plan ran the Soil and Water Assessment Tool (SWAT) and Source Loading and Management Model (SLAMM) for all sub-watersheds in the Upper Rock River Basin. The SWAT model is able to predict the impact of land use management on the transport of nutrients, water, sediment, and pesticides. Actual cropping, tillage**,** and nutrient management practices typical to Wisconsin were input into the model. Other data inputs into the model include: climate data, hydrography, soil types, elevation, land use, contours, political/municipal boundaries, MS4 boundaries, vegetated buffer strips, wetlands, point source loads, and WDNR-Enhanced USGS 1:24K DRG topographic maps.

The SWAT model from the Upper Rock River TMDL was run on the entire Sinissippi Lake Watershed**,** which consists of Wildcat Creek, Sinissippi Lake–Rock River, Dead Creek, Baker Creek, Town of Ixonia, Norwegian Cemetery-Rock River, Town of Watertown-Rock River, and Silver Creek watersheds (Figure 5.1). To characterize the loading in just the Lake Sinissippi-Rock River sub watershed the STEPL model was used. STEPL1 (Spreadsheet Tool for Estimating Pollutant Load) is another watershed model that calculates nutrient loads based on land use, soil type, and agricultural animal concentrations. The SWAT model analysis for the Lake Sinissippi-Rock River Watershed can be seen in Appendix B.

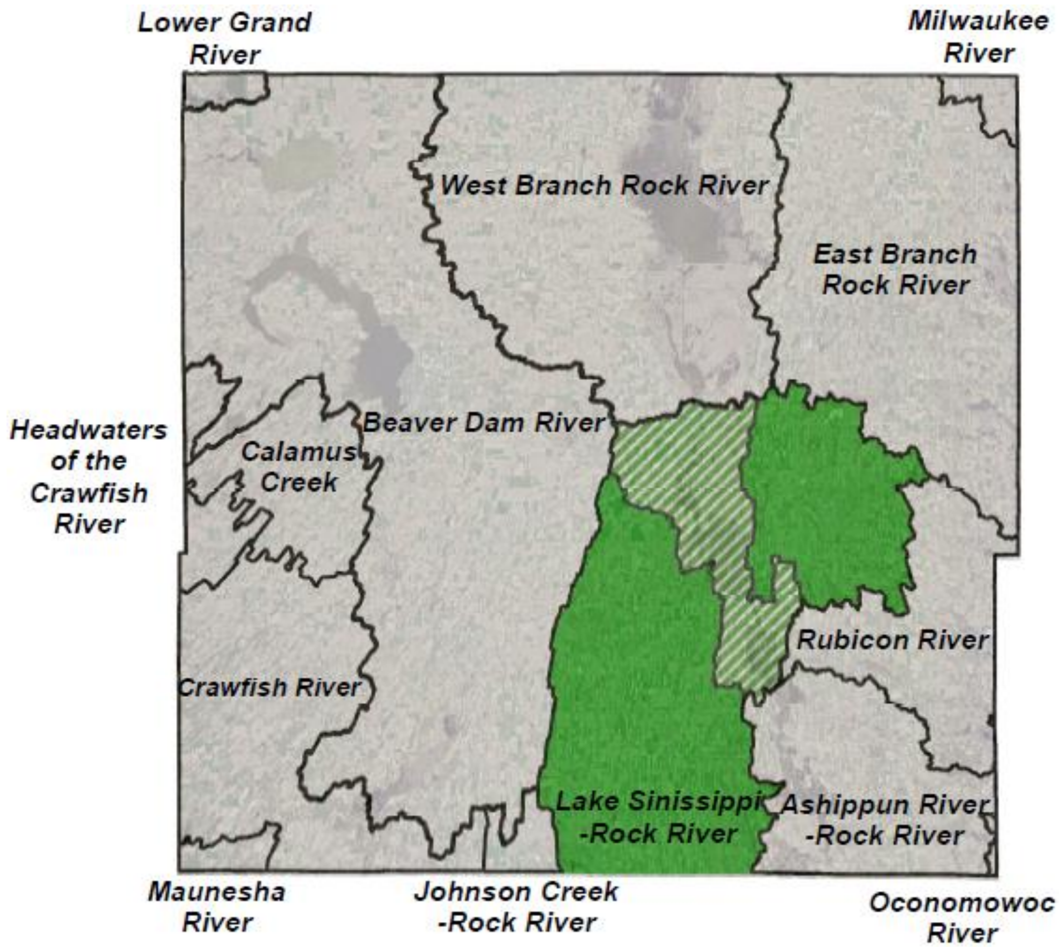


Figure 5.1: Lake Sinissippi Huc-10 Watershed

Both loading models predict agriculture is the main contributor of phosphorus and sediment in the watershed. According to the STEPL model**,** the Lake Sinissippi-Rock River Watershed contributes an estimated 53,173.27 lbs. of phosphorus and 9,806.21 tons of sediment to the Rock River per year. The SWAT model estimated 1,589,543 lbs. of phosphorus and 177,843 tons of sediment per year for the entire Upper Rock River Subbasin. Therefore, the Lake Sinissippi-Rock River sub watershed is estimated to be responsible for 3.3% of TP and 5.5% of TSS in the Rock River Basin. Agriculture**,** including pastureland and barnyards**,** contributes 96.7% of the phosphorus loading in the Lake Sinissippi-Rock River Watershed. Agriculture including pastures and gullies contributes 97.7% of the sediment loading in the Lake Sinissippi_Rock River Watershed.

6.0 Watershed Inventory

6.1 Barnyard Inventory Results

Location and data on current livestock operations were compiled through existing Land and Water Conservation Department data, air photo interpretation, and windshield surveys. There are a total of 23 active livestock operations with an estimated 1,450 livestock animals including dairy and beef farms. The approximate location of these barnyards are shown in Figure 6.1. There are no CAFO operations in the watershed. However, a dairy CAFO runs a majority of the land in the NW section.

Barnyard data was entered in to the NRCS BARNY spreadsheet tool to estimate phosphorus loading. According to the BARNY calculations an estimated 566.3 lbs. of phosphorus per year can be attributed to barnyard runoff from the operations shown in Table 6.1. STEPL model loading estimates barnyard phosphorus loading significantly higher at 4,275.26 lbs. of phosphorus. Barnyard runoff accounts for approximately 8.3% of the total phosphorus loading from agriculture. Barnyard runoff is not a significant source of phosphorus in this watershed. Barnyards that exceed the annual phosphorus discharge limit of 15 lbs/year will be eligible for cost share assistance to obtain necessary reductions in phosphorus loading. Estimated phosphorus loadings per farm site over 15 lbs. P/year are shown in Table 6.1.

Table 6.1: Farms with ≥ 15 lbs P/yr Loading

Farm ID	lbs P
#2963	106.2
#3687	94.9
#3436	75.2
#6120	42.0
#3501	41.9
#5845	40.6
#3389	37.2
#2780	31.8
#4125	29.7
#3365	24.2
#3781	23.1
#5680	19.5

6.2 Streambank Inventory Results

ArcGIS was used to determine the location of perennial and intermittent streams in the watershed area. There are approximately 30 miles of perennial and intermittent streams in the Lake Sinissippi-Rock River watershed including its tributaries.

6.3 Upland Inventory

Agricultural uplands were inventoried by windshield survey, use of GIS data and tools, and with aerial photography for this plan. The use of a tool developed by the WDNR called EVAAL (Erosion Vulnerability Assessment for Agricultural Lands) and its data sets were used to determine priority/critical areas for best management practices to control soil erosion in the watershed. The tool estimates the vulnerability of a field to erosion and can be used to determine internally draining areas, potential for gully erosion, and potential for sheet and rill erosion. Other GIS methods also used to determine priority areas include the Compound Topographic Wetness Index and Normalized Difference Tillage Index. Figure 6.4.

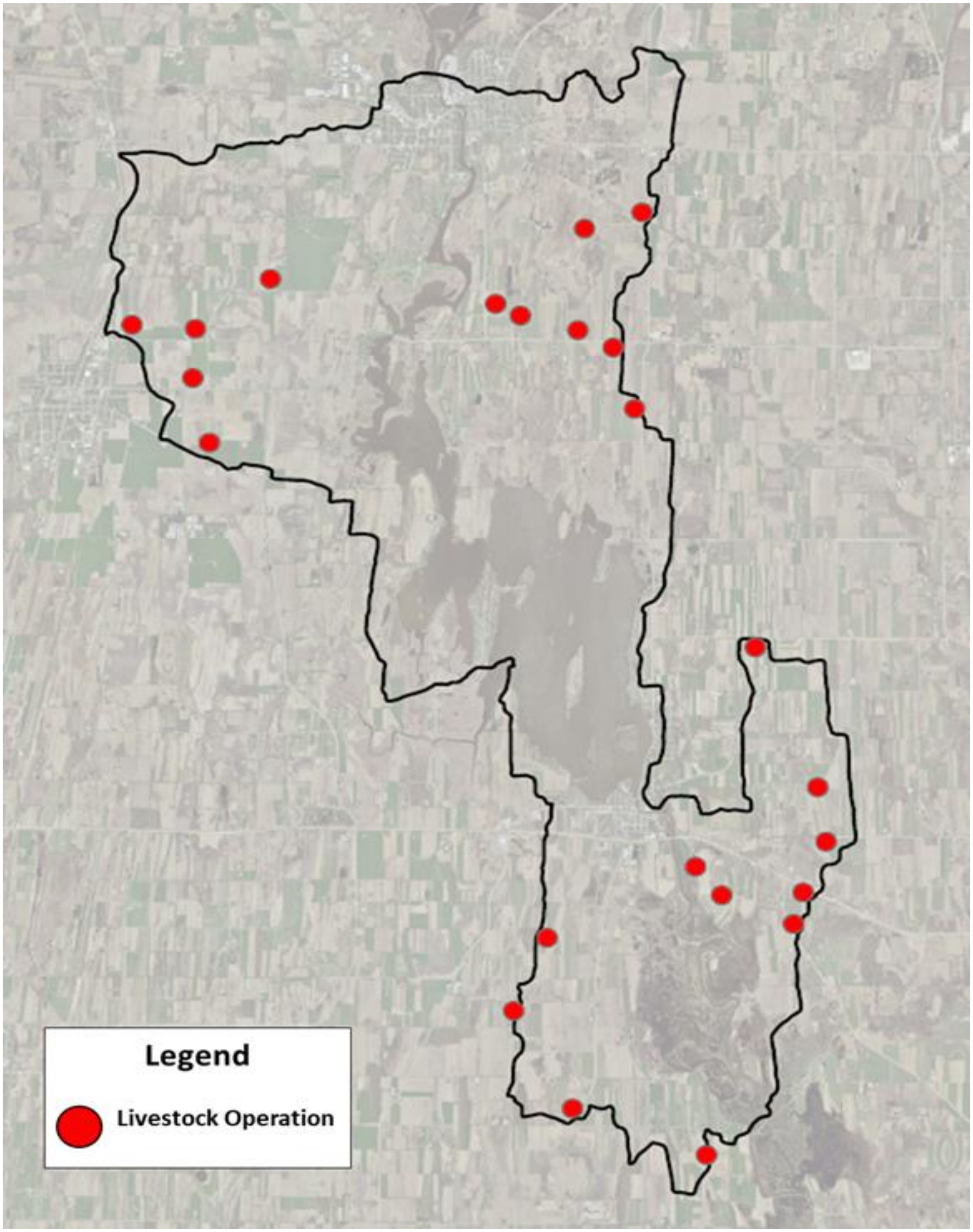


Figure 6.1: Watershed Livestock Operations

Tillage Practices and Residue Management

Dodge County has been conducting a Transect Survey of the county since 1999. We have over 800 GPS points that we check each year for tillage, crops, and residue amounts. There are only 22 points in the Lake Sinissippi-Rock River Watershed. The small number of points may not be representative of the watershed. This data is used to determine the average soil loss, % crops grown, types of tillage used, and % residue after planting. Using this data, crops grown are 32% Soybeans, 32% Alfalfa, 23% Corn for Grain, 9% Corn Silage, and 4% Sweet Corn. Tillage used (Figure 6.2) is; 22% is Fall Chisel; 9% is Spring Cultivation; 31% was not worked; 22% is No-Tilled; 4% Fall Moldboard Plowing; 9% is Fall Vertical Till. Residue (Figure 6.3) is: 46% of the cropland has greater than 50% residue (this includes Alfalfa), 18% of the cropland has 30-50% residue and 36% of the cropland has less than 30% residue. Additionally, estimations of residue and tillage on the cropland within Lake Sinissippi-Rock River Watershed are based off Normalized Difference Tillage Index (NDTI) is provided in Figure 6.4.

Figure 6.2 - Tillage in Lake Sinissippi

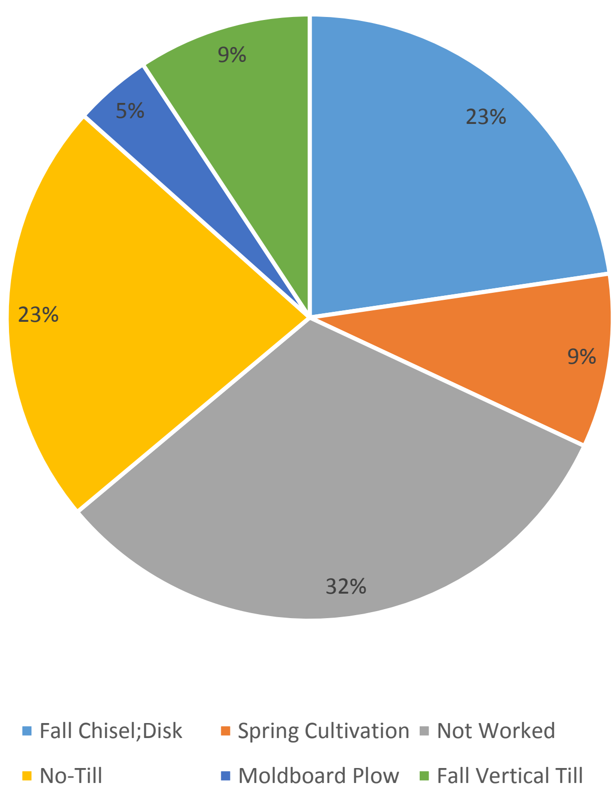
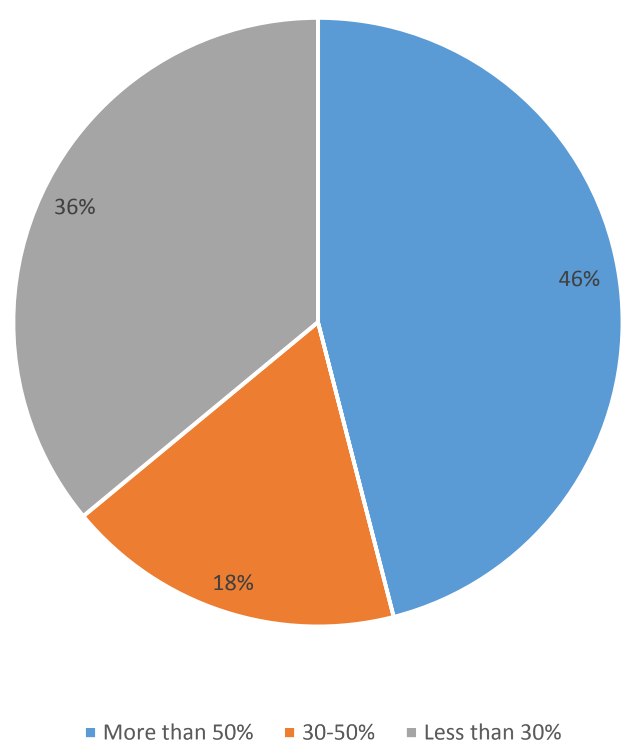


Figure 6.3 - % Residue in Lake Sinissippi Watershed



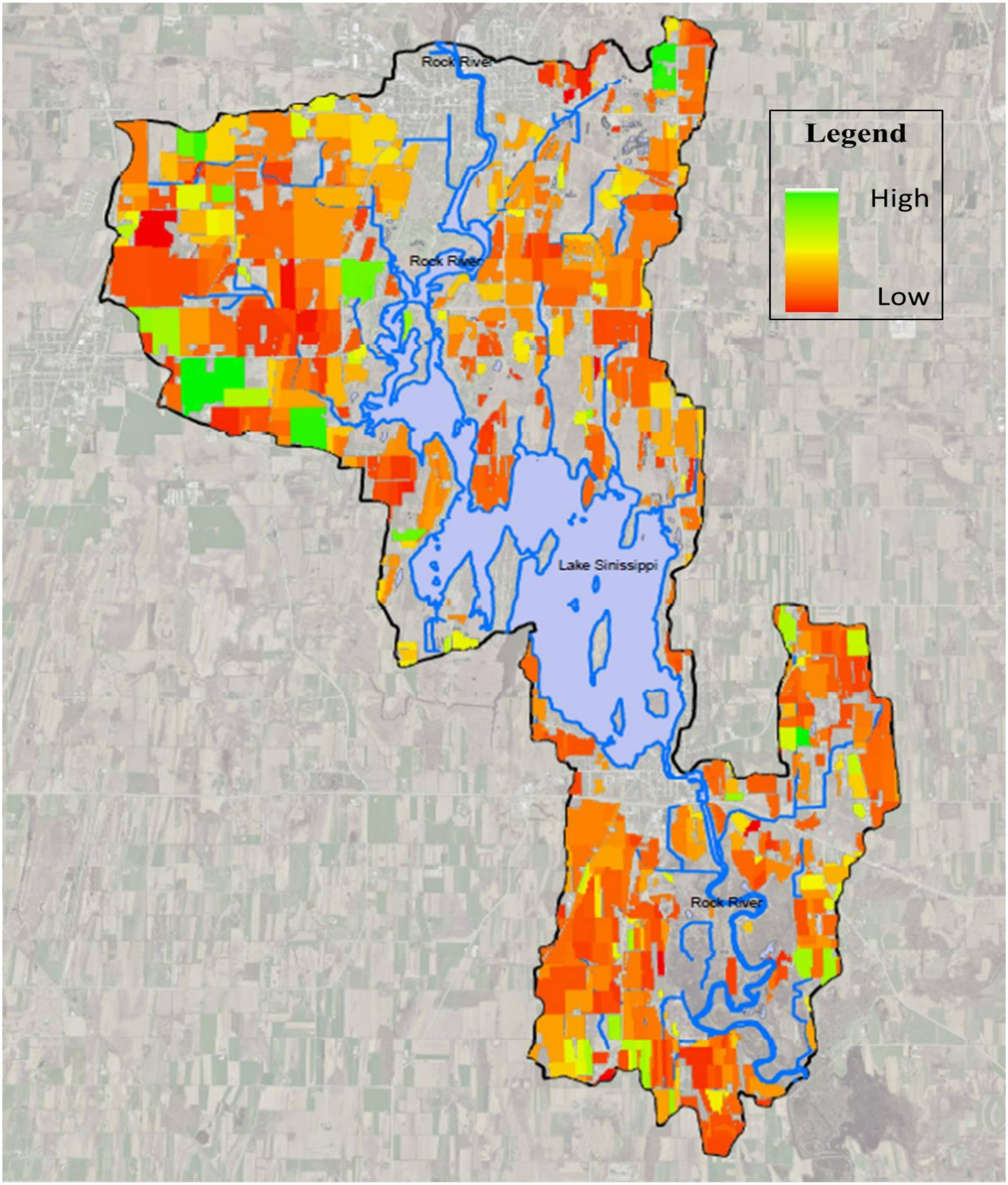


Figure 6.4: Crop Residue Estimates based on Normal Difference Tillage Index (NDTI)

Erosion Vulnerability

The EVAAL (Erosion Vulnerability Analysis for Agricultural Lands) tool was used to determine areas in the watershed that are more prone to sheet, rill, and gully erosion. The tool analyzes the watershed based on precipitation, land cover, and elevation data by running the EVAAL tool twice for the USLE and using the high C-factor for “worst case” and low C-factor for “best case” scenarios, the worst case can be subtracted from the best case which indicates areas with the greatest potential for improvement (Figure 6.5). Current tillage practices within the Lake Sinissippi-Rock River watershed were estimated to fall between the best and worst-case scenarios shown on figure 6.5 These EVAAL maps are an important tool to prioritize ag fields in the watershed-that may be contributing the most sediment and phosphorus in comparison to other fields in the watershed. The EVAAL analysis will be used throughout this plan’s ten year implementation schedule to identify critical areas in the watershed for reducing soil erosion and phosphorus loading.

Nutrient Management Planning

Nutrient management plans are conservation plans specific to anyone applying manure or commercial fertilizer. Nutrient management plans address concerns related to soil erosion, manure management, and nutrient applications. Nutrient management plans must meet the standards of the Wisconsin NRCS 590 standard.

About 24.7% of the cropland acres in the Lake Sinissippi-Rock River Watershed are covered under a nutrient management plan. Nutrient management coverage is shown by parcel in Figure 6.6. There are approximately 2,803 acres covered by a NMP and 11,337.2 acres not covered in the watershed. Approximately 27% of the Lake Sinissippi-Rock River Watershed is not zoned for the Farmland Preservation Program. We anticipate more land has a nutrient management plan, but are not required to report the acres to our department.

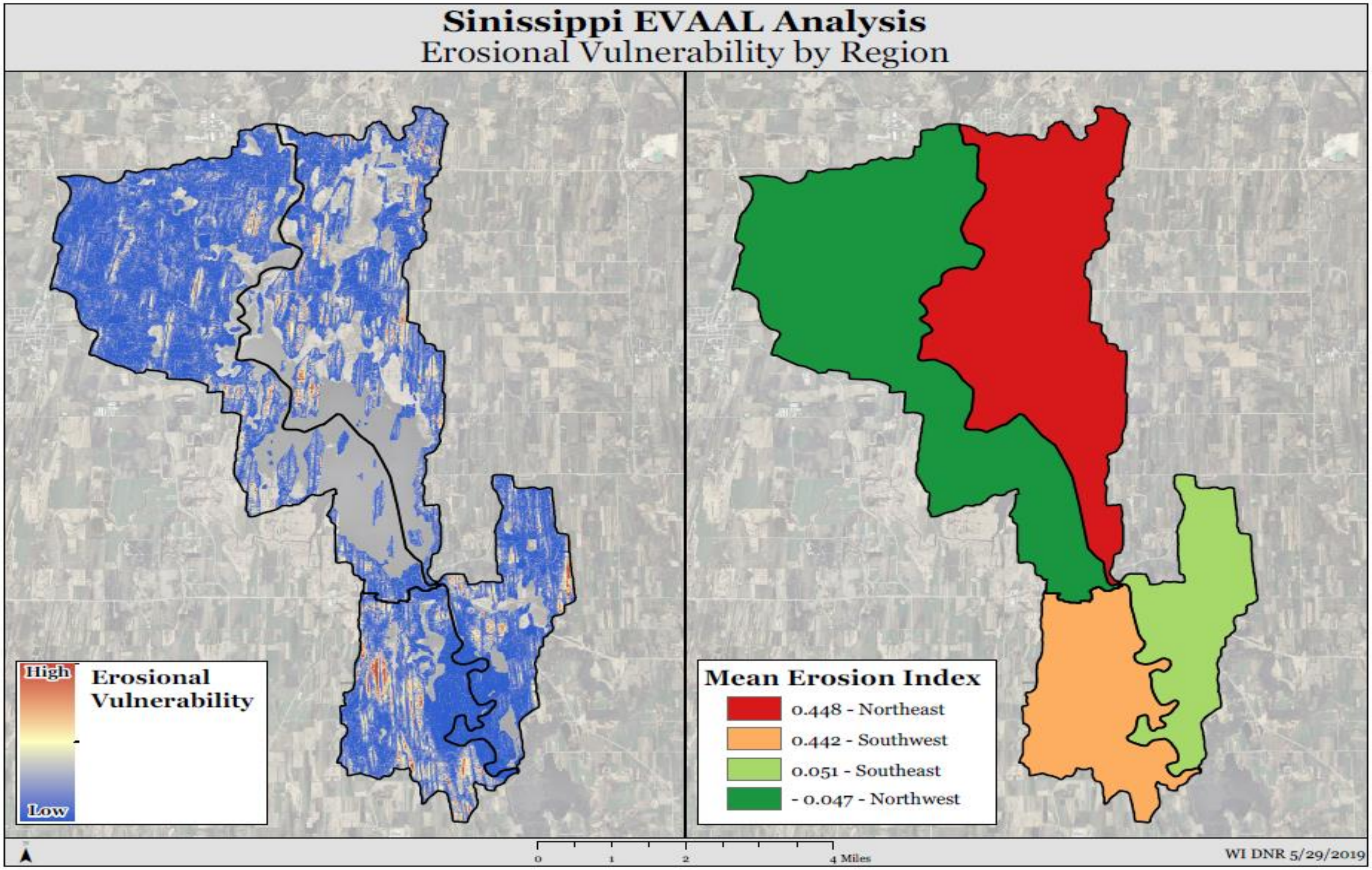


Figure 6.5: Erosion Vulnerability Index

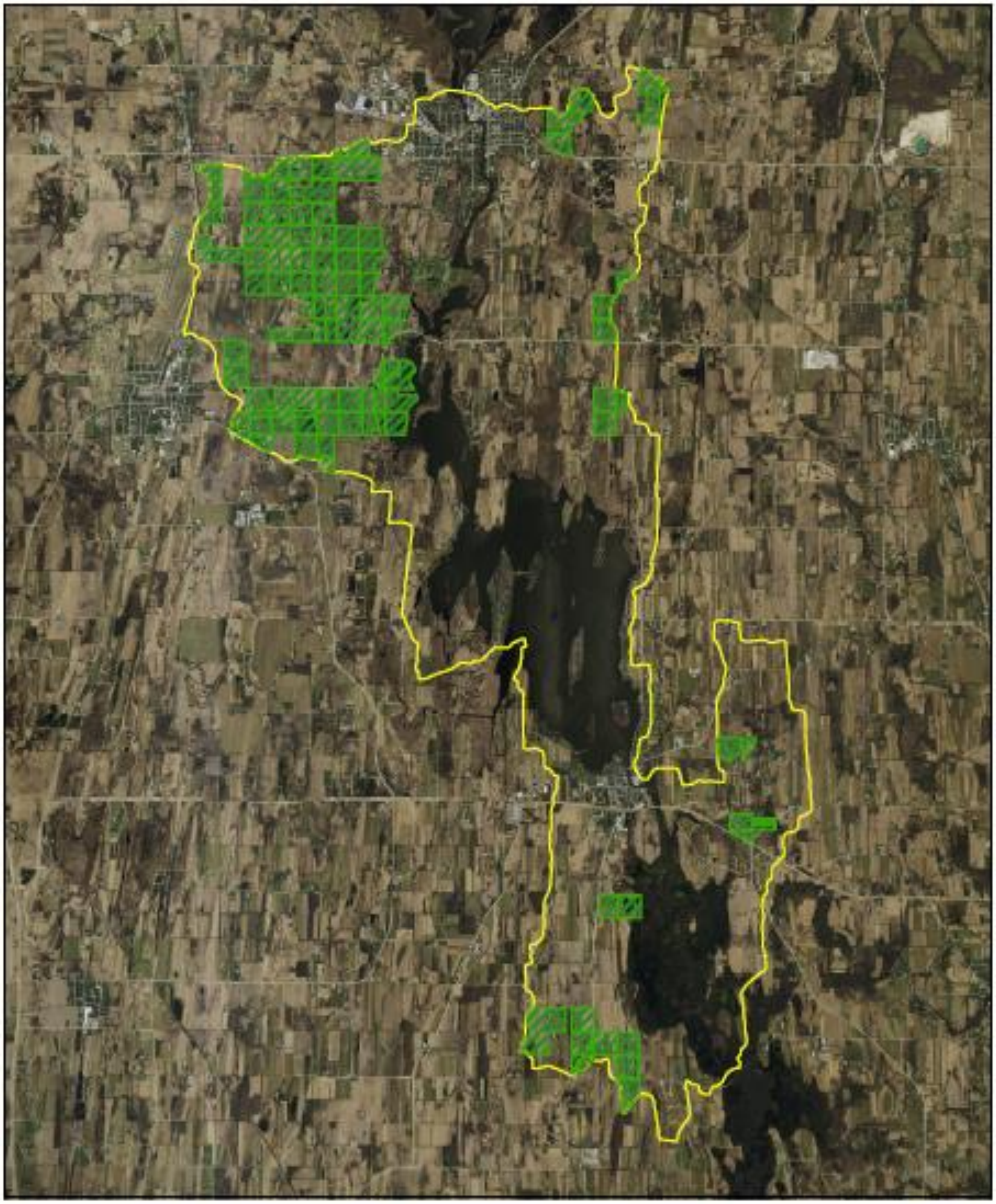


Figure 6.6: Nutrient Management Plan Coverage

Grazing/Pastureland Management

By doing one on one inventory with farms in the area, we were also able to determine how many farms grazed or pastured their livestock. Approximately 205 acres in the watershed area is currently being used as pasture for livestock. Most of the farmers that do pasture their livestock in the watershed do it for exercise and not as a means of forage with the exception of a few smaller hobby farms with horses and beef cattle. According to the EVAAL analysis of crop rotations from satellite imagery in the watershed, there are 2,714 acres of land in the category of pasture/hay/grassland. Based on our farm site visits and air photo analysis the majority of the land in the pasture/hay/grassland category is not pasture but mostly hay fields and grassland. The STEPL model estimated 405.08 lbs. of phosphorus/year and 131.16 tons of sediment per year can be attributed to the pasture/hay/grassland use category.

Vegetative Buffer Strips

Riparian Buffers

Riparian buffers filter out sediment and nutrients from water before reaching a stream channel. Buffers also reduce the amount of runoff volume, provide wildlife habitat, and help regulate stream temperature. A minimum of 35 feet of buffer for streams is generally recommended for water quality protection. Any stream without a 35 ft. buffer is considered a priority buffer area. In addition to meeting the standard 35 ft. buffer**,** some priority area buffers may need to be extended to 50 ft. to provide necessary space for slowing down cropland runoff, treatment and corresponding reductions in pollutant loads. Priority riparian buffer areas were determined using aerial photography for the Lake Sinissippi-Rock River watershed. These tillage setback areas may also open up opportunities for treatment of tile drainage via two stage ditches or other practices that reduce P loading. Drain tiles are common practice throughout the watershed due to the predominant hydrologic C and D soils. Priority areas within the watershed which could serve as potential spots for installation of buffers are depicted in figure 6.7

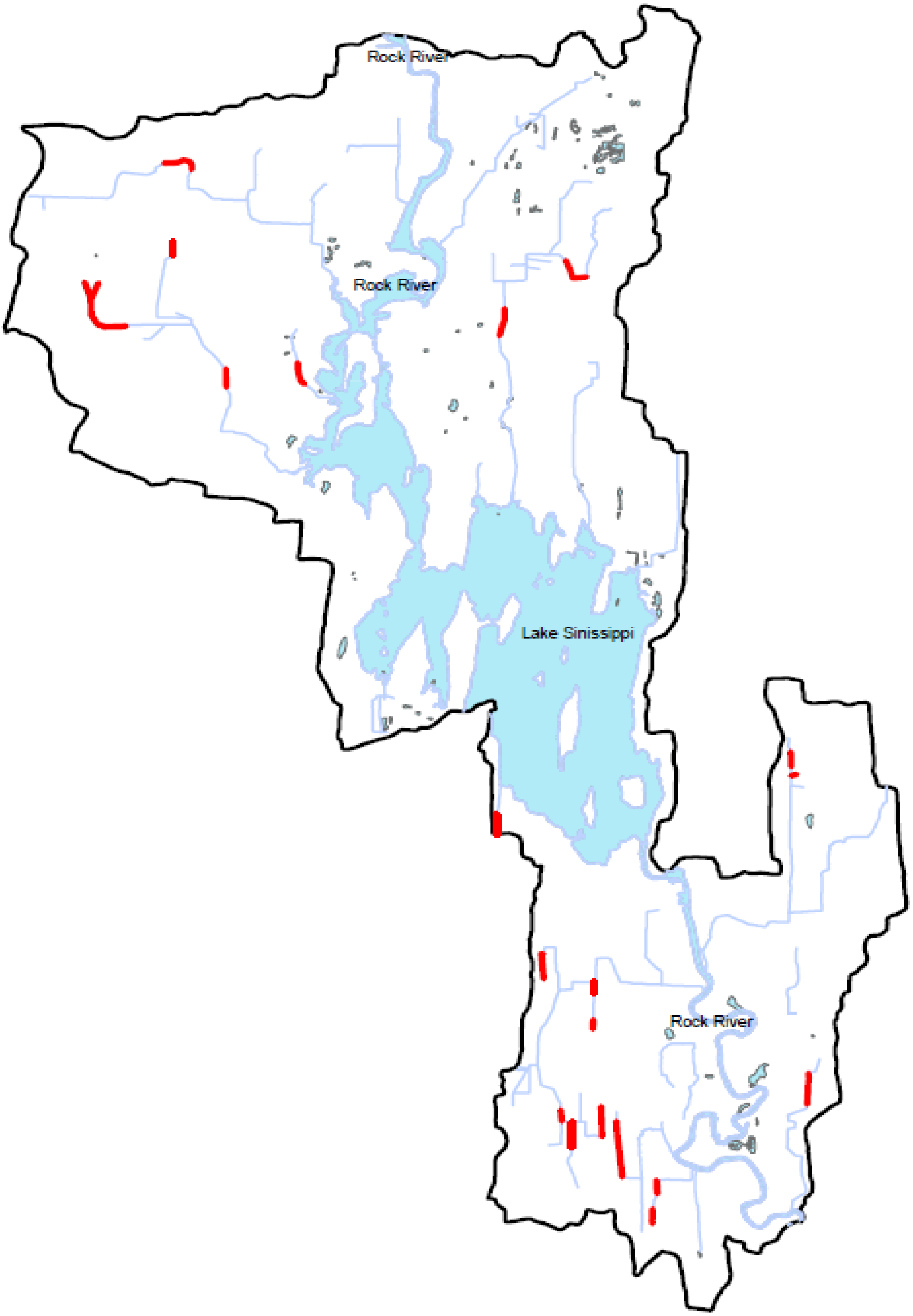


Figure 6.7: Potential Riparian Buffer Zones

Tillage Setback and Field Borders

During windshield surveys of the watershed area**,** there were many fields noted that did not have any tillage setback from drainage ditches. Enforcement of the NR 151.03 tillage setback performance standard in this watershed where there are identified soil/water resource protection concerns will be necessary in reducing nutrient and sediment loading and to implement this plans phosphorus and sediment reduction goals. The NR 151.03 tillage setback performance standard states that no tillage operation may be conducted within 5 ft. from the top of the channel of surface waters, and tillage setbacks greater than 5 ft. but no more than 20 ft. may be required to meet this standard. In addition to meeting the tillage setback to surface waters, additional field borders may be needed along artificial drainage ditches if there is a resource concern.

Gully and Concentrated Flow Stabilization

WASCOB, grassed waterway, and concentrated flow area seeding load reductions, were estimated by providing an estimated average height and width for all gullies identified in Lake Sinissippi-Rock River watershed using windshield surveys and aerial photography. In total, Lake Sinissippi-Rock River watershed has an estimated 7,305 feet (1.38 miles) of concentrated flow erosion. This plan will work to address 5,000 feet of concentrated flow erosion over the ten year schedule and it is estimated such practices will reduce 322.8lbs TP and 112.8T TSS/yr.

Current Management Practices/Projects

The Lake Sinissippi-Rock River Watershed is an area in Dodge County that has had little conservation work done in the past. A majority of the cropland in the Lake Sinissippi-Rock River Watershed does not meet the zoning requirements to make it eligible for the Farmland Preservation program. A majority of the Nutrient Management plans are required because of Dodge County's Manure Storage Ordinance.

7.0 Watershed Goals and Management Objectives

The main focus of the watershed project is to meet the limits set by the Upper Rock River TMDL for total phosphorus and sediment (TSS). Additional goals were set that address critical issues in the watershed area based on watershed inventory results and are described in Table 7.1. Management objectives address the sources that need to be addressed in order to meet the watershed goals.

Table 7.1: Watershed Goals and Management Objectives

Goal	Indicators	Cause or Source of Impact	Management Objective
Improve surface water quality to meet the TMDL limits for total phosphorus and sediment.	Total Phosphorus, Total Suspended Sediment	High phosphorus levels causing algal growth and decreased dissolved oxygen. Cropland and barnyard runoff.	Reduce the amount of sediment and phosphorus loads from cropland. Reduce the amount of phosphorus runoff from livestock facilities.
Increase citizens' awareness of water quality issues and active participation in stewardship of the watershed.	Interview/Questionaire results	Lack of awareness of environmental issues and their impact	Increase public awareness of wate quality issues and increase participation in watershed conservation activities.
Reduce runoff volume and flood levels during peak storm events.	Peak flow discharges and flash flooding of the creeks and their tributaries occurring during heavy precipitation events	Increased impervious area, tile drainage, and ditching. Inadequate storm water practices. Poor soil health	Reduce the flow of runoff from upland areas to streams. Increase soil infiltration.

8.0 Management Measures Implementation

The Lake Sinissippi-Rock River Watershed plan presents the following recommended plan of actions needed over the next 10 years in order to achieve TMDL based water quality reduction targets and watershed goals = 62% reduction of TP and 24% reduction of sediment/TSS from agriculture/nonpoint sources. Since there is approximately 326,400 acres draining into Lake Sinissippi, we will apply these reduction goals to individual streams instead of Lake Sinissippi. The plan implementation matrix provides a guideline to what kinds of practices are needed in the watershed and to what extent they are needed to achieve these watershed goals. This plan provides a timeline for which practices should be completed, possible funding sources, and agencies responsible for implementation.

Existing runoff management standards have been established by the State of Wisconsin. Chapter NR 151 provides runoff management standards and prohibitions for agriculture. This plan recommends enforcement of the state runoff standards when implementing the plan. NR 151.005 (Performance standard for total maximum daily loads) states that a crop producer or livestock producer subject to this chapter shall reduce discharges of pollutants from a livestock facility or cropland to surface waters if necessary to meet a load allocation in a US EPA and state approved TMDL. Local ordinances and regulations will also be used to implement conservation practices and compliance. County Land and Water Conservation and NRCS departments will work with landowners to implement conservation practices. Landowners will be educated on programs and funding available to them as well as current state and local agricultural regulations.

Many alternative and new conservation technologies and methods are currently being developed and evaluated within Wisconsin or nearby states to control phosphorus runoff from cropland. Incorporation of new and alternative technologies and management methods into this implementation plan will likely be necessary to achieve desired water quality targets. New practices will need to be evaluated for effectiveness and feasibility before incorporation into the plan. Examples of new technologies and methods that may be needed to reach TMDL based reduction goals in the Lake Sinissippi-Rock River watershed include, but are not limited to the following practices:

- Application of soil amendments to fields such as Gypsum, Fly ash, or Polyacryamide (PAM): Soil amendments can reduce phosphorus solubility.
- Saturated Buffer: Diversion of tile drainage to riparian buffer area reducing nutrient loading.
- Constructed Treatment Wetlands.

Table 8.1: Management Measures Implementation Matrix

Recommendations	Indicators	Milestones			Timeline	Funding Sources	Implementation
		0-3 years	3-7 years	7-10 years			
1) Management Objective: Reduce the amount of sediment and phosphorus loading from agricultural fields and uplands							
a) Application of conservation practices to cropland. These practices include: • Utilization of strip cropping and/or contour cropping practices on fields. • Increase acreage of conservation tillage (No till, Strip till, Mulch Till) in watershed area. Fields must meet 30% residue. • Implement use of cover crops. • Installation of field borders. • Enforcement of NR151.03 standard for tillage setback from surface waters where necessary. • Use of vertical manure injection on fields with cover crops & reduced tillage. • Prescribed grazing	# acres cropland with conservation practices applied	1,500	2,500	1,766	0-10 years	EQIP, TRM, CSP, AM, WQT	LWCD, NRCS
b) Installation of grassed waterways in priority areas.	# of linear feet of grassed waterways installed	750	1750	500	0-10 years	EQIP, CREP, AM, WQT	LWCD, NRCS

Recommendations	Indicators	Milestones			Timeline	Funding Sources	Implementation
		0-3 years	3-7 years	7-10 years			
c) Critical Area Planting	# linear feet of critical area plantings	500	1000	500	0-10 years		LWCD, NRCS
d) Installation of vegetative buffers along perennial and intermittent streams and legal drains.	# acres of buffers installed	3	10	6	0-10 years	CREP/CRP, EQIP, AM, WQT	LWCD, NRCS
e) Nutrient Management: Sign up remaining landowners for nutrient management.	# of landowners signed up for nutrient management plans	5	10	10	0-10 years	EQIP, TRM, SEG, AM, WQT	LWCD, NRCS
f) Checks to make sure installed practices and management plans are being maintained and properly followed.	# of farms checked	10	15	15	0-10 years	N/A	LWCD
g) Enforcement of NR 151.03 standard for tillage setback from surface waters where necessary	% of fields meeting standard tillage setback	25%	50%	75%	0-10 years	N/A	LWCD
h) Evaluate and use new technologies and innovative practices to reduce phosphorus and sediment loading from cropland. (Examples include: phosphorus removal structures, saturated buffers, soil amendment applications, interseeding cover crops)	# sites where new technologies have been used and assessed for effectiveness and feasibility	0	1	1	0-10 years	NRCS, Other Federal/State/Private funding	LWCD, NRCS

Recommendations	Indicators	Milestones			Timeline	Funding Sources	Implementation
		0-3 years	3-7 years	7-10 years			
2) Management Objective: Slow the flow of runoff from upland areas to watershed streams							
a) Increase water storage by restoring wetlands.	# of acres of wetlands restored	0	1	1	0-10 years	EQIP, CREP/CRP, WQT, AM	LWCD, NRCS, FWS
b) Install Water and Sediment Control Basins to store and slow flow of runoff.	# of WASCOBS installed	0	1	0	0-10 years	EQIP, AM, WQT	LWCD, NRCS
c) Increase soil infiltration by implementing practices (a-i) under Management Objective 1.	–	–	–	–	–	–	–
3) Management Objective: Reduce phosphorus runoff from barnyards							
a) Retrofit barnyard sites with necessary runoff control structures (gutters, filter strips, settling basins, clean water diversions)	# of barnyard sites addressed and retrofitted with necessary runoff control measures	2	2	2	0-10 years	EQIP, TRIM, AM, WQT	LWCD, NRCS
b) Manure management on livestock operation sites.	# of new or updated manure storage facilities	0	1	1	0-10 years	EQIP, TRIM, AM, WQT	LWCD, NRCS

1. *A combination of the listed practices will be applied to agricultural fields to get the desired reductions required by the TMDL. Not all practices listed will be applied to each field. The combinations of practices applied will vary by field. In most cases just applying one practice to a field will not get desired reductions and a combination of 2-3 practices will be necessary to get desired reductions. See Appendix C.*

Recommendations	Indicators	Milestones			Timeline	Funding Sources	Implementation
		0-3 years	3-7 years	7-10 years			
Annually meet with WDNR Nonpoint Source and TMDL staff to review and discuss NR 151 implementation efforts in the watershed. Items for review will include, but not be limited to, 1-6 below.	# of annual meetings	3	3	4	0-10 years	N/A	LWCD, WDNR

1. *Do plan implementation efforts for agricultural cropland/operations in the watershed reflect the following priority:*
   - *Priority 1 - Achieve compliance with NR 151 performance standards on a majority of agricultural acres/operations in the watershed**
   - *Priority 2 – After a majority of agricultural cropland or operations in the watershed* are found in compliance with existing NR 151 standards, then adoption of additional practices on agricultural acres/operations already in compliance with NR 151 is completed to further reduce pollutant loads from agricultural sources in watershed.*

   ** = NR 151 Implementation/Compliance rates may vary within the watershed and require dividing the watershed into sub-basins.*
2. *If item 1 is not met, then how and when can plan implementation efforts change to meet item 1?*
3. *Complete annual watershed inventory to determine current number agricultural cropland acres/farms - out of total number of cropland acres/farms in watershed - that are complying with NR151.*
4. *Identify how many cropland acres/farms in watershed have received/been documented in compliance with NR 151 via letter.*
5. *Share/Review copies of NR 151 compliance letters with WDNR staff.*
6. *Summarize NR 151 priorities, compliance inventory and documentation efforts within annual 9 element plan progress reports.*

9.0 Load Reductions

Load reductions for agricultural best management practices were estimated using STEPL model and load reductions from barnyards were estimated using the BARNY model. Percent reduction was based on the STEPL model agricultural baseline loading of 53,173.27 lbs. of phosphorus and 9806.21 tons sediment to the Rock River per year. This will change the percent reduction calculations: 6505.64 lbs. TP reduction/53,173.27 lbs. P = 12% reduction. 891.88 tons/Sediment reduction/9,806.21 tons Sediment = 9.3% reduction. This plan will focus only on the Cropland, Pastureland, Feedlots, and Shoreline Stabilization because this is where a majority of the pollutant loads are generated. After adoption of the practices shown in Table 9.1 in the Lake Sinissippi-Rock River watershed, a 12% reduction in TP and 9.3% reduction in TSS is expected. These estimated reductions make progress towards, but fall short of the TMDL phosphorus and suspended sediment goals. This plan attempts to achieve BMP implementation on 50% of the total cropland acres. It is expected that the remaining of TP and TSS can be achieved by working on the remaining 50% cropland in the watershed or by implementing additional or new/innovative practices on acres with existing cropland practices during future ten-year plan efforts.

Another challenge that presents itself to improving water quality within agricultural dominated watersheds is legacy phosphorus in the cropland soils and streambeds. In recent years, scientists and watershed managers are finding that water quality is not responding as well as expected to implemented conservation practices (Sharpley et al 2013). They are attributing this slower and smaller response to legacy phosphorus, primarily from cropland soils. Legacy phosphorus is used to describe the accumulated phosphorus that can serve as a long-term source of P to surface waters. Legacy phosphorus in a soil occurs when phosphorus in soils builds up much more rapidly than the decline due to crop uptake. In stream channels, legacy phosphorus can result from upland sediment erosion followed by sediment deposition of particulate phosphorus, sorption of dissolved phosphorus onto riverbed sediments or suspended sediments, or by incorporation into the water column (Sharpley et al 2013). While legacy phosphorous may be an issue the Lake Sinissippi-Rock River Watershed, most of the waterways (outside of the Rock River and Lake Sinissippi) are drainage ditches and cleaned periodically. Therefore, legacy phosphorous will not be a focus in this watershed plan.

Table 9.1: Expected Load Reduction from Recommended Best Management Practices

Management Measure Category	Total Units (size/length)	Total Cost	Estimated Load Reduction			
			TP (lbs/yr)	Percent	TSS (t/yr)	Percent
Vegetative Riparian Buffers	18 acres	72,000.00	132.9	0.2	48.8	0.5
Barnyard Retrofits (filter strips, waste storage, clean water diversions, maintenance/repair of existing practices, etc)	6 sites	485,000.00	166.92	0.3	NA	NA
Practices applied to Cropland (Conservation Tillage/Residue Management, Cover Crops, Nutrient Management, Contour Cropping, Strip Cropping, Tillage Setback, Field Border, Vertical Manure Injection, Prescribed Grazing)1	5,766 acres	222,838.00	5900.12	10.9	762.08	7.9
Gully Stabilization (Grassed Waterways, Critical Area Plantings, WASCOBS)	5,000 ft./1WASCOB	44,500.00	281.4	0.5	75.9	0.8
Use of new technologies and innovative practices to reduce phosphorus and sediment loading from cropland (Instream treatment in drainage ditches, saturated buffers, water control structures for tile outlets, phosphorus removal structures, soil amendment applications) 2	Unknown	NA	Unknown	NA	Unknown	NA
Wetland Restoration	2 Sites	17,000.00	24.3	0.1	5.1	0.1
Totals		**841,338.00**	**6505.64**	**12.0**	**891.88**	**9.3**

1. This category does not indicate that all these practices will be applied to all 17,062 acres of cropland. A combination of conservation practices applied to a majority of the cropland in the watershed is necessary to get the desired pollutant load reductions suggested by the TMDL. It is also important to note that not all fields will need to apply more than one practice to meet desired reduction goals.

2. The amount of new technologies and management measures needed has not been determined, as well as, expected load reductions and cost. If new management measures/ technologies prove effective and feasible they will be incorporated into the plan with more accurate load reductions, cost, and amount needed. Depending on the efficiencies realized by new innovative practices, the number or combinations of other field practices required may be reduced.

10.0 Information and Education

This information and education plan is designed to increase participation in conservation programs and implementation of conservation practices within Lake Sinissippi-Rock River watershed by informing the landowners of assistance and tools available to them and providing information on linkages between land management and downstream effects on water quality.

The town of Hubbard is not zoned for Farmland Preservation. The town of Hustisford changed their zoning in 2018 and are now eligible for Farmland Preservation tax credits. The town of Oak Grove has been zoned for Farmland Preservation for many years. We estimated approximately 57% of the land in Lake Sinissippi-Rock River Watershed is in the townships of Hubbard and Hustisford. As a result, there has been little work done in these two townships for promoting/adopting soil conservation practices.

10.1 Recommended Information and Education

Goals of the information and education plan: Create public awareness of water quality issues in the watershed, increase public involvement in watershed stewardship, and increase communication and coordination among municipal officials, businesses, and agricultural community.

Objectives

- Educate local officials about the watershed plan. Develop targeted educational materials to appropriate audience in the watershed.
- Host workshops, meetings, and events that landowners can attend to learn about conservation practices.
- Increase landowners' adoption of conservation practices.
- Inform public of current water quality issues in the Upper Rock River Watershed Basin and how the Lake Sinissippi-Rock River watershed contributes.

Target Audience

There are multiple target audiences that will need to be addressed in this watershed. Target audiences in this watershed will be agricultural landowners and operators, local government officials, agricultural businesses and organizations. Focused attention will be on agricultural landowners and operators since the main source of pollutant loading in the watershed is from agricultural land. Non-operator agricultural landowners are an important subset of this group as they are usually~~,~~ not focused on, and are less likely to, participate in conservation programs.

Existing Education Campaigns

Dodge County Farmers for Healthy Soil - Healthy Water is a farmer led group that has had great success in the past 2 years for providing winter and summer workshops and demonstration plots on reduced tillage and cover crops. They meet once a month and are starting to move their meetings around the county. This plan will work to collaborate and build upon these existing education efforts.

I&E Plan Recommended Actions

An Information and Education Plan matrix (Table 14) was developed as a tool to help implement the I&E plan. The matrix includes recommended action campaigns, target audience, package for delivery of message, schedule, outcomes, estimated costs, and supporting organizations.

Evaluation

The I&E plan should be evaluated regularly to provide feedback regarding the effectiveness of the outreach campaigns. Section 13.3 describes milestones related to watershed education activities that can be used to evaluate the I&E plan implementation efforts.

Table 10.1: Information and Education Plan Implementation Matrix

Information and Education Plan Implementation Matrix						
Information and Education Action	***Target Audience***	***Recommendations***	***Schedule***	***Outcomes***	***Cost***	***Implementation***
Inform the public on watershed project	General Public	-Public notice in local newspaper upon completion of watershed plan. -Present plan to public at a public meeting. -Provide a link on county website for watershed project updates/progress	0-3 years	General public is aware of watershed implementation plan and has better understanding of how they can impact water quality.	$800	LWCD
Educate landowners on watershed project and progress.	Private landowners, agricultural landowners/ operators	Bi-annual/annual newsletter including watershed updates as well as information on new practices and programs.	0-10 years	Landowners are informed on project and progress. Landowners can stay up to date on new practices and strategies available.	$4,500	LWCD
Educate agricultural landowners and operators about the plan, its recommendation actions, and technical assistance	Agricultural landowners/ operators	• Distribute educational materials on conservation practices and programs every 2 years. • One on one contact with at least three individual landowners per year to provide tools and resources.	0-10 years	• Agricultural landowners are informed about conservation practices, cost share programs, and technical assistance available to them. • Increase in interest in utilizing and installing	$8,000	LWCD

Information and Education Plan Implementation Matrix						
Information and Education Action	***Target Audience***	***Recommendations***	***Schedule***	***Outcomes***	***Cost***	***Implementation***
and funding available.		• Orchestrate group meetings with agricultural landowners in watershed every two years to share knowledge and foster community connections for long term solutions. • Offer 4 workshops to agricultural landowners to educate them on conservation practices that should be used to preserve the land and protect water resources. • Tour local demonstration farm and other sites that have implemented conservation practices.		conservation practices. • Improved communication between agricultural landowners, willingness to share ideas, and learn from other agricultural landowners. • Agricultural landowners recognize the benefit of conservation farming practices and how it improves water quality. • Agricultural landowners see success of conservation practices as well as problems that can be expected.		LWCD
Reach out to non-operator land owners.	Non-operator agricultural landowners	• Distribute educational materials targeted to non-operator agricultural landowners. • One on one contact and group meetings with non-operator agricultural land owners to share knowledge and foster community connections for long term solutions.	0-5 years	Non-operator landowners are informed on conservation practices. Increased participation rates in conservation activities from non-operator land owners.	$2,000	LWCD

Information and Education Plan Implementation Matrix						
Information and Education Action	***Target Audience***	***Recommendations***	***Schedule***	***Outcomes***	***Cost***	***Implementation***
Educate local officials about the completed plan. Encourage amendments of municipal comprehensive plans, codes, and ordinances to include watershed plan goals and objectives.	Elected officials in Dodge County, Towns of Herman, Hubbard, Hustisford, Rubicon, and Williamstown, Village of Iron Ridge.	Present project plan to officials and conduct meetings with government officials.	1-2 years	Local municipalities adopt plan and amend ordinances, codes, and plans to include watershed plan goals and objectives.	$0	LWCD
Educate homeowners on actions they can take to reduce polluted runoff from their yards.	Homeowners	Distribute educational materials to homeowners on how to reduce polluted stormwater runoff from their yards.	0-5 years	Homeowners are aware of the impact they can have on water quality and actions they can take to reduce pollutions from their yards.		
Educate local agricultural businesses and organizations on objectives of watershed project.	Agronomists, Co-ops, Seed dealers	Meetings with local agricultural organizations to share goals of project and planned conservation practices and outreach needed.	0-5 years	Local agricultural organizations are aware of watershed project and can assist landowners with conservation needs as well as help deliver common message to protect water quality in watershed area.	$1,000	LWCD

Information and Education Plan Implementation Matrix						
Information and Education Action	***Target Audience***	***Recommendations***	***Schedule***	***Outcomes***	***Cost***	***Implementation***
Outcome of information and education plan.	Agricultural landowners/ operators	Survey agricultural landowners on water quality awareness, knowledge of conservation practices, and participation on conservation practices.	5-7 years	Increased awareness of water quality and conservation practices in the watershed area in comparison to 2014 survey.	$2,500	LWCD

11.0 Cost Analysis

Cost estimates were based on current cost-share rates, incentives payments to get necessary participation, and current conservation project installation rates. Current conservation project installation rates were obtained through conversations with county conservation technicians. Landowners will be responsible for maintenance costs associated with installed practices. The total cost to implement the watershed plan is estimated to be $3,147,250 with an additional $800,000 in new technology costs.

Summary of Cost Analysis

- $1,894,818 to implement best management practices.
- $1,170,840 needed for technical assistance.
- $70,000 needed for information and education.
- $11,592 for water quality monitoring.
- $800,000 for new innovative practices.

Table 11.1: Cost Estimates for Implementation of Best Management Practices

BMP	Quantity	Cost/Unit ($)	Total Cost ($)
Upland Control			
Conservation Tillage (ac)	2,200	18.50	40,700
Cover Crops (ac)	1,166	20.00	23,300
Grass Waterways (ln ft)	3,000	7.50	22,500
Critical Area Planting (ln ft)	2,000	5.00	10,000
Vegetative Buffers (ac)	18	4,000.00	72,000
Nutrient Mgt. (ac)	1,973	10.00	59,190
Wetland Restoration (ac)	2	10,000.00	20,000
Water and Sediment Control Basin (ea)	1	12,000.00	12,000
Contour Farming (ac)	566	8.00	4,528
Vertical Manure Injection (ac)	500	50.00	25,000
Prescribed Grazing (ac)	50	52.00	2,600
Streambank and Shoreline Protection	26,400	45.00	1,118,000
Barnyard Runoff Control			
Filter Strip/Wall (ea)	2	28,000.00	56,000
Roof Gutters (ln ft)	825	12.00	9,000
Waste Storage (ea)	2	200,000.00	400,000
Milkhouse Waste Treatment (ea)	2	10,000.00	20,000
Technical Assistance			
Conservation Technician	1	54,924	549,240
Conservation Agronomist	1	62,160	621,600

Estimated Costs of New/Alternative Practices:

Cost of new technologies/management methods was not included in this estimate since the quantity of these technologies that may be needed is not yet known. Approximate costs for a selected few new technologies are as follows:

- $25-45/ton gypsum. Typical application rate to improve soil physical properties, water infiltration/percolation, and water quality is 1,000-9,000 lbs./acre (Ohio State University 2011).
- Drainage water management structure for tile drains: $500-$2,000 each unit or $20-$110/acre.

Table 11.2: Information and Education Costs

Information and Education	Cost
Staff hours (2,000hrs x $25/hr)	$50,000
Materials (Postage, printing costs, paper costs, and other presentation materials)	$20,000

Table 11.3: Water Quality Monitoring Costs

Water Quality Monitoring Activity	Cost ($)
TP, TSS, DRP Lab Analysis	11,592

Operation & Maintenance

This plan will require a landowner to agree to a 10-year maintenance period for the upland and barnyard runoff control practices listed in table 11.1 above. For annual practices that require re-installation of management each year such as conservation tillage, cover crops, and nutrient management, landowners are required to maintain the practice for each period that cost sharing is available. Therefore annual assistance may be required for certain practices. Upon completion of the operation and maintenance period, point sources may be able to work with operators and landowners to continue implementation of the BMP’s under a pollutant trading agreement (non EPA 319 monies).

12.0 Funding Sources

There are many state and federal programs that currently provide funding sources for conservation practices. Recently the option of adaptive management, water quality trading, and phosphorus variance has become other options for funding of practices.

12.1 Federal and State Funding Sources

A brief description of current funding programs available and their acronyms are listed below:

Environmental Quality Incentives Program (EQIP) - Program provides financial and technical assistance to implement conservation practices that address resource concerns. Farmers receive flat rate payments for installing and implementing runoff management practices.

Conservation Reserve Program (CRP) - A land conservation program administered by the Farm Service Agency. Farmers enrolled in the program receive a yearly rental payment for environmentally sensitive land that they agree to remove from production. Contracts are 10-15 years in length. Eligible practices include buffers for wildlife habitat, wetlands buffer, riparian buffer, wetland restoration, filter strips, grass waterways, shelter belts, living snow fences, contour grass strips, and shallow water areas for wildlife.

Conservation Reserve Enhancement Program (CREP) - Program provides funding for the installation, rental payments, and an installation incentive. A 15-year contract or perpetual contract conservation easement can be entered into. Eligible practices include filter strips, buffer strips, wetland restoration, tall grass prairie and oak savanna restoration, grassed waterway, and permanent native grasses.

ACEP- Agricultural Conservation Easement Program - New program that consolidates three former programs (Wetlands Reserve Program, Grassland Reserve Program, and Farm and Ranchlands Protection Program). Under this program NRCS provides financial assistance to eligible partners for purchasing Agricultural Land Easements that protect the agriculture use and conservation values of eligible land.

Targeted Runoff Management Grant Program (TRM) - Program offers competitive grants for local governments for controlling nonpoint source pollution. Grants reimburse costs for agriculture or urban runoff management practices in critical areas with surface or groundwater quality concerns. The cost-share rate for TRM projects is up to 70% of eligible costs.

Conservation Stewardship Program (CSP) – Program offers funding for participants that take additional steps to improve resource condition. Program provides two types of funding through 5-year contracts; annual payments for installing new practices and maintaining existing practices as well as supplemental payments for adopting a resource conserving crop rotation.

Farmable Wetlands Program (FWP) - Program designed to restore previously farmed wetlands and wetland buffer to improve both vegetation and water flow. The Farm Service Agency runs the program through the Conservation Reserve Program with assistance from other government agencies and local conservation groups.

Land Trusts- Landowners also have the option of working with a land trust to preserve land. Land trusts preserve private land through conservation easements, purchase land from owners, and accept donated land.

12.2 Adaptive Management and Water Quality Trading

Adaptive management and water quality trading are potential sources of funding in this watershed if there are interested point sources. Adaptive management and water quality trading can be easily confused. Adaptive management and water quality trading can provide a more economically feasible option for point source dischargers to meet their waste load allocation limits. Point sources provide funding for best management practices to be applied in a watershed and receive credit for the reduction from that practice. Adaptive management focuses on compliance with phosphorus criteria while water quality trading focuses on compliance with a discharge limit.

12.3 Phosphorus Multi- Discharger Variance (Wisconsin Act 378)

In April of 2014, Act 378 was enacted; this act required the Wisconsin Department of Administration in consultation with the Department of Natural Resources to determine if applying with phosphorus causes Wisconsin substantial and economic hardship. If so, DNR will work with the EPA to implement a phosphorus Multi-discharger Phosphorus Variance to help point sources comply with phosphorus standards in a more economically viable way. A multi- discharger variance extends the timeline for complying with low level phosphorus limits. In exchange, point sources agree to step wise reduction of phosphorus within their effluent as well as helping to address nonpoint source of phosphorus from farm fields, cities or natural areas by paying $50 per pound to implement projects designed to improve water quality. A permittee that chooses to make payments for phosphorus reduction will make payments to each county that is participating in the program and has territory within the basin in which the point source is located in proportion to the amount of territory each county has within the basin. A county will then use the payments to provide cost sharing for projects to reduce the amount of phosphorus entering the waters of the state, for staff to implement phosphorus reduction projects, and/or for modeling or monitoring to evaluate the amount of phosphorus in the waters of the state for planning purposes.

13.0 Measuring Plan Progress and Success

Monitoring of plan progress will be an essential component of achieving the desired water quality goals. Plan progress and success will be tracked by water quality improvement, progress of best management practice implementation, and by participation rates in public awareness and education efforts.

13.1 Water Quality Monitoring

In order to measure the progress and effectiveness of the watershed plan, water quality monitoring will be conducted throughout the plans ten year schedule. Physical, and chemical data will need to be collected to establish baseline water quality and biological conditions in the watershed and then repeated to verify Lake Sinissippi-Rock River is meeting TMDL reduction goals and meeting designated use standards.

Stream Water Quality Monitoring

There are no named streams in the Lake Sinissippi-Rock River Watershed. There are a number of drainage systems within the watershed that are not drainage districts. Some of these go dry in the summer. There are four locations that may stay wet year round that we will attempt to sample from. These samples will be sent to the UW-Stevens Point Bio Monitoring Lab for analysis. Total Phosphorus(TP) and Total Suspended Solids(TSS) will be collected from these sites. TP and TSS samples will be collected in 30-day intervals from May through October in 2020, 2025, and 2030 following WISCALM (2014) protocols for TP. (See Table 13.1) On each sampling date, LWCD and/or volunteers will collect and transfer surface water samples to the Wisconsin State Laboratory of Hygiene for the analysis of TP, TSS. We will work with Rock River Coalition, WDNR and Lake Districts to find and train local citizens to be our volunteer water samplers. If any of these ditches go dry, other methods of monitoring will have to be done, ie. SNAP-Plus, Barny.

Water Quality Indicators

Plan progress will also be measured by collecting water quality data using Wisconsin WISCALM (2014) protocols for TP and evaluating same samples for TSS. Median summer phosphorus concentrations, annual phosphorus and suspended sediment loading rates will be used to determine if there are measureable improvements in water quality over time in the watershed. Evaluation of legacy P sources in the watershed will not take place. Since the water courses are drainage ditches and cleaned periodically, there is not legacy P to evaluate.

The water quality-monitoring table will be updated periodically after WQ sampling in the watershed is completed in 2020, 2025 and 2030. The table will not only help provide WQ monitoring milestones, but also to tract/document WQ monitoring actions over time. We recognize:

- Current (TP and TSS) Values are not yet available for the four proposed WQ sampling stations.
- Plan has milestones to collect and include WQ monitoring information as data becomes available.
- Long Term Values (10 yrs.) column will likely be higher than 0.075 ug/L TP because the total practices in ten-year plan (modeled in STEPL) show it is unlikely to achieve the required load reduction and, therefore, this TP concentration.

Table 13.1. Water Quality Monitoring Indicators for Success.

Monitoring Recommendation	Indicators	Current Values	Target Value or Goal for Lower East Watershed	Medium Term (5 yrs.)	Long Term (10 yrs.)	Implementation	Funding
1. Ditch on Hwy. S @ Mittlestadt farm	Summer Median Total Phosphorus (mg/l)	NA	0.075	NA	0.075	Volunteers/ LWCD	WDNR Grants
2. Ditch on Hwy S@ Bunkoske farm	Summer Median Total Phosphorus (mg/l)	NA	0.075	NA	0.075	Volunteers/ LWCD	WDNR Grants
3. Ditch on Hwy R @ Mueller farm	Summer Median Total Phosphorus (mg/l)	NA	0.075	NA	0.075	Volunteers/ LWCD	WDNR Grants
4. Ditch on Hilltop Rd. @ Black Oak Farms LLC.	Summer Median Total Phosphorus (mg/l)	NA	0.075	NA	0.075	Volunteers/ LWCD	WDNR Grants

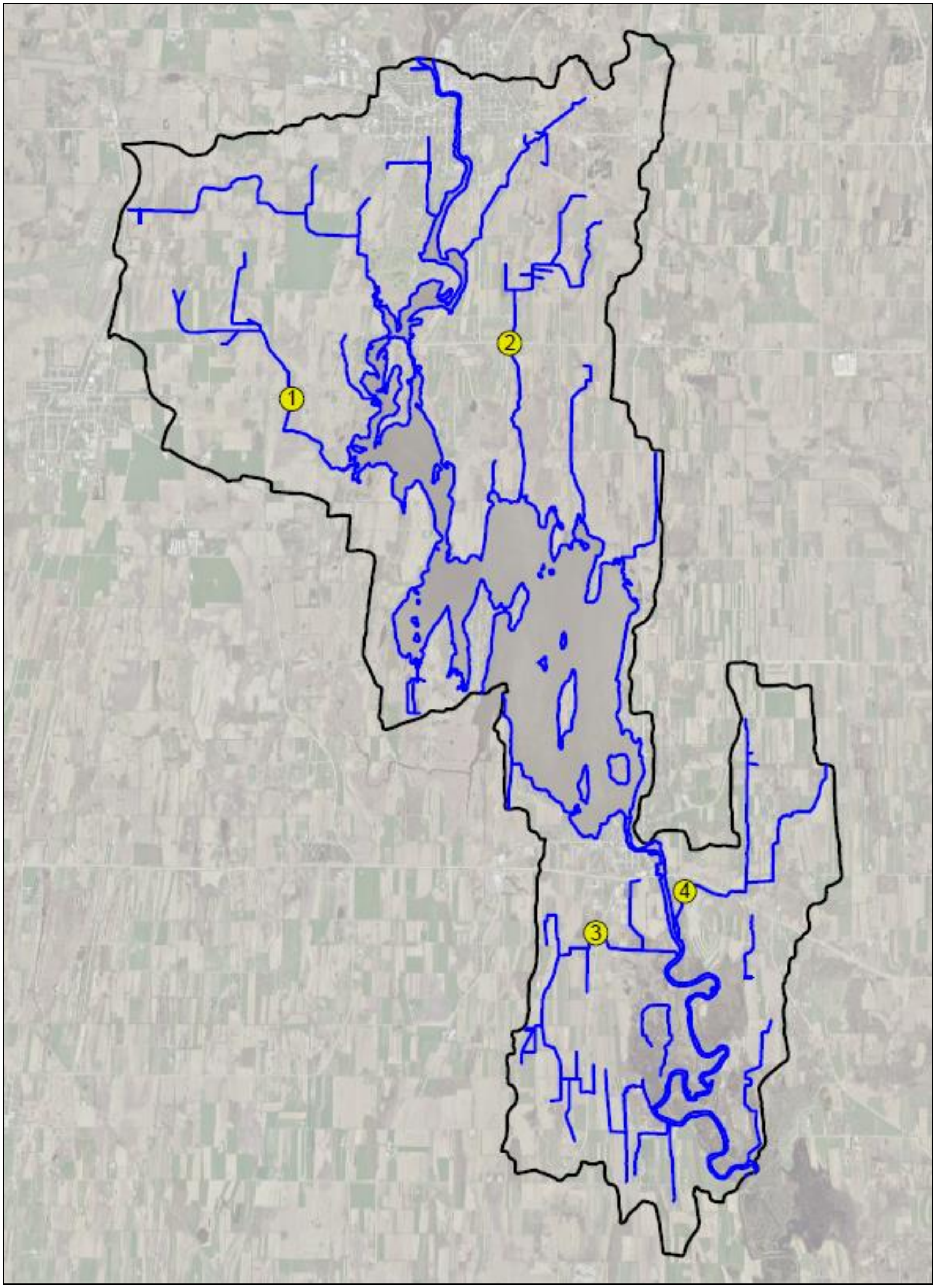


Figure 13.1: Water Quality Monitoring Sites

13.2 Tracking of Progress and Success of Plan

Progress and success of the Lake Sinissippi-Rock River Watershed Project will be tracked by the following components:

1) Information and education activities and participation
2) Pollution reduction estimates using models and based on number and types of BMP's installed
3) Water quality monitoring
4) Administrative review

Dodge County Land and Water Conservation Department will be responsible for tracking progress of the plan. Progress reports will be completed annually, and a final report will be prepared at the end of the ten year schedule.

1) **Information and education reports will include:**
    a) Number of landowners/operators in the watershed plan area.
    b) Number of eligible landowners/operators in the watershed plan area.
    c) Number of landowners/operators contacted.
    d) Number of cost-share agreements signed.
    e) Number and type of information and education activities held, who lead the activity, how many invited, how many attended, and any measurable results of I&E activities.
    f) Number of informational flyers/brochures distributed per given time period.
    g) Number of one on one contacts made with landowners in the watershed.
    h) Number of municipalities that adopt municipal comprehensive plans, codes, and ordinances, supportive of watershed plan goals and objectives.
    i) Comments or suggestions for future activities.

2) **Pollution Reduction Evaluation Based on BMP's Installed**
    Installed best management practices will be mapped using GIS. Pollution reductions from completed projects will be evaluated using models and spreadsheet tools such as STEPL and SNAP Plus for upland practices and the BARNY model for barnyard practices. The annual report will include:
    a) Planned and completed BMP's.
    b) Pollutant load reductions and percent of goal planned and achieved.
    c) Cost-share funding source of planned and installed BMP's.
    d) Numbers of checks to make sure management plans (nutrient management, grazing management) are being followed by landowners.
    e) Number of checks to make sure practices are being operated and maintained properly.
    f) The fields and practices selected and funded by a point source (adaptive management or water quality trading) compliance options will be carefully

tracked to assure that Section 319 funds are not being used to implement practices that are part of a point source permit compliance strategy.

g) Number of new and alternative technologies and management measures assessed for feasibility, used, and incorporated into plan.
h) Possibilities of natural variation, lack of proper maintenance, and/or unforeseen consequences will be assessed as part of installing best management practices in the watershed.

3) **Water Quality Monitoring Reporting Parameters:**
   a) Total phosphorus, dissolved reactive phosphorus, total suspended solids from volunteer grab sampling in 2020, 2025 and 2030.
   b) Macroinvertebrate Index of Biotic Integrity.
   c) Fish IBI surveys.

4) **Administrative Review** tracking and reporting will include:
   a) Status of grants relating to project.
   b) Status of project administration including data management, staff training, and BMP monitoring.
   c) Status of nutrient management planning, and easement acquisition and development.
   d) Number of cost-share agreements.
   e) Total amount of money on cost-share agreements.
   f) Total amount of landowner reimbursements made.
   g) Staff salary and fringe benefits expenditures.
   h) Staff travel expenditures.
   i) Information and education expenditures.
   j) Equipment, materials, and supply expenses.
   k) Professional services and staff support costs.
   l) Total expenditures for the county.
   m) Total amount paid for installation of BMP's and amount encumbered for cost-share agreements.
   n) Number of Water Quality Trading/Adaptive Management contracts.

13.3 Progress Evaluation

Due to the uncertainty of models and the efficiency of best management practices, an adaptive management approach should be taken with this sub watershed. Milestones are essential when determining if management measures are being implemented and how effective they are at achieving plan goals over given time periods. Milestones are based on the plan implementation schedule with short term (0-3 years), medium term (3-7 years), and long term (7-10 years) milestones. After the implementation of practices and monitoring of water quality, plan progress and success should be evaluated after each milestone period. In addition to the annual report an additional progress report should be completed at the end of each milestone period. The progress report will be used to identify and track plan implementation to ensure that progress is being made and to make corrections as necessary. Plan progress will be determined by minimum progress criteria for management practices, water quality monitoring, and information and education activities held. If lack of progress is demonstrated, factors resulting in milestones not being met should be included in the report. Adjustments should be made to the plan based on plan progress and any additional new data and/or watershed tools. If any projections are not met, possible land treatment deteriorations will be looked into.

Minimum Progress Criteria for Revisiting Plan Milestones

This plan contains several milestones that will be carefully tracked and monitored over time to determine if sufficient progress is being made to meet plan goals/pollutant reductions. The following criteria will be used to determine when plan milestones and reduction goals should be revised due to minimal progress achieved:

- Less than 25% of planned Landowner participation is achieved by year 5
- Less than 25% of planned cropland practices are met by year 3
- Less than 25% of funding is available/awarded to implement by year 3
- Less than 25% of funding for conservation staff is awarded/available by year 3
- Conservation staff shortages occur and technical assistance resources are limited for two years between years 1-5

Water Quality Monitoring Progress Evaluation

This implementation plan recognizes that estimated pollutant load reductions and expected improvement in water quality or aquatic habitat may not occur immediately following implementation of practices due to several factors (described below) that will need to be taken into consideration when evaluating water quality data. These factors can affect or mask progress that plan implementation has made elsewhere. Consultation with the DNR and Water Quality biologists will be critical when evaluating water quality or aquatic habitat monitoring results. If the target values/goals for water quality improvement for the milestone period are not being achieved, the water quality targets or timetable for pollutant reduction will need to evaluated and adjusted as necessary.

The following criteria will be evaluated when water quality and aquatic habitat monitoring is completed after implementation of practices:

- Changes in land use or crop rotations within the same watershed where practices are implemented. (Increase in cattle numbers, corn silage acres, and/or urban areas can negatively impact stream quality and water quality efforts)

- Location in watershed where land use changes or crop rotations occur. (Where are these changes occurring in relation to implemented practices?)
- Watershed size, location where practices are implemented and location of monitoring sites.
- Climate, precipitation and soil conditions that occurred before and during monitoring periods. (Climate and weather patterns can significantly affect growing season, soil conditions, and water quality)
- Frequency and timing of monitoring.
- Percent of watershed area (acres) or facilities (number) meeting NR 151 performance standards and prohibitions.
- Percent of watershed area (acres) or facilities (number) that maintain implemented practices over time.
- Extent of gully erosion on crop fields within watershed over time. How many are maintained in perennial vegetation vs. plowed under each year?
- Stability of bank sediments and how much this sediment may be contributing P and TSS to the stream
- How "Legacy' sediments already within the stream and watershed may be contributing P and sediment loads to stream?
- Does monitored stream meet IBI and habitat criteria but does not meet TMDL water quality criteria?
- Are targets reasonable? Load reductions predicted by models could be overly optimistic

Lake Sinissippi-Rock River is part of reach 18 of the Upper Rock River TMDL, which calls for 62% reduction of TP and 24% reduction of TSS from agriculture/nonpoint sources with reduction load numbers represented in Figure 9.1.

Table 13.2: Total Load Reductions in lbs of TP & TSS for the Rock River and Lake Sinissippi-Rock River

Recommendations	Starting lbs	Estimated Watershed Reduction	Milestones		
			0-3 years	3-7 years	7-10 years
Reach 18 of the Rock River					
Reductions to lbs/TP	62%				
Reductions to lbs/TSS	24%				
Lake Sinissippi-Rock River					
Reductions to lbs/TP	51,471.30 lbs/TP	12.6%	48713.05	45,963.87	44,965.56
Reductions to lbs/TSS	9,585.19 lbs/TSS	9.3%	9,201.78	8,819.35	8,693.31

Management Measures/Information and Education Implementation Progress Evaluation

Implementation milestones for management measures are shown in the 10 Year Management Measures Plan Matrix (Table 12) and milestones for Information and Education Plan implementation are shown in Table 20. If less than 25% of the implementation milestones are being met for each milestone period, the plan will need to be evaluated and revised to either change the milestone(s) or to implement projects or actions to achieve the milestone(s) that are not being met.

If it has been determined that implementation milestones are not being met the following questions should be evaluated and included in the progress report:

- Did weather related causes postpone implementation?
- Was there a shortfall in anticipated funding for implementing management measures?
- Was there a shortage of technical assistance?
- Was the amount of time needed to install some of the practices misjudged?
- Were cultural barriers to adoption accounted for?

13.4: Land Treatment Depreciation

USEPA Technical Memorandum #1: Adjusting for Depreciation of Land Treatment when Planning Watershed Projects

This memorandum provided discusses how land treatment projects can be negatively affected in different manners such as natural variability, lack of proper maintenance, and unforeseen consequences. Natural variability depicts how erratic weather patterns occurring either within a year or from year to year can disrupt or render conservation practices ineffective. Lack of proper maintenance calls out how lack of good management plans can lead to practices and land treatments to work at a lesser capacity as what they were originally intended for. Unforeseen consequences is a discussion of how doing certain practices can lead to different issues that were not necessarily thought of prior to implementation. The memorandum then elaborates on assessing depreciation and adjusting planning processes to account for such possibilities.

This memo can be an extremely helpful tool for anyone who works in agriculture or conservation to reference when implementing land treatments. Considering how erratic and unpredictable weather patterns are increasingly becoming and with more emphasis falling on how to farm around said weather with enduring as little runoff and erosion as possible, this document has never been more relevant than it is in today's reality.

This document will be utilized to evaluate implementation of conservation practices and will be used as a reference guide when looking at part two of section 13.2 of the "Lake Sinissippi-Rock River Nonpoint Source Watershed Implementation Plan" labeled, “Installed Best Management Practices.” This document will create positive discussion about how to avoid land treatment deprecation when planning and installing practices in Lake Sinissippi-Rock River. The memo will also provide us a possible guideline for performing BMP monitoring across the lifespan of the Lake Sinissippi-Rock River plan. Section 13.3 of the plan discusses progress evaluation and whether or not the practices installed are being implemented in the most efficient manner. If watershed goals are not being met at certain points throughout the plans’ existence, it may prove useful to review BMP’s implemented to determine if depreciation has occurred due to previously unforeseen consequences.

14.0 Literature Cited

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Appendix A: Glossary of Terms and Acronyms

BARNY- Wisconsin adapted version of the ARS feedlot runoff model that estimates amount of phosphorus runoff from feedlots.

Baseline –An initial set of observations or data used for comparison or as a control.

Best Management Practice (BMP) – A method that has been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources.

Cost-Sharing- Financial assistance provided to a landowner to install and/or use applicable best management practices.

Ephemeral gully- Voided areas that occur in the same location every year that are crossable with farm equipment and are often partially filled in by tillage.

Geographic Information System (GIS) – A tool that links spatial features commonly seen on maps with information from various sources ranging from demographics to pollutant sources.

Index of Biotic Integrity – An indexing procedure commonly used by academia, agencies, and groups to assess watershed condition based on the composition of a biological community in a water body.

Lateral Recession Rate- the thickness of soil eroded from a bank surface (perpendicular to the face) in an average year, given in feet per year.

Natural Resources Conservation Service (NRCS) - Provides technical expertise and conservation planning for farmers, ranchers, and forest landowners wanting to make conservation improvements to their land.

Phosphorus Index (PI) – The phosphorus index is used in nutrient management planning. It is calculated by estimating average runoff phosphorus delivery from each field to the nearest surface water in a year given the field's soil conditions, crops, tillage, manure and fertilizer applications, and long term weather patterns. The higher the number the greater the likely hood that the field is contributing phosphorus to local water bodies.

Riparian – Relating to or located on the bank of a natural watercourse such as a river or sometimes of a lake or tidewater

Soil Nutrient Application Manager (SNAP) – Wisconsin's nutrient management planning software.

Spreadsheet Tool for Estimating Pollutant Load (STEPL) - Model that calculates nutrient loads (Phosphorus, Nitrogen, and Biological Oxygen Demand) by land use type and aggregated by watershed.

Soil and Water Assessment Tool (SWAT) – A small watershed to river basin-scale model to simulate the quality and quantity of surface and ground water and predict the environmental impact of land use, land management practices, and climate change. Model is widely used in assessing soil erosion prevention and control, non-point source pollution control and regional management in watersheds.

Stream Power Index (SPI) – Measures the erosive power of overland flow as a function of local slope and upstream drainage area.

Total Suspended Sediment (TSS) - The organic and inorganic material suspended in the water column and greater than 0.45 micron in size.

Total Maximum Daily Load (TMDL) - A calculation of the maximum amount of pollutant that a water body can receive and still meet water quality standards.

United States Geological Survey (USGS) – Science organization that collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems.

United States Environmental Protection Agency (USEPA) – Government agency to protect human health and the environment.

University of Wisconsin Extension (UWEX) – UW-Extension works with UW- System campuses, Wisconsin counties, tribal governments, and other public and private organizations to help address economic, social, and environmental issues.

Wisconsin Department of Natural Resources (WDNR) – State organization that works with citizens and businesses to preserve and enhance the natural resources of Wisconsin.

Appendix B: Technical Memorandum #1: Adjusting for Depreciation of Land Treatment when Planning Watershed Projects

United States Environmental Protection Agency

This Technical Memorandum is one of a series of publications designed to assist watershed projects, particularly those addressing nonpoint sources of pollution. Many of the lessons learned from the Clean Water Act Section 319 National Nonpoint Source Monitoring Program are incorporated in these publications.

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Technical Memorandum #1

Adjusting for Depreciation of Land Treatment When Planning Watershed Projects

Introduction

Watershed-based planning helps address water quality problems in a holistic manner by fully assessing the potential contributing causes and sources of pollution, then prioritizing restoration and protection strategies to address the problems (USEPA 2013). The U.S. Environmental Protection Agency (EPA) requires that watershed projects funded directly under section 319 of the Clean Water Act implement a watershed-based plan (WBP) addressing the nine key elements identified in EPA's *Handbook for Developing Watershed Plans to Restore and Protect our Waters (USEPA 2008)*. EPA further recommends that all other watershed plans intended to address water quality impairments also include the nine elements. The first element calls for the identification of causes and sources of impairment that must be controlled to achieve needed load reductions. Related elements include a description of the nonpoint source (NPS) management measures—or best management practices (BMPs)—needed to achieve required pollutant load reductions, a description of the critical areas in which the BMPs should be implemented, and an estimate of the load reductions expected from the BMPs.

Fields near Seneca Lake, New York.

Once the causes and sources of water resource impairment are assessed, identifying the appropriate BMPs to address the identified problems, the best locations for additional BMPs, and the pollutant load reductions likely to be achieved with the BMPs depends on accurate information on the performance levels of both BMPs already in place and BMPs to be implemented as part of the watershed project. All too often, watershed managers and Agency staff have assumed that, once certified as installed or adopted according to specifications, a BMP continues to perform its pollutant reduction function at the same efficiency (percent pollutant reduction) throughout its design or contract life, sometimes longer. An important corollary to this assumption is that BMPs in place during project planning are performing as originally intended. Experience in NPS watershed projects across the nation, however, shows that, without diligent operation and maintenance, BMPs and their effects probably will depreciate over time, resulting in less efficient pollution reduction. Recognition of this fact is important at the project planning phase, for both existing and planned BMPs.

Knowledge of land treatment depreciation is important to ensure project success through the adaptive management process (USEPA 2008). BMPs credited during the planning phase of a watershed project will be expected to achieve specific load reductions or other water quality benefits as part of the overall plan to protect or restore a water body. Verification that BMPs are still performing their functions at anticipated levels is essential to keeping a project on track to achieve its overall goals. Through adaptive management, verification results can be used to inform decisions about needs for additional BMPs or maintenance or repair of existing BMPs. In a watershed project that includes short-term (3–5 years) monitoring, subtle changes in BMP performance level might not be detectable or critical, but planners must account for catastrophic failures, BMP removal or discontinuation, and major maintenance shortcomings. Over the longer term, however, gradual changes in BMP performance level can be significant in terms of BMP-specific pollutant control or the role of single BMPs within a BMP system or train. The weakest link in a BMP train can be the driving force in overall BMP performance.

Application of and methods for BMP tracking in NPS watershed projects are described in detail in *Tech Notes 11* (Meals et al. 2014).

This technical memorandum addresses the major causes of land treatment depreciation, ways to assess the extent of depreciation, and options for adjusting for depreciation. While depreciation occurs throughout the life of a watershed project, the emphasis is on the planning phase and the short term (i.e., 3–5 years).

Causes of Depreciation

Depreciation of land treatment function occurs as a result of many factors and processes. Three of the primary causes are natural variability, lack of proper maintenance, and unforeseen consequences.

Natural Variability

Climate and soil variations across the nation influence how BMPs perform. Tiessen et al. (2010), for example, reported that management practices designed to improve water quality by reducing sediment and sediment-bound nutrient export from agricultural fields can be less effective in cold, dry regions where nutrient export is primarily snowmelt driven and in the dissolved form, compared to similar practices in warm, humid regions. Performance levels of vegetation-based BMPs in both agricultural and urban settings can vary significantly through the year due to seasonal dormancy. In a single locale, year-to-year variation in precipitation affects both agricultural management and BMP performance levels. Drought, for example, can suppress crop yields, reduce nutrient uptake, and result in nutrient surpluses left in the soil after harvest where they are vulnerable to runoff or leaching loss despite careful nutrient management. Increasing incidence of extreme weather and intense storms can overwhelm otherwise well-designed stormwater management facilities in urban areas.

Lack of Proper Maintenance

Most BMPs—both structural and management—must be operated and maintained properly to continue to function as designed. Otherwise, treatment effectiveness can depreciate over time. For example, in a properly functioning detention pond, sediment typically accumulates in the forebay. Without proper maintenance to remove accumulated sediment, the capacity of the BMP to contain and treat stormwater is diminished. Similarly, a nutrient management plan is only as effective as its implementation. Failure to adhere to phosphorus (P) application limits, for example, can result in soil P buildup and increased surface and subsurface losses of P rather than the loss reductions anticipated.

Jackson-Smith et al. (2010) reported that over 20 percent of implemented BMPs in a Utah watershed project appeared to be no longer maintained or in use when evaluated just 5 years after project completion. BMPs related to crop production enterprises and irrigation systems had the lowest rate of continued use and maintenance (~75 percent of implemented BMPs were still in use), followed by pasture and grazing planting and management BMPs (81 percent of implemented BMPs were still in use). Management practices (e.g., nutrient management) were found to be particularly susceptible to failure.

Practices are sometimes simply abandoned as a result of changes in landowner circumstances or attitudes. In a Kansas watershed project, farmers abandoned a nutrient management program because of perceived restrictive reporting requirements (Osmond et al. 2012).

Abandoned waste storage structure.

In the urban arena, a study of more than 250 stormwater facilities in Maryland found that nearly one-third of stormwater BMPs were not functioning as designed and that most needed maintenance (Lindsey et al. 1992). Sedimentation was a major problem and had occurred at nearly half of the facilities; those problems could have been prevented with timely maintenance.

Hunt and Lord (2006) describe basic maintenance requirements for bioretention practices and the consequences of failing to perform those tasks. For example, they indicate that mulch should be removed every 1–2 years to both maintain available water storage volume and increase the surface infiltration rate of fill soil. In addition, biological films might need to be removed every 2–3 years because they can cause the bioretention cell to clog.

In plot studies, Dillaha et al. (1986) observed that vegetative filter strip-effectiveness for sediment removal appeared to decrease with time as sediment accumulated within the filter strips. One set of the filters was almost totally inundated with sediment during the cropland experiments and filter effectiveness dropped 30–60 percent between the first and second experiments. Dosskey et al. (2002) reported that up to 99 percent of sediment was removed from cropland runoff when uniformly distributed over a buffer area, but as concentrated flow paths developed over time (due to lack of maintenance), sediment removal dropped to 15–45 percent. In the end, most structural BMPs have a design life (i.e., the length of time the item is expected to work within its specified parameters). This period is measured from when the BMP is placed into service until the end of its full pollutant reduction function.

Unforeseen Consequences

The effects of a BMP can change directly or indirectly due to unexpected interactions with site conditions or other activities. Incorporating manure into cropland soils to reduce nutrient runoff, for example, can increase erosion and soil loss due to soil disturbance, especially in comparison to reduced tillage. On the other hand, conservation tillage can result in accumulation of fertilizer nutrients at the soil surface, increasing their availability for loss in runoff (Rhoton et al. 1993). Long-term reduction in tillage also can promote the formation of soil macropores, enhancing leaching of soluble nutrients and agrichemicals into ground water (Shipitalo et al. 2000). Stutter et al. (2009) reported that establishment of vegetated buffers between cropland and a watercourse led to enhanced rates of soil P cycling within the buffer, increasing soil P solubility and the potential for leaching to watercourses.

Despite widespread adoption of conservation tillage and observed reductions in particulate P loads, a marked increase in loads of dissolved bioavailable P in agricultural tributaries to Lake Erie has been documented since the mid-1990s. This shift has been attributed to changes in application rates, methods, and timing of P fertilizers on cropland in conservation tillage not subject to annual tillage (Baker 2010; Joosse and Baker 2011). Further complicating matters, recent research on fields in the St. Joseph River watershed in northeast Indiana has demonstrated that about half of both soluble P and total P losses from research fields occurred via tile discharge, indicating a need to address both surface and subsurface loads to reach the goal of 41 percent reduction in P loading for the Lake Erie Basin (Smith et al. 2015).

Several important project planning lessons were learned from the White Clay Lake, Wisconsin, demonstration projects in the 1970s, including the need to accurately assess pollutant inputs and the performance levels of BMPs (NRC 1999). Regarding unforeseen consequences, the project learned through monitoring that a manure storage pit built according to prevailing specifications actually caused ground water contamination that threatened a farmer's well water. This illustrates the importance of monitoring implemented practices over time to ensure that they function properly and provide the intended benefits.

Control of urban stormwater runoff (e.g., through detention) has been widely implemented to reduce peak flows from large storms in order to prevent stream channel erosion. Research has shown, however, that although large peak flows might be controlled effectively by detention storage, stormflow conditions are extended over a longer period of time. Duration of erosive and bankfull flows are increased, constituting channel-forming events. Urbonas and Wulliman (2007) reported that, when captured runoff from a number of individual detention basins in a stream system is released over time, the flows accumulate as they travel downstream, actually increasing peak flows along the receiving waters. This situation can diminish the collective effectiveness of detention basins as a watershed management strategy.

Assessment of Depreciation

The first—and possibly most important—step in adjusting for depreciation of implemented BMPs is to determine its extent and magnitude through BMP verification.

BMP Verification

At its core, BMP verification confirms that a BMP is in place and functioning properly as expected based on contract, permit, or other implementation evidence. A BMP verification process that documents the presence and function of BMPs over time should be included in all NPS watershed projects.

At the project planning phase, verification is important both to ensure accurate assessment of existing BMP performance levels and to determine additional BMP and maintenance needs. Verification over time is necessary to determine if BMPs are maintained and operated during the period of interest.

Documenting the presence of a BMP is generally simpler than determining how well it functions, but both elements of verification must be considered to determine if land treatment goals are being met and whether BMP performance is depreciating. Although land treatment goals might not be highly specific in many watershed projects, it is important to document what treatment is implemented. Verification is described in detail in *Tech Notes 11* (Meals et al. 2014). This technical memorandum focuses on specific approaches to assessing depreciation within the context of an overall verification process.

Methods for Assessing BMP Presence and Performance Level

Whether a complete enumeration or a statistical sampling approach is used, methods for tracking BMPs generally include direct measurements (e.g., soil tests, onsite inspections, remote sensing) and indirect methods (e.g., landowner self-reporting or third-party surveys). Several of these methods are discussed in *Tech Notes 11* (Meals et al. 2014). Two general factors must be considered when verifying a BMP: the presence of the BMP and its pollutant removal efficiency. Different types of BMPs require different verification methods, and no single approach is likely to provide all the information needed in planning a watershed project.

Certification

The first step in the process is to determine whether BMPs have been designed and installed/adopted according to appropriate standards and specifications. Certification can either be the final step in a contract between a landowner and a funding agency or be a component of a permit requirement.

Certification provides assurance that a BMP is fully functional for its setting at a particular time. For example, a stormwater detention pond or water and sediment control basin must be properly sized for its contributing area and designed for a specific retention-and-release performance level. A nutrient management plan must account for all sources of nutrients, consider current soil nutrient levels, and support a reasonable yield goal. A cover crop must be planted in a particular time window to provide erosion control and/or nutrient uptake during a critical time of year. Some jurisdictions might apply different nutrient reduction efficiency credits for cover crops based on planting date. Some structural BMPs like parallel tile outlet terraces require up to 2 years to fully settle and achieve full efficiency; in those cases, certification is delayed until full stability is reached. Knowledge that a BMP has been applied according to a specific standard supports an assumption that the BMP will perform at a certain level of pollutant reduction efficiency, providing a baseline against which future depreciation can be compared. Practices voluntarily implemented by landowners without any technical or financial assistance could require special efforts to determine compliance with applicable specifications (or functional equivalence). Pollution reduction by practices not meeting specifications might need to be discounted or not counted at all even when first installed.

Depreciation assessment indicators

Ideally, assessment of BMP depreciation would be based on actual measurement of each BMP's performance level (e.g., monitoring of input and output pollutant loads for each practice). Except in very rare circumstances, this type of monitoring is impractical. Rather, a watershed project generally must depend on the use of indicators to assess BMP performance level.

The most useful indicators for assessing depreciation are determined primarily by the type of BMP and pollutants controlled, but indicators might be limited by the general verification approach used. For example, inflow and outflow measurements of pollutant load can be used to determine the effectiveness of constructed wetlands, but a verification effort that uses only visual observations will not provide that data or other information about wetland functionality. A central challenge, therefore, is to identify meaningful indicators of BMP performance level that can be tracked under different verification schemes. This technical memorandum provides examples of how to accomplish that end.

Nonvegetative structural practices

Performance levels of nonvegetative structural practices—such as animal waste lagoons, digesters, terraces, irrigation tailwater management, stormwater detention ponds, and pervious pavement—can be assessed using the following types of indicators:

- Measured on-site performance data (e.g., infiltration capacity of pervious pavement),
- Structural integrity (e.g., condition of berms or other containment structures), and
- Water volume capacity (e.g., existing pond volume vs. design) and mass or volume of captured material removed (e.g., sediment removed from stormwater pond forebay at cleanout).

In some cases, useful indicators can be identified directly from practice standards. For example, the Natural Resources Conservation Service lists operation and maintenance elements for a water and sediment control basin (WASCoB) (*USDA-NRCS 2008*) that include:

- Maintenance of basin ridge height and outlet elevations,
- Removal of sediment that has accumulated in the basin to maintain capacity and grade,
- Removal of sediment around inlets to ensure that the inlet remains the lowest spot in the basin, and
- Regular mowing and control of trees and brush.

These elements suggest that ridge and outlet elevations, sediment accumulation, inlet integrity, and vegetation control would be important indicators of WASCoB performance level.

Required maintenance checklists contained in stormwater permits also can suggest useful indicators. For example, the *Virginia Stormwater Management Handbook* (VA DCR 1999) provides an extensive checklist for annual operation and maintenance inspection of wet ponds. The list includes many elements that could serve as BMP performance level indicators:

- Excessive sediment, debris, or trash accumulated at inlet,
- Clogging of outlet structures,

- Cracking, erosion, or animal burrows in berms, and
- More than 1 foot of sediment accumulated in permanent pool.

Assessment of these and other indicators would require on-site inspection and/or measurement by landowners, permit-holders, or oversight agencies.

Vegetative structural practices

Performance levels of vegetative structural practices—such as constructed wetlands, swales, rain gardens, riparian buffers, and filter strips—can be assessed using the following types of indicators:

- Extent and health of vegetation (e.g., measurements of soil cover or plant density),
- Quality of overland flow filtering (e.g., evidence of short-circuiting by concentrated flow or gullies through buffers or filter strips),
- On-site capacity testing of rain gardens using infiltrometers or similar devices, and
- Visual observations (e.g., presence of water in swales and rain gardens).

Parking lot rain garden.

As for non-vegetative structural practices, assessment of these indicators would require on-site inspection and/or measurement by landowners, permit-holders, or oversight agencies.

Nonstructural vegetative practices

Performance levels of nonstructural vegetative practices—such as cover crops, reforestation of logged tracts, and construction site seeding—can be assessed using the following types of indicators:

- Density of cover crop planting (e.g., plant count),
- Percent of area covered by cover crop, and
- Extent and vitality of tree seedlings.

These indicators could be assessed by on-site inspection or, in some cases, by remote sensing, either from satellite imagery or aerial photography.

Management practices

Performance levels of management practices—such as nutrient management, conservation tillage, pesticide management, and street sweeping—can be assessed using the following types of indicators:

- Records of street sweeping frequency and mass of material collected,
- Area or percent of cropland under conservation tillage,

- Extent of crop residue coverage on conservation tillage cropland, and
- Fertilizer and/or manure application rates and schedules, crop yields, soil test data, plant tissue test results, and fall residual nitrate tests.


Illustration of line-transect method for residue.

Assessment of these indicators would generally require reporting by private landowners or municipalities, reporting that is required under some regulatory programs. Visual observation of indicators such as residue cover, however, can also be made by on-site inspection or windshield survey.

Data analysis

Data on indicators can be expressed and analyzed in several ways, depending on the nature of the indicators used. Indicators reporting continuous numerical data—such as acres of cover crop or conservation tillage, manure application rates, miles of street sweeping, mass of material removed from catch basins or detention ponds, or acres of logging roads/landings revegetated—can be expressed either in the raw form (e.g., acres with 30 percent or more residue cover) or as a percentage of the design or target quantity (e.g., percent of contracted acres achieving 30 percent or more of residue cover). These metrics can be tracked year to year as a measure of BMP depreciation (or achievement). During the planning phase of a watershed project, it might be appropriate to collect indicator data for multiple years prior to project startup to enable calculation of averages or ranges to better estimate BMP performance levels over crop rotation cycles or variable weather conditions.

Indicators reporting categorical data—such as maintenance of detention basin ridge height and outlet elevations, condition of berms or terraces, or observations of water accumulation and flow—are more difficult to express quantitatively. It might be necessary to establish an ordinal scale (e.g., condition rated on a scale of 1–10) or a binary yes/no condition, then use best professional judgment to assess influence on BMP performance.

In some cases, it might be possible to use modeling or other quantitative analysis to estimate individual or watershed-level BMP performance levels based on verification data. In an analysis of stormwater BMP performance levels, Tetra Tech (2010) presented a series of BMP performance curves based on monitoring and modeling data that relate pollutant removal efficiency to depth of runoff treated (Figure 1). Where depreciation indicators track changes in depth of runoff treated as the capacity of a BMP decreases (e.g., from sedimentation), resulting changes in pollutant removal could be determined from a performance curve. This type of information can be particularly useful during the planning phase of a watershed project to estimate realistic performance levels for existing BMPs that have been in place for a substantial portion of their expected lifespans.

The performance levels of structural agricultural BMPs in varying condition can be estimated by altering input parameters in the *Soil and Water Assessment Tool* (SWAT) model (Texas A&M University 2015a); other models such as the *Agricultural Policy/Environmental eXtender* (APEX) model (Texas A&M

University 2015b) also can be used in this way (including application to some urban BMPs). For urban stormwater, engineering models like *HydroCAD* (HydroCAD Software Solutions 2011) can be used to simulate hydrologic response to stormwater BMPs with different physical characteristics (e.g., to compare performance levels under actual vs. design conditions). Even simple spreadsheet models such as the Spreadsheet Tool for Estimating Pollutant Load (*STEPL*) (USEPA 2015) can be used to quantify the effects of BMP depreciation by varying the effectiveness coefficients in the model.

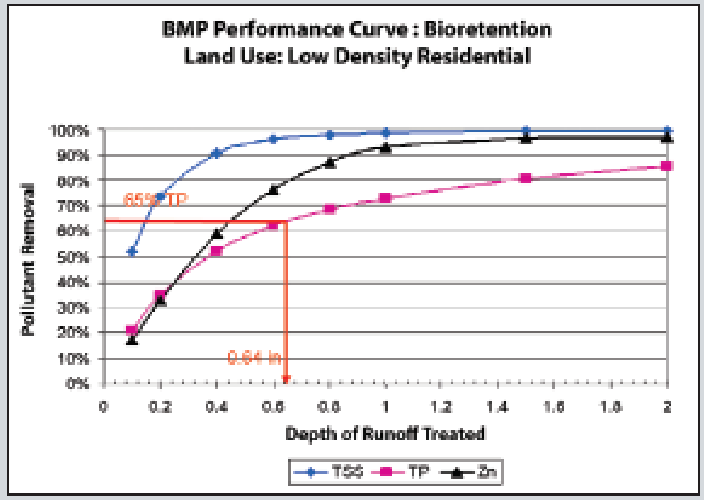

Figure 1. BMP Performance Curve for Bioretention BMP (Tetra Tech 2010).

Data from verification efforts and analysis of the effects of depreciation on BMP performance levels must be qualified based on data confidence. "Confidence" refers mainly to a quantitative assessment of the accuracy of a verification result. For example, the number of acres of cover crops or the continuity of streamside buffers on logging sites determined from aerial photography could be determined by ground-truthing to be within +10 percent of the true value at the 95 percent confidence level. Confidence also can refer to the level of trust that BMPs previously implemented continue to function (e.g., the proportion of BMPs still in place and meeting performance standards). For example, reporting that 75 percent of planned BMPs have been verified is a measure of confidence that the desired level of treatment has been applied.

While specific methods to evaluate data confidence are beyond the scope of this memo, it is essential to be able to express some degree of confidence in verification results—both during the planning phase and over time as the project is implemented. For example, an assessment of relative uncertainty of BMP performance during the planning phase can be used as direct follow-up to verification efforts to those practices for which greater quantification of performance level is needed. In addition, plans to implement new BMPs also can be developed with full consideration of the reliability of BMPs already in place.

Adjusting for Depreciation

Information on BMP depreciation can be used to improve both project management and project evaluation.

Project Planning and Management

Establishing baseline conditions

Baseline conditions of pollutant loading include not only pollutant source activity but also the influence of BMPs already in place at the start of the project. Adjustments based on knowledge of BMP depreciation can provide a more realistic estimate of baseline pollutant loads than assuming that existing land treatment has reduced NPS pollutant loads by some standard efficiency value.

Establishing an accurate starting point will make load reduction targets—and, therefore, land treatment design—more accurate. Selecting appropriate BMPs, identifying critical source areas, and prioritizing land treatment sites will all benefit from an accurate assessment of baseline conditions. Knowledge of depreciation of existing BMPs can be factored into models used for project planning (e.g., by adjusting pollutant removal efficiencies), resulting in improved understanding of overall baseline NPS loads and their sources.

While not a depreciation issue per se, when a BMP is first installed—especially a vegetative BMP like a buffer or filter strip—it usually takes a certain amount of time before its pollutant reduction capacity is fully realized. For example, Dosskey et al. (2007) reported that the nutrient reduction performance of newly established vegetated filter strips increased over the first 3 years as dense stands of vegetation grew in and soil infiltration improved; thereafter, performance level was stable over a decade. When planning a watershed project, vegetative practices should be examined to determine the proper level of effectiveness to assume based on growth stage. Also, because of weather or management conditions, some practices (e.g., trees) might take longer to reach their full effectiveness or might never reach it. The Stroud Preserve, Pennsylvania, section 319 National Nonpoint Source Monitoring Program (NNPSMP) project (1992–2007) found that slow tree growth in a newly established riparian forest buffer delayed significant NO_3–N (nitrate) removal from ground water until about 10 years after the trees were planted (Newbold et al. 2008).

The performance of practices can change in multiple ways over time. For example, excessive deposition in a detention pond that is not properly maintained could reduce overall percent removal of sediment because of reduced capacity as illustrated in Figure 1. The relative and absolute removal efficiencies for various particle size fractions (and associated pollutants) also can change due to reduced hydraulic retention time. Fine particles generally require longer settling times than larger particles, so removal efficiency of fine particles (e.g., silt, clay) can be disproportionally reduced as a detention pond or similar BMP fills with sediment and retention time deteriorates. Expert assessment of the condition and likely current performance level of existing BMPs, particularly those for which a significant amount of pollutant removal is assumed, is essential to establishing an accurate baseline for project planning.

Adaptive watershed management

Watershed planning and management is an iterative process; project goals might not all be fully met during the first project cycle and management efforts usually need to be adjusted in light of ongoing changes. In many cases, several cycles—including mid-course corrections—might be needed for a project to achieve its goals. Consequently, EPA recommends that watershed projects pursue a dynamic and adaptive approach so that implementation of a watershed plan can proceed and be modified as new information becomes available (USEPA 2008). Measures of BMP implementation commonly used as part of progress assessment should be augmented with indicators of BMP depreciation. Combining this information with other relevant project data can provide reliable progress assessments that will indicate gaps and weaknesses that need to be addressed to achieve project goals.

BMP design and delivery system

Patterns in BMP depreciation might yield information on systematic failures in BMP design or management that can be addressed through changes to standards and specifications, contract terms, or permit requirements. This information could be particularly helpful during the project planning phase when both the BMPs and their implementation mechanisms are being considered. For example, a cost-sharing schedule that has traditionally provided all or most funding upon initial installation of a BMP could be adjusted to distribute a portion of the funds over time if operation and maintenance are determined to be a significant issue based on pre-project information. Some BMP components, on the other hand, might need to be dropped or changed to make them more appealing to or easier to manage by landowners. Within the context of a permit program, for example, corrective actions reports might indicate specific changes that should be made to BMPs to ensure their proper performance.

Project Evaluation

Monitoring

Although short-term (3–5 year) NPS watershed projects will not usually have a sufficiently long data record to evaluate incremental project effects, data on BMP depreciation might still improve interpretation of collected water quality data. Even in the short term, water quality monitoring data might reflect cases in which BMPs have suffered catastrophic failures (e.g., an animal waste lagoon breach), been abandoned, or been maintained poorly. Meals (2001), for example, was able to interpret unexpected spikes in stream P and suspended sediment concentrations by walking the watershed and discovering that a landowner had over-applied manure and plowed soil directly into the stream.

Longer-term efforts (e.g., total maximum daily loads[1]) might engage in sustained monitoring beyond individual watershed project lifetime(s). The extended monitoring period will generally allow detection of more subtle water quality impacts for which interpretation could be enhanced with information on BMP depreciation. While not designed as BMP depreciation studies, the following two examples illustrate how changes in BMP performance can be related to water quality.

In a New York dairy watershed treated with multiple BMPs, Lewis and Makarewicz (2009) reported that the suspension of a ban on winter manure application 3 years into the monitoring study led to dramatic increases in stream nitrogen and phosphorus concentrations. First and foremost, knowledge of that suspension provided a reasonable explanation for the observed increase in nutrient levels. Secondly, the study was able to use data from the documented depreciation of land treatment to determine that the winter spreading ban had yielded 60–75 percent reductions in average stream nutrient concentrations.

The Walnut Creek, Iowa, Section 319 NNPSMP project promoted conversion of row crop land to native prairie to reduce stream NO_3-N levels and used simple linear regression to show association of two monitored variables: tracked conversion of row crop land to restored prairie vegetation and stream NO_3-N concentrations (Schilling and Spooner 2006). Because some of the restored prairie was plowed back into cropland during the project period—and because that change was

[1] "Total maximum daily loads" as defined in §303(d) of the Clean Water Act.

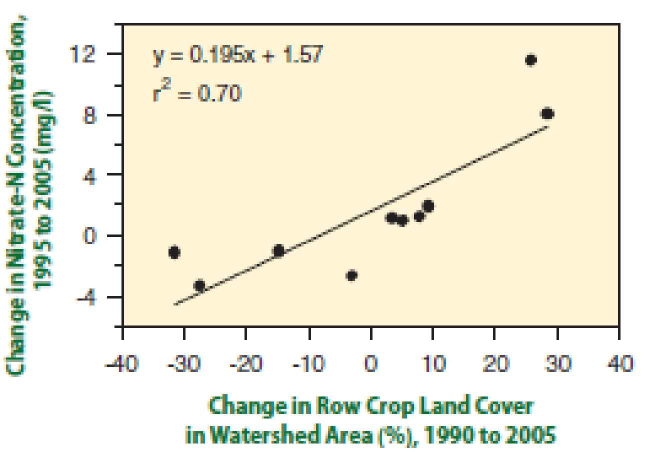

Figure 2. Relating Changes in Stream Nitrate Concentrations to Changes in Row Crop Land Cover in Walnut Creek, Iowa (Schilling and Spooner 2006)).

documented—the project was able to show not only that converting crop land to prairie reduced stream NO_3-N concentrations but also that increasing row crop land led to increased NO_3-N levels (Figure 2).

Modeling

When watershed management projects are guided or supported by modeling, knowledge of BMP depreciation should be part of model inputs and parameterization.

The magnitude of implementation (e.g., acres of treatment) and the spatial distribution of both annual and structural BMPs should be part of model input and should not be static parameters. Where BMPs are represented by pollutant reduction efficiencies, those percentages can be adjusted based on verification of land treatment performance levels in the watershed. Incorporating BMP depreciation factors into models might require setting up a tiered approach for BMP efficiencies (e.g., different efficiency values for BMPs determined to be in fair, good, or excellent condition) rather than the currently common practice of setting a single efficiency value for a practice assumed to exist. This approach could be particularly important for management practices such as agricultural nutrient management or street sweeping, in which degree of treatment is highly variable. For structural practices, a depreciation schedule could be incorporated into the project, similar to depreciating business assets. In the planning phase of a watershed project, multiple scenarios could be modeled to reflect the potential range of performance levels for BMPs already in place.

Recommendations

The importance of having accurate information on BMP depreciation varies across projects and during the timeline of a single project. During the project planning phase, when plans for the achievement of pollutant reduction targets rely heavily on existing BMPs, it is essential to obtain good information on the level of performance of the BMPs to ensure that plan development is properly informed. If existing BMPs are a trivial part of the overall watershed plan, knowledge of BMP depreciation might not be critical during planning. As projects move forward, however, the types of BMPs implemented, their relative costs and contributions to achievement of project pollutant reduction goals, and the likelihood that BMP depreciation will occur during the period of interest will largely determine the type and extent of BMP verification required over time. The following recommendations should be considered within this context:

- For improved characterization of overall baseline NPS loads, better identification of critical source areas, and more effective prioritization of new land treatment during project planning, collect accurate and complete information about:
  - Land use,

    - Land management, and
    - The implementation and operation of existing BMPs. This information should include:
        - Original BMP installation dates,
        - Design specifications of individual BMPs,
        - Data on BMP performance levels if available, and
        - The spatial distribution of BMPs across the watershed.
- Track the factors that influence BMP depreciation in the watershed, including:
    - Variations in weather that influence BMP performance levels,
    - Changes in land use, land ownership, and land management,
    - Inspection and enforcement activities on permitted practices, and
    - Operation, maintenance, and management of implemented practices.
- Develop and use observable indicators of BMP status/performance that:
    - Are tailored to the set of BMPs implemented in the watershed and practical within the scope of the watershed project's resources,
    - Can be quantified or scaled to document the extent and magnitude of treatment depreciation, and
    - Are able to be paired with water quality monitoring data.
- After the implementation phase of the NPS project, conduct verification activities to document the continued existence and function of implemented practices to assess the magnitude of depreciation and provide a basis for corrective action. The verification program should:
    - Identify and locate all BMPs of interest, including cost-shared, non-cost-shared, required, and voluntary practices;
    - Capture information on structural, annual, and management BMPs;
    - Obtain data on BMP operation and maintenance activities; and
    - Include assessment of data accuracy and confidence.
- To adjust for depreciation of land treatment, apply verification data to watershed project management and evaluation by:
    - Applying results directly to permit compliance programs,
    - Relating documented changes in land treatment performance levels to observed water quality,
    - Incorporating measures of depreciated BMP effectiveness into modeling efforts, and
    - Using knowledge of treatment depreciation to correct problems and target additional practices as necessary to meet project goals in an adaptive watershed management approach.

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Appendix C: STEPL Results

Baseline

2. Total load by land uses (with BMP)					
Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)	E. coli Load (Billion MPN/yr)
Urban	7551.92	1219.87	29526.44	177.71	0.00
Cropland	128900.80	46790.95	225469.36	9454.03	0.00
Pastureland	1203.77	405.08	3387.61	131.16	0.00
Forest	506.39	274.68	1232.92	20.66	0.00
Feedlots	26130.37	4275.26	34840.49	0.00	0.00
User Defined	62.58	51.63	125.17	19.56	0.00
Septic	387.36	151.72	1581.72	0.00	0.00
Gully	4.94	4.07	9.87	3.08	0.00
Streambank	0.00	0.00	0.00	0.00	0.00
Groundwater	0.00	0.00	0.00	0.00	0.00
Total	164748.13	53173.27	296173.56	9806.21	0.00
		51471.30		9585.19	
		9%		4%	

Planned

2. Total load by land uses (with BMP)					
Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)	E. coli Load (Billion MPN/yr)
Urban	7551.92	1219.87	29526.44	177.71	0.00
Cropland	116673.75	40603.94	219761.31	8562.15	0.00
Pastureland	1203.77	405.08	3387.61	131.16	0.00
Forest	506.39	274.68	1232.92	20.66	0.00
Feedlots	24714.27	3956.64	34840.49	0.00	0.00
User Defined	62.58	51.63	125.17	19.56	0.00
Septic	387.36	151.72	1581.72	0.00	0.00
Gully	60.80	50.16	121.60	38.00	0.00
Streambank	1.02	0.84	2.04	0.64	0.00
Groundwater	0.00	0.00	0.00	0.00	0.00
Total	151161.87	46714.56	290579.28	8949.88	0.00
		44965.66		8693.31	
		21%		14%	

TP Reduced lbs/yr	Sediment Reduced tons/yr
6505.64	891.88
12.60%	9.30%

#5 - Contour Farming/590 #6 - Contour Farming/Cover Crops #7 - 590/Conservation Tillage #8 - Conservation Tillage/Cover Crops

Estimate an area-weighted combined efficiency of multiple BMPs (in parallel) across a watershed

Update BMP List

NW

Enter total treated land use area (acre) 2489.50 Cropland

Enter the subarea treated by each selected BMP type (upto 20 varying frequency of treatment allowed)

Treatment	Area (ac)	Select a BMP Type	N	P	BOD	Sediment	E. coli
1	1900.00	Nutrient Management 2 (Determined Rate Plus Additional Considerations)	0.247	0.560	0.000	0.000	0.000
NMP2 + CT1	285.00	Combined BMPs-Calculated	0.360	0.717	0.000	0.400	0.000
CT1 + Cover Crops	300.00	Combined BMPs-Calculated	0.317	0.401	0.000	0.463	0.000
4	4.50	Buffer - Grass (35ft wide)	0.457	0.735	0.000	0.341	0.000
5		0 No BMP	0.000	0.000	0.000	0.000	0.000
6		0 No BMP	0.420	0.440	0.000	0.407	0.000
7		0 No BMP	0.000	0.000	0.000	0.000	0.000
8		0 No BMP	0.000	0.000	0.000	0.000	0.000
9		0 No BMP	0.000	0.000	0.000	0.000	0.000
10		0 No BMP	0.000	0.000	0.000	0.000	0.000
11		0 No BMP	0.000	0.000	0.000	0.000	0.000
12		0 No BMP	0.000	0.000	0.000	0.000	0.000
13		0 No BMP	0.000	0.000	0.000	0.000	0.000
14		0 No BMP	0.000	0.000	0.000	0.000	0.000
15		0 No BMP	0.000	0.000	0.000	0.000	0.000
16		0 No BMP	0.000	0.000	0.000	0.000	0.000
17		0 No BMP	0.000	0.000	0.000	0.000	0.000
18		0 No BMP	0.000	0.000	0.000	0.000	0.000
19		0 No BMP	0.000	0.000	0.000	0.000	0.000
20		0 No BMP	0.000	0.000	0.000	0.000	0.000
Total Land Use Area	2489.50	nter the calculated value in Table 7. located in "BMPs" tab, under the appropriate watershed -->	**0.269**	**0.559**	**0.000**	**0.102**	**0.000**

Total Area check: OK

total cropland acres is 4774

percent treated acres = 52.0%

Estimate an area-weighted combined efficiency of multiple BMPs (in parallel) across a watershed

Update BMP List

NE

Enter total treated land use area (acre) 1535.50 Cropland

Enter the subarea treated by each selected BMP type (upto 20 varying frequency of treatment allowed)

Treatment	Area (ac)	Select a BMP Type	N	P	BOD	Sediment	E. coli
1	531.00	Nutrient Management 2 (Determined Rate Plus Additional Considerations)	0.247	0.560	0.000	0.000	0.000
2	100.00	Conservation Tillage 1 (30-59% Residue)	0.150	0.356	0.000	0.403	0.000
NMP2 + CT1	600.00	Combined BMPs-Calculated	0.360	0.717	0.000	0.400	0.000
CT1 + Cover Crops	300.00	Combined BMPs-Calculated	0.317	0.401	0.000	0.463	0.000
5	4.50	Buffer - Grass (35ft wide)	0.457	0.735	0.000	0.341	0.000
6		0 No BMP	0.420	0.440	0.000	0.407	0.000
7		0 No BMP	0.000	0.000	0.000	0.000	0.000
8		0 No BMP	0.000	0.000	0.000	0.000	0.000
9		0 No BMP	0.000	0.000	0.000	0.000	0.000
10		0 No BMP	0.000	0.000	0.000	0.000	0.000
11		0 No BMP	0.000	0.000	0.000	0.000	0.000
12		0 No BMP	0.000	0.000	0.000	0.000	0.000
13		0 No BMP	0.000	0.000	0.000	0.000	0.000
14		0 No BMP	0.000	0.000	0.000	0.000	0.000
15		0 No BMP	0.000	0.000	0.000	0.000	0.000
16		0 No BMP	0.000	0.000	0.000	0.000	0.000
17		0 No BMP	0.000	0.000	0.000	0.000	0.000
18		0 No BMP	0.000	0.000	0.000	0.000	0.000
19		0 No BMP	0.000	0.000	0.000	0.000	0.000
20		0 No BMP	0.000	0.000	0.000	0.000	0.000
Total Land Use Area	1535.50	nter the calculated value in Table 7. located in "BMPs" tab, under the appropriate watershed -->	**0.299**	**0.578**	**0.000**	**0.274**	**0.000**

Total Area check: OK

total cropland acres is 3062.2

percent treated acres = 50.0%

SW

Estimate an area-weighted combined efficiency of multiple BMPs (in parallel) across a watershed

Enter total treated land use area (acre) 1030.50 Cropland

Update BMP List

Enter the subarea treated by each selected BMP type (upto 20 varying frequency of treatment allowed)

Treatment	Area (ac)	Select a BMP Type	N	P	BOD	Sediment	E. coli
1	375.00	Nutrient Management 2 (Determined Rate Plus Additional Considerations)	0.247	0.560	0.000	0.000	0.000
2	100.00	Conservation Tillage 1 (30-59% Residue)	0.150	0.356	0.000	0.403	0.000
NMP2 + CT1	85.00	Combined BMPs-Calculated	0.360	0.717	0.000	0.400	0.000
CT1 + Cover Crops	100.00	Combined BMPs-Calculated	0.317	0.401	0.000	0.463	0.000
Contour Farming + 590	100.00	Combined BMPs-Calculated	0.457	0.735	0.000	0.341	0.000
Contour Farming + Cover Crops	266.00	Combined BMPs-Calculated	0.420	0.440	0.000	0.407	0.000
7	4.50	Buffer - Grass (35ft wide)	0.338	0.435	0.000	0.533	0.000
8		0 No BMP	0.000	0.000	0.000	0.000	0.000
9		0 No BMP	0.000	0.000	0.000	0.000	0.000
10		0 No BMP	0.000	0.000	0.000	0.000	0.000
11		0 No BMP	0.000	0.000	0.000	0.000	0.000
12		0 No BMP	0.000	0.000	0.000	0.000	0.000
13		0 No BMP	0.000	0.000	0.000	0.000	0.000
14		0 No BMP	0.000	0.000	0.000	0.000	0.000
15		0 No BMP	0.000	0.000	0.000	0.000	0.000
16		0 No BMP	0.000	0.000	0.000	0.000	0.000
17		0 No BMP	0.000	0.000	0.000	0.000	0.000
18		0 No BMP	0.000	0.000	0.000	0.000	0.000
19		0 No BMP	0.000	0.000	0.000	0.000	0.000
20		0 No BMP	0.000	0.000	0.000	0.000	0.000
Total Land Use Area	1030.50	nter the calculated value in Table 7. located in "BMPs" tab, under the appropriate watershed -->	0.319	0.523	0.000	0.258	0.000

Total Area check: OK

total cropland acres is 2052.7

percent treated acres = 50.0%

SE

Estimate an area-weighted combined efficiency of multiple BMPs (in parallel) across a watershed

Enter total treated land use area (acre) 728.50 Cropland

Update BMP List

Enter the subarea treated by each selected BMP type (upto 20 varying frequency of treatment allowed)

Treatment	Area (ac)	Select a BMP Type	N	P	BOD	Sediment	E. coli
1	194.00	Nutrient Management 2 (Determined Rate Plus Additional Considerations)	0.247	0.560	0.000	0.000	0.000
2	80.00	Conservation Tillage 1 (30-59% Residue)	0.150	0.356	0.000	0.403	0.000
NMP2 + CT1	150.00	Combined BMPs-Calculated	0.360	0.717	0.000	0.400	0.000
CT1 + Cover Crops	100.00	Combined BMPs-Calculated	0.317	0.401	0.000	0.463	0.000
Contour Farming + 590	100.00	Combined BMPs-Calculated	0.457	0.735	0.000	0.341	0.000
Contour Farming + Cover Crops	100.00	Combined BMPs-Calculated	0.420	0.440	0.000	0.407	0.000
7	4.50	Buffer - Grass (35ft wide)	0.338	0.435	0.000	0.533	0.000
8		0 No BMP	0.000	0.000	0.000	0.000	0.000
9		0 No BMP	0.000	0.000	0.000	0.000	0.000
10		0 No BMP	0.000	0.000	0.000	0.000	0.000
11		0 No BMP	0.000	0.000	0.000	0.000	0.000
12		0 No BMP	0.000	0.000	0.000	0.000	0.000
13		0 No BMP	0.000	0.000	0.000	0.000	0.000
14		0 No BMP	0.000	0.000	0.000	0.000	0.000
15		0 No BMP	0.000	0.000	0.000	0.000	0.000
16		0 No BMP	0.000	0.000	0.000	0.000	0.000
17		0 No BMP	0.000	0.000	0.000	0.000	0.000
18		0 No BMP	0.000	0.000	0.000	0.000	0.000
19		0 No BMP	0.000	0.000	0.000	0.000	0.000
20		0 No BMP	0.000	0.000	0.000	0.000	0.000
Total Land Use Area	728.50	nter the calculated value in Table 7. located in "BMPs" tab, under the appropriate watershed -->	0.322	0.555	0.000	0.296	0.000

Total Area check: OK

total cropland acres is 1448.3

percent treated acres = 50.0%

Total Cropland Acres
11,337.2

Total Cropland Acres with BMP's
5,784.0
50%

Lake Sinissippi-Rock River 9Key Plan – FUTURE Practices and Combined BMP Pollutant