# MISSISSIPPI RIVER-WINONA WATERSHED
# WATERSHED RESTORATION & PROTECTION STRATEGY


Winona County SWCD

Whitewater River Watershed Project

CLEAN WATER LAND & LEGACY AMENDMENT

Minnesota Pollution Control Agency

Winona County

newground

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## Key Terms

**Assessment Unit Identifier (AUID):** The unique water body identifier for each river reach comprised of the USGS eight-digit HUC plus a three-character code unique within each HUC.

**Aquatic life impairment:** The presence and vitality of aquatic life is indicative of the overall water quality of a stream. A stream is considered impaired for impacts to aquatic life if the fish Index of Biotic Integrity (IBI), macroinvertebrate IBI, dissolved oxygen, turbidity, or certain chemical standards are not met.

**Aquatic recreation impairment:** Streams are considered impaired for impacts to aquatic recreation if fecal bacteria standards are not met. Lakes are considered impaired for impacts to aquatic recreation if total phosphorus, chlorophyll-a, or Secchi disc depth standards are not met.

**Hydrologic Unit Code (HUC):** A Hydrologic Unit Code (HUC) is assigned by the USGS for each watershed. HUCs are organized in a nested hierarchy by size. For example, the Minnesota River Basin is assigned a HUC-4 of 0702 and the Pomme de Terre River Watershed is assigned a HUC-8 of 07020002.

**Impairment:** Water bodies are listed as impaired if water quality standards are not met for designated uses including: aquatic life, aquatic recreation, and aquatic consumption.

**Index of Biotic integrity (IBI):** A method for describing water quality using characteristics of aquatic communities, such as the types of fish and invertebrates found in the waterbody. It is expressed as a numerical value between 0 (lowest quality) to 100 (highest quality).

**Protection:** This term is used to characterize actions taken in watersheds of waters not known to be impaired to maintain conditions and beneficial uses of the waterbodies.

**Restoration:** This term is used to characterize actions taken in watersheds of impaired waters to improve conditions, eventually to meet water quality standards and achieve beneficial uses of the waterbodies.

**Source (or Pollutant Source):** This term is distinguished from 'stressor' to mean only those actions, places or entities that deliver/discharge pollutants (e.g., sediment, phosphorus, nitrogen, pathogens).

**Stressor (or Biological Stressor):** This is a broad term that includes both pollutant sources and non-pollutant sources or factors (e.g., altered hydrology, dams preventing fish passage) that adversely impact aquatic life.

**Total Maximum Daily Load (TMDL):** A calculation of the maximum amount of a pollutant that may be introduced into a surface water and still ensure that applicable water quality standards for that water are met. A TMDL is the sum of the wasteload allocation for point sources, a load allocation for nonpoint sources and natural background, an allocation for future growth (i.e., reserve capacity), and a margin of safety as defined in the Code of Federal Regulations.

# Acronyms

| | |
|---|---|
| AUID | Assessment Unit Identifier |
| BWSR | Board of Water and Soil Resources |
| DO | Dissolved Oxygen |
| EPA | Environmental Protection Agency |
| HUC | Hydrologic Unit Code |
| IBI | Index of Biotic Integrity |
| LiDAR | Light Detection and Ranging |
| MDA | Minnesota Department of Agriculture |
| MDH | Minnesota Department of Health |
| MGS | Minnesota Geological Survey |
| mg/L | milligrams per Liter |
| MPCA | Minnesota Pollution Control Agency |
| MRWW | Mississippi River - Winona Watershed |
| MS4 | Municipal Separate Storm Sewer System |
| N | Nitrogen |
| NPDES | National Pollutant Discharge Elimination System |
| NRCS | Natural Resources Conservation Service |
| P | Phosphorus |
| SDS | State Disposal System |
| SETSJPB | Southeast SWCD Technical Support Joint Powers Board |
| SEMWRB | South East Minnesota Water Resources Board |
| SID | Stressor Identification |
| SRMCWD | Stockton-Rollingstone-Minnesota City Watershed District |
| SSTS | Subsurface Sewage Treatment Systems (septic) |
| SWAT | Surface Water Assessment Tool |
| SWCD | Soil and Water Conservation District |
| TMDL | Total Maximum Daily Load |
| TSS | Total Suspended Solids |
| WWJPB | Whitewater Watershed Joint Powers Board |
| WQ | Water Quality |
| WRAPS | Watershed Restoration and Protection Strategies |

## Summary

The Mississippi River - Winona Watershed (MRWW) covers 419,200 acres in Wabasha, Winona, and Olmsted counties in southeast Minnesota. The Whitewater River falls within this watershed and is well known for its state park and trout fishing. The Whitewater River discharges into the Mississippi River at Weaver Bottoms, an important Mississippi River backwater and waterfowl staging area. A majority of the watershed supports a thriving agricultural economy with 29.3% of land being cropland and 27.0% being hay/pasture. Forest covers a large portion of the watershed as well, and only a small percentage of the watershed is developed. The largest city in the watershed is Winona (population 27,000), located on the Mississippi River.

This Watershed Restoration and Protection Strategy (WRAPS) document is meant as a foundation of technical information that can be used to assist in development of tools and prioritization of efforts by local governments, land owners, and other stakeholder groups. The information can be used to determine what strategies will be best to make improvements and protect good quality resources, as well as focus those strategies to targeted locations.

Chapter 1 provides background information on the watershed. Chapter 2 details watershed conditions based on results from Intensive Watershed Monitoring, Stressor Identification (SID), and Total Maximum Daily Load (TMDL) calculations. A few main points from these two chapters:

- The MRWW lies completely within the Driftless Area and is a karsted landscape
- Conservation has a strong history in this watershed
- Twenty-eight streams and two lake basins were assessed with the following results:
    - Aquatic recreation use: both basins of Lake Winona are non-supporting of this use based on excess nutrients; 17 stream reaches are non-supporting based on bacteria levels
    - Aquatic life use: 11 stream reaches are fully supporting this use while 17 stream reaches are non-supporting
    - Drinking water use (based on nitrate): two stream reaches are non-supporting
- Trend analysis shows improving conditions for total suspended solids, but degrading conditions for nitrate and chloride
- The SID process determined the probable causes of aquatic life stress to be low dissolved oxygen (DO), elevated temperature, nitrate, total suspended solids (TSS), degraded physical habitat and loss of physical connectivity for four fish and 12 aquatic macroinvertebrate communities.
- The MRWW TMDL Report was put on public notice in 2015 and received final approval by the U.S. Environmental Protection Agency (EPA) in July of 2016. It addressed 25 impairments on 19 waterbodies (2 lakes and 17 stream reaches/AUIDs). Lake and stream allocations and reductions needed to meet standards were developed in that TMDL report.

Chapter 3 of this report provides the results of prioritization and strategy development. It summarizes priority areas for targeting actions to improve water quality and geographically locates where watershed restoration and protection actions should take place. This prioritization and targeting is shown using

maps and an implementation table of strategies broken into three geographic regions of the watershed. The maps and table highlight areas that are high priority for restoration, medium priority for restoration, and priority areas for protection efforts. Civic engagement efforts used during WRAPS development to assist with prioritization and strategy development are also discussed. A few highlights of this chapter include:

- The main issues in the MRWW are:
    - Nitrate concentrations exceed standards in some coldwater streams.
    - Upland areas and flood plains are contributing too much sediment to the system, causing concentrations to exceed standards in some streams throughout the watershed.
    - Widespread issue of high bacteria concentrations.
    - Physical habitat of aquatic macroinvertebrates and fish are being affected by various practices in the watershed.
- Key strategies that will help address these issues are:
    - Soil health best management practices (BMPs)
    - Stream/Streambank restoration: Reduction of sediment loss from upland areas and stabilization of flood plains, terraces and stream banks, especially on the main stem of the Whitewater subwatershed
    - Nutrient management BMPs: nitrate reduction via reduction of input to and loss from corn/soy agricultural acres
    - Riparian corridor management: address physical habitat issues that are affecting aquatic life communities of the streams
    - Structural impoundment BMPs
    - Determination of why bacteria concentrations remain high in many streams despite numerous efforts at reduction
- Civic engagement efforts during WRAPS development included:
    - Three citizen summits, each hosting approximately 100 citizens
    - Land owner/resident surveys
    - Development of a watershed website
    - Distribution of quarterly newsletters highlighting citizens of the watershed
    - The citizen group Healthy Lake Winona formed after the third citizen summit with a goal of revitalizing Lake Winona.

Chapter 4 documents a monitoring plan necessary to assess conditions in the MRWW. This will include following the watershed approach framework model with intensive watershed monitoring scheduled to occur in the MRWW in 2020. Also, the Minnesota Pollution Control Agency's (MPCA's) watershed pollutant load monitoring network continually collects information at three locations in the MRWW. This is integral to understanding trends in the watershed.

## What is the WRAPS Report?


The state of Minnesota has adopted a "watershed approach" to address the state's 80 "major" watersheds (denoted by 8-digit hydrologic unit code or HUC). This watershed approach incorporates **water quality assessment, watershed analysis, civic engagement, planning**, **implementation**, and **measurement of results** into a 10-year cycle that addresses both restoration and protection.

As part of the watershed approach, waters not meeting state standards are still listed as impaired and TMDL studies are calculated, as they have been in the past, but in addition the watershed approach process facilitates a more cost-effective and comprehensive characterization of multiple water bodies and overall watershed health. A key aspect of this effort is to develop and utilize watershed-scale models and other tools to identify strategies and actions for point and nonpoint source pollution that will cumulatively achieve water quality targets. For nonpoint source pollution this report informs local planning efforts, but ultimately the local partners decide what work will be included in their local plans. This report also serves as a watershed plan addressing EPA's Nine Minimum Elements to qualify applicants for eligibility for Clean Water Act (CWA) Section 319 implementation funds.

**Purpose**

- Support local working groups and jointly develop scientifically-supported restoration and protection strategies to be used for subsequent implementation planning
- Summarize Watershed Approach work done to date including the following reports:
  - *Mississippi River-Winona Watershed Monitoring and Assessment (MPCA 2013)*
  - *Mississippi River-Winona Biotic Stressor Identification (MPCA 2015)*
  - *Mississippi River-Winona Watershed Total Maximum Daily Load (MPCA 2016)*

**Scope**

- Impacts to aquatic recreation and impacts to aquatic life in streams. Impacts to drinking water on coldwater streams. Impacts to aquatic recreation in lakes.
- Strategy development for restoration and protection of watershed resources.

**Audience**

- Watershed stakeholders (those with an interest in technical details of their watershed and those whose actions and decisions are called upon for implementation)
- Local working groups (local governments, SWCDs, watershed management groups, etc.)
- State agencies (MPCA, DNR, BWSR, etc.)

## 1. Watershed Background & Description

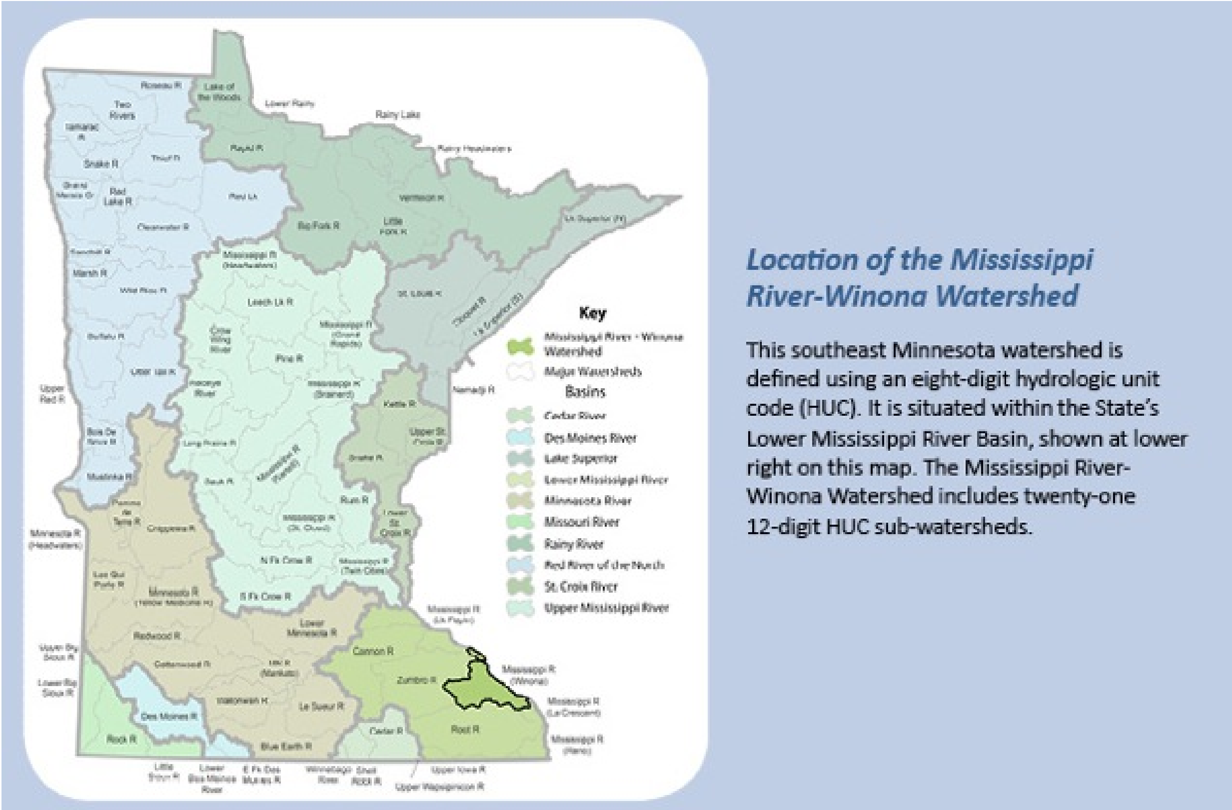



**Figure 1. Green area with bold-black outline indicates location of Mississippi River-Winona Watershed in Minnesota.**

The Mississippi River-Winona Watershed (MRWW) drains approximately 419,200 acres of Minnesota's southeastern Wabasha, eastern Olmsted and northern Winona Counties, stretching from the outlet of Lake Pepin, 50 miles southeast along the Minnesota/Wisconsin border (Figure 1). The watershed lies completely within the Driftless Area ecoregion (EPA 2007) in the Lower Mississippi River Basin (Figure 4).

The MRWW includes three 10 HUC watershed areas (Figure 2). One is the Whitewater River, which begins as three warmwater streams in the western plains of the watershed, consisting of gently rolling land that is heavily row cropped. Moving east, it transitions to a more rolling landscape dissected by steep valleys with wooded slopes. The eastern portion still has crop fields, but they are smaller with more hay and pasture present. Spring-fed coldwater streams are also found in the eastern portion, as well as the only assessed lake, Lake Winona.

Water quality of streams in the MRWW has been studied for many decades. One example is the Rural Clean Water Program, which funded a study completed in 1989 on Garvin Brook (Wall et al. 1989), a coldwater trout stream that discharges directly to the Mississippi River, which was experiencing sedimentation and habitat destruction. An associated study by the MPCA and University of Minnesota titled Nitrate and Pesticide Contamination of Ground Water in the Garvin Brook Area of Southeastern Minnesota: Sources and Trends (Wall et al. 1991) further analyzed what the issues were and how they might be addressed. Findings from these studies led farmers to take initiative to install BMPs on their land that reduced nitrate, sediment, and bacteria leaving their land. Work has continued on this prized trout stream, including a stream habitat improvement project led by Trout Unlimited, funded by the Lessard-Sams Outdoor Heritage Council.

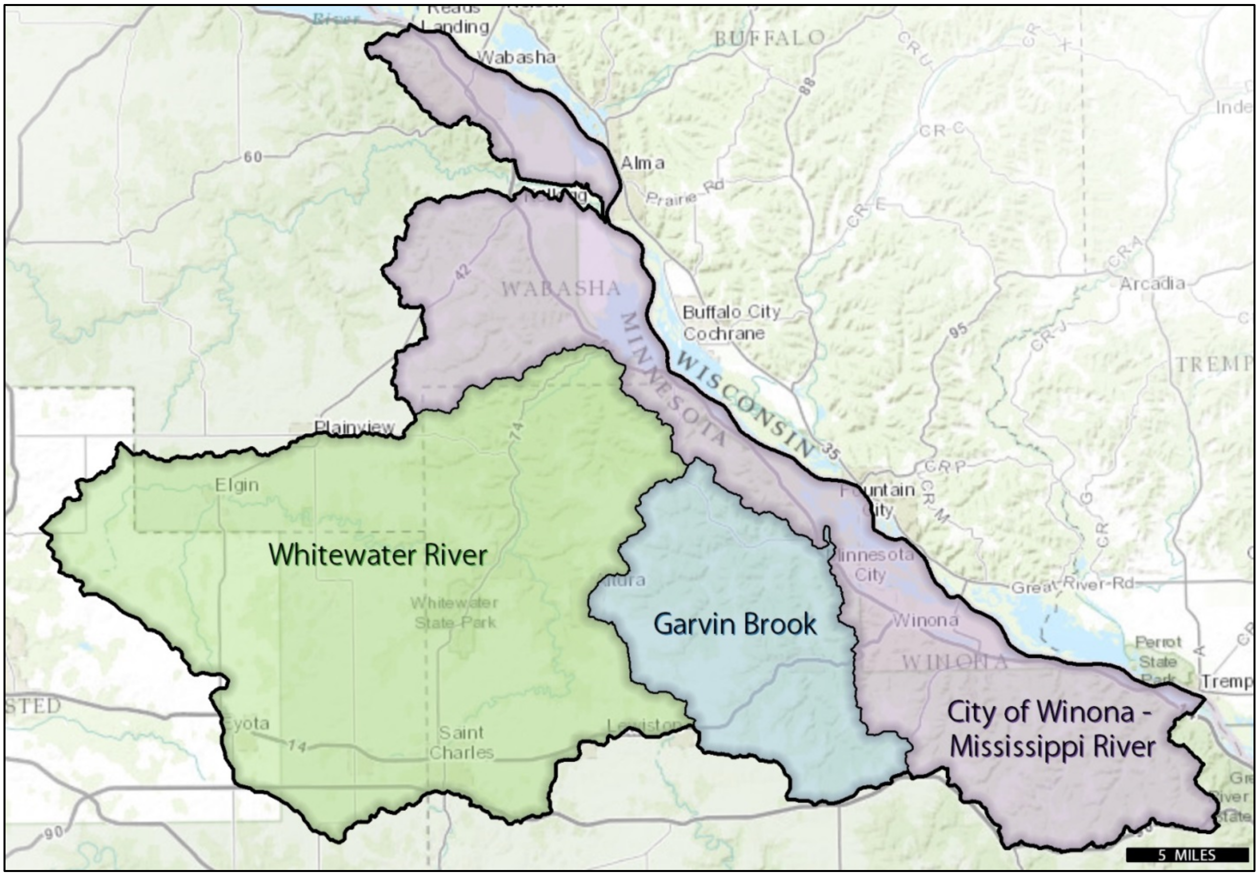
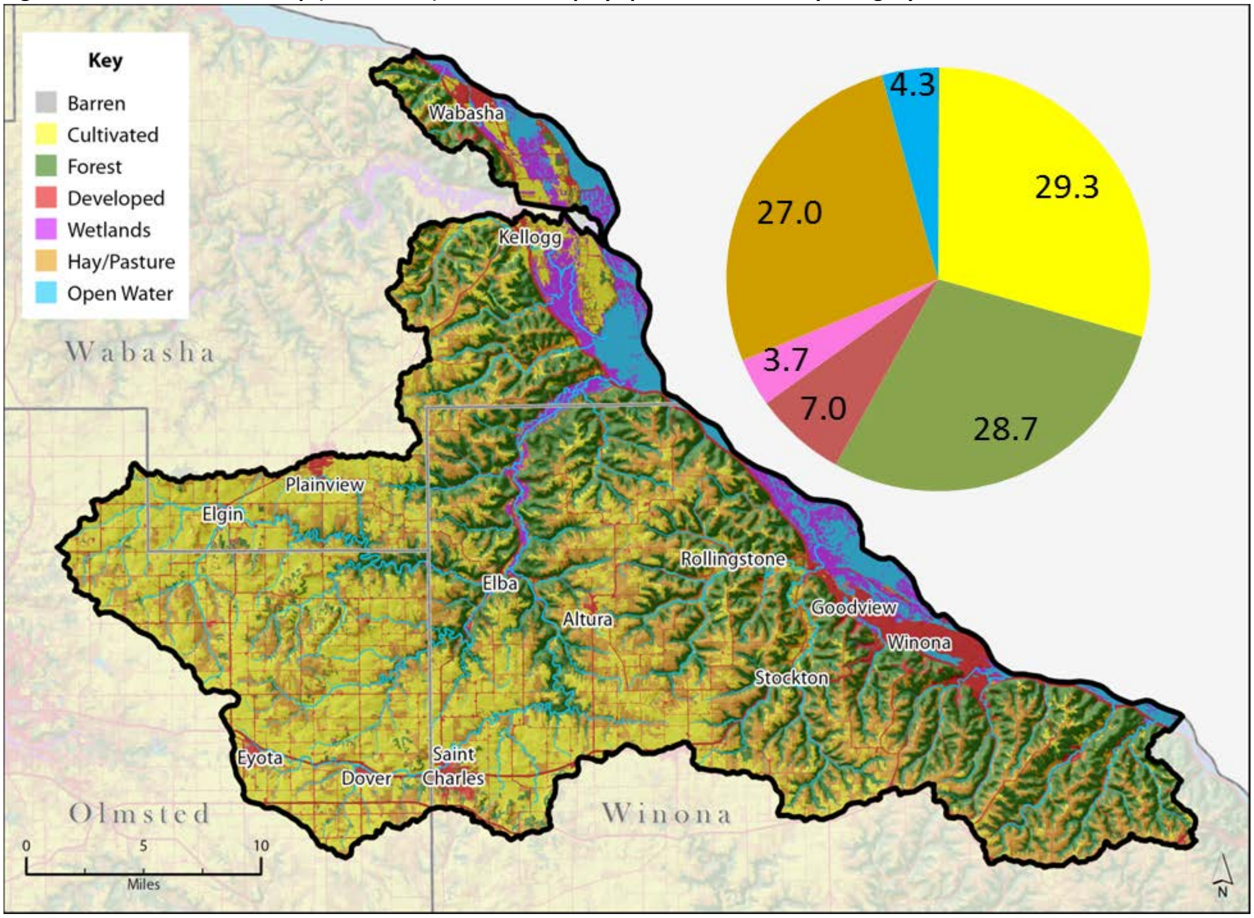



**Figure 2. MRWW area illustrating the 10 HUC subwatersheds within it: Whitewater River; Garvin Brook; and city of Winona-Mississippi River.**

**Figure 3. MRWW land use map (NLCD 2011). Pie chart displays percent land use by category**




## 1.1 Population and Land Use

The landscape of this area provides a vast resource for recreation and wildlife. An abundance of water, beautiful scenery and widespread public access make it a popular destination for fishing, paddling, hiking, hunting and other outdoor recreation. Whitewater State Park draws about 300,000 visitors annually. The entire MRWW falls in the karsted Driftless Area (Figure 4), where one billion dollars is generated by recreational trout fishing every year (Betz 2012).

The MRWW supports a thriving agricultural economy with 29.3% of land being cropland and 27.0% being hay/pasture. Rich soils of the western Rochester Plateau are largely row cropped. Cropland in the eastern areas is discontinuous on hilltops and in valleys and is dominated by hay and pasture. Dairy and beef are major livestock types in the watershed. Both Wabasha and Winona counties are important dairy producers for the state; Winona County ranks second and Wabasha County ranks fifth (MDA 2009 and MDA 2010). Forest is a major land use as well, covering 28.7% of the land area (Figure 3).

The Whitewater River flows generally northeast through the 21,050-acre Whitewater Wildlife Management Area and Whitewater State Park, entering the Mississippi River at Weaver Bottoms, an important Mississippi River backwater and nationally significant waterfowl staging area in the Upper Mississippi National Wildlife and Fish Refuge. The Whitewater River is a state designated Water Trail, managed for canoeing and kayaking. Crystal Springs Fish Hatchery, near the South Fork of the Whitewater River, contributes to restoration of native trout populations statewide. Also in the watershed are a number of smaller streams that flow directly to the Mississippi River, including Garvin

Brook and East Indian Creek (see MRWW online map; click "Maps" tab). The watershed has a history of damaging floods, including one in 2007 that reshaped the river.

The total population of the MRWW area was 57,112, as of the 2010 U.S. Census. This was a slight population growth since the 2000 U.S. Census, when the population was 55,242. Winona, population 27,952, is the watershed's largest city. Situated on a broad plain between towering bluffs and the Mississippi River, it is a rail and river transportation hub and home to Winona State University, St. Mary's University, Minnesota State College-Southeast Technical and the Minnesota Marine Art Museum. Examples of other watershed communities include: Altura (pop. 493), Elba (pop. 152), Eyota (pop. 1,977), Plainview (pop. 3,340), Rollingstone (pop. 664), St. Charles (pop. 3,736), Stockton (pop. 697) and Wabasha (pop. 2,520) (U.S. Census Bureau 2010). A majority of the watershed's land is privately owned – approximately 85% (NRCS 2008)

**History of Agricultural Land Use in Southeastern Minnesota**

As Euro-Americans began to settle Minnesota during the early 1800s, Native American tribes such as the Dakota and Objibwe had rangeland and were growing crops including corn, potatoes, turnips and pumpkins. During early Euro-American settlement of Minnesota (1820 through 1870), the southeastern portion of the state was among the first settled due to the wooded landscape which provided materials for fuel, fences and houses, and the close proximity to the Mississippi River. Wheat farming in Minnesota was first practiced in its southeastern portion with the principal wheat-growing counties being Olmsted, Goodhue, Fillmore, Wabasha, Dakota and Winona in 1870. The majority of farmers in the area grew a wheat monoculture as their exclusive cash crop, and it was shipped to market via river boats. By the end of this settlement period, four-fifths of the population of Minnesota was concentrated in the southeastern part of the state.

Diversification of farms in the southeast occurred from 1900 through 1920. Instead of producing only wheat, there was an incorporation of oats, corn, barley, vegetables, fruits and livestock. Dairy farms became prevalent, with Winona being one of the top dairy farm counties and having a high concentration of cheese-making.

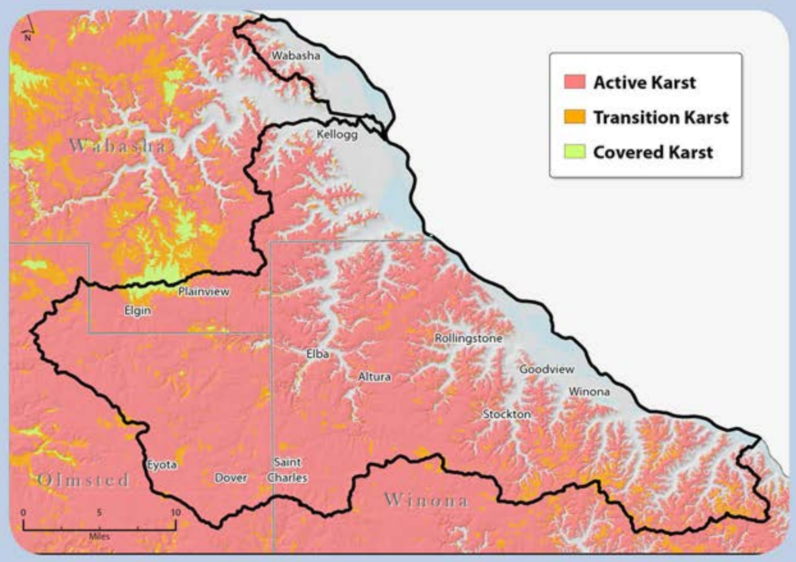
Agriculture continued to diversify in Minnesota in the 1940s and 1950s. Southeastern Minnesota started to concentrate on cattle, hogs, corn and soybeans after World War II. This area raised about a quarter of the state's main farm products, as well as poultry, dairy products, eggs, cheese, vegetables, and apples (Granger and Kelly 2005).

Conservation efforts from the 1930s to present times helped reduce soil erosion rates from some of the land clearing and farming practices used early on in Euro-American settlement, however legacy sediment from the late 19th and early 20th centuries still impacts the waterways (Argabright et al. 1996 and Mast et al. 1999). It is important to note that the first Soil and Water Conservation District (SWCD) in Minnesota was created in 1938 in the MRWW – the Winona SWCD (first called the Burns-Homer-Pleasant district) in response to the Dust Bowl of the 1930s (MASWCD). This watershed has a long standing history of looking to understand issues facing the health of the land and its people, and responding with implementation of appropriate BMPs. Much has been done, and much work is left to complete in order to ensure the MRWW continues to thrive.


The Driftless Area is characterized by gently rolling to steeply sloped karst topography, wooded slopes, coldwater streams, diverse aquatic environments including trout habitat, and rare prairie and ice-age remnant plant communities. On the Driftless Area map at left, the Mississippi River-Winona Watershed is outlined in black.

**Figure 4. The Mississippi River-Winona Watershed is part of the Driftless Area ecoregion, an area outlined in brown in the map that includes areas in Minnesota, Iowa, Illinois and Wisconsin that were not impacted by the most recent glaciers.**

## 1.2 Impacts to Groundwater Quality




### *WHAT IS KARST?*

Underneath this watershed's beautiful farms, hills, woods and streams is a natural, integrated drainage system called *karst*. It is formed by the dissolving action of water on limestone, and over time creates unusual features including sinkholes, springs, disappearing streams, complex, underground drainage systems, and caves. It is a challenge for water protection because surface water and pollutants move rapidly through its web of underground crevasses, often ending up in groundwater used for drinking.

**Figure 5. Karst terrain in the MRWW. Karst areas are all underlain with carbonate bedrock, where active karst has less than 50 ft. of sediment cover, transition karst has 50-100 ft. of sediment cover and covered karst has more than 100 ft. of sediment cover.**

### Groundwater

Southeastern Minnesota water resources are challenging to protect because limestone is slowly dissolved by infiltrating rainwater, sometimes forming hidden, rapid pathways from pollution release points to drinking water wells or surface water. These pathways can be widened, interconnected fractures or caves in the subsurface. Sometimes the process of dissolving limestone forms distinctive landforms on the ground surface, and in other places there is no distinctive landform at all. Together, the processes that dissolve limestone bedrock and the landforms that result are called karst (MPCA website). This geology makes the groundwater (and subsequently surface water) highly susceptible to pollution because contaminants on the land can easily reach groundwater, which then mixes with rivers and streams (MPCA 1989).

In karst landscapes, which encompass the entire MRWW (Figure 5), the distinction between groundwater and surface water is commonly blurry, and sometimes very tenuous. Groundwater may emerge as a spring, flow a short distance above ground, only to vanish in a disappearing stream, and perhaps re-emerge farther downstream again as surface water.

The intimate connection between groundwater and surface water gives rise to a large number of coldwater streams in southeastern Minnesota where trout and other important species thrive. Pollution traveling rapidly along a groundwater path may emerge at a stream, thus posing a threat to the animals and plants living there. In the same way, pollution that has reached surface water can easily become groundwater pollution, thus posing a pollution risk to the people living in the MRWW whose drinking water is groundwater.

**Groundwater as the source of drinking water**
It can be assumed that all citizens of the MRWW rely on groundwater for their source of drinking water. Of the roughly estimated 23,000 households in this watershed, approximately 80% are served by 14 community public water supply systems and approximately 20% of the households obtain water from private wells.

**Vulnerability to contamination**
Of these 14 community public water supply systems, seven have primary wells that are considered vulnerable to contamination from the land surface. The Minnesota Department of Health (MDH) has developed a method for assessing the vulnerability of water supply to contaminants from activities at the land surface. The vulnerability determination is made considering the geologic sensitivity, well construction, and water chemistry data and isotopic composition (tritium) of the source water (Appendix A. Information from the MDH's database on public and private wells within subdivisions of the MRWW),

## 1.3 Primary Pollutant and their effects


**Figure 6. These pollutants can impact human health, aquatic recreation and aquatic habitat.**

### What are the effects of the area's primary pollutants?

***Concerns about nitrogen*** relate to human health, aquatic life toxicity, eutrophication, nitrogen gasses and atmospheric concerns. Nitrate is a concern for human health when elevated levels reach drinking water supplies. Consumption of high nitrate water has notably contributed to methemoglobinemia or "blue baby syndrome" in infants. (MDH)

***E. coli* is a sub-group of fecal bacteria** used in water quality monitoring as "indicator organisms" meaning if they are found to be present in a water sample, it is an indication of the possible presence of pathogens. Countless numbers of bacteria, viruses and other microorganisms exist in water and in bodies of humans and animals. Most of these microorganisms are beneficial, however about 10% are harmful and known as pathogens. If ingested by humans, pathogens can release toxins causing sickness or even death.

***When soil leaves the land***, a life-giving resource is lost. Suspended sediment clouds streams, making it difficult for aquatic species to see food. Increased duration of suspended sediment can cause species diversity loss. When suspended sediment falls to the stream bottom, impacts to macroinvertebrate and fish habitats can lead to decreased diversity and spawning. Also, many contaminants attach to and are therefore carried with sediment.

## 1.4 Local Conservation Legacy and Today's Choice

Current surface water quality conditions, while in need of improvement, would be worse if people of previous generations had not seen what was happening and acted during the past 100 years. Much is at stake and failure is a real risk—including streams that don't support diverse life, depleted soil, farms and farmers who don't prosper, and water-borne illness. Minnesota's 2013 Nutrient Reduction Strategy shows that to some degree these risks are already happening.

***In the MRWW 56% of the land is agricultural***, including cropland and hay/pasture land area. Based solely on land use statistics, this places significant responsibility for action on farmland owners (residents and absentee) and farm operators to address some of the watershed issues.

***However, all citizens have a responsibility***. In town and on non-farm acreages, private and public wastewater systems and stormwater runoff must be managed.

A small number of citizen leaders in town and country have stepped forward to lead by example in this watershed, implementing practices to help reach water quality goals, and then sharing projects with neighbors. Conservation professionals work hard to facilitate, provide information, foster connections and function efficiently within a complex system. Efforts by state leaders create opportunities for collaboration and there seems to be gathering momentum (Figure 7).

This strategy builds on those efforts, and brings focus to the work of the next decade—work that will require serious, energetic momentum to restore and protect local waters before further degradation occurs.

# WE STAND ON A LEGACY OF SERVICE

## Local citizens have protected our inheritance and influenced both state and national policy to improve water quality

**1915** *Winona citizen John Latsch gives properties to the City of Winona and establishes a board to provide, enlarge, improve, and maintain public parks and animal, bird, fish, game and hunting preserves on those properties and on Mississippi River Island No. 72. Before his death in 1934, Latsch buys and donates more than 18,000 acres including Aghaming Park, Gabrych Park and Westfield Golf Course; John Latsch State Park and portions of Whitewater State Park in Minnesota; and Trempealeau Mountain, John Latsch Overlook, and portions of Merrick and Perrot state parks in Wisconsin. He also funds the John C. Latsch Public Baths to provide Winona with safe swimming and recreation for decades.*

**1923** *The area's Wil Dilg Isaak Walton League chapter is the first in the nation, founded to thwart threats to thousands of acres of wildlife habitat on the upper Mississippi. Will Dilg, a friend of John Latsch, organizes 50 colleagues who lobby for federal action to preserve and protect habitat for future generations.*

**1924** *As a result of the above efforts Congress authorizes the Federal Wildlife and Fish Refuge Act, the basis for the federal refuge system that now protects thousands of acres of prime habitat across the country.*

**1934** *Civilian Conservation Corps builds trails and buildings on public lands; works with farmers to reduce erosion. Contour strip farming is introduced.*

**1935** *President Roosevelt signs the Soil Conservation Act, recognizing that "soil erosion is a menace to the national welfare." The Act provides permanently for the control and prevention of soil erosion and establishes the Soil Conservation Service.*

**1935** *Gilmore Valley watershed becomes a Soil Conservation Service demonstration site. Contour strips alternating corn and hay are introduced to conserve soil.*

**1937** *President Roosevelt sends a model Soil Conservation District law to state governors, suggesting that farmers and ranchers receive authority to establish districts for conservation of soil and water resources. Twenty two states adopt the law immediately, including Minnesota. All others follow.*

**1938** *The success of erosion control demonstration sites leads to certification of the Burns-Homer-Pleasant Conservation District, first in Minnesota (located in the Mississippi River-Winona Watershed). Two hundred people attend the first meeting at Homer Hall.*

**1939** *The State certifies Rollingstone-Stockton-Gilmore Conservation District, the second in Minnesota.*

**1941** *The Whitewater Conservation District is certified as the ninth in Minnesota.*

**Figure 7. A summary of progress from previous and current actions undertaken in the MRWW. Local actions are marked with gold; state and federal policy decisions influencing efforts to improve water quality in the MRWW (and elsewhere) are red.**

**1950s** *Terraces and crop-pasture rotations are initiated.*

**1955** *The Minnesota Legislature authorizes local government units called watershed districts, led by local directors with authority to tax and invest to solve and prevent water-related problems.*

**1958** *Rollingstone-Stockton-Gilmore and Whitewater Conservation Districts merge to become the Winona Conservation District.*

**1958** *The Isaak Walton League and southern Minnesota conservation leaders convince the State Legislature to establish southeast Minnesota's 1,016,204-acre Richard J. Dorer State Hardwood Forest, which now provides erosion reduction, stream stabilization, diverse habitat, and recreation.*

**1958** *The Stockton-Rollingstone-Minnesota City Watershed District is established to control erosion and reduce flooding.*

**1972** *Congress passes the Clean Water Act to restore and maintain the chemical, physical, and biological integrity of the nation's waters. The Act initiates a flow of some $1.6 billion in federal grants and loans to help Minnesota cities treat wastewater prior to discharge into lakes or streams, and establishes a permitting process called the National Pollutant Discharge Elimination System.*

**1977** *Win-Cres Trout Unlimited is formed by southeast Minnesota residents to restore and protect local trout streams. Win-Cres and Hiawatha (Rochester-based) Trout Unlimited chapters continuously, energetically invest and continue today.*

**1980** *Winona-based Mississippi River Revival begins working for a clean river through water quality monitoring, clean-up, environmental education, celebration, and advocacy for Clean Water Act compliance.*

**1980s** *Pickwick and Lake La Belle are ravaged by floods. Winona County SWCD, Minnesota Board of Water & Soil Resources, and Soil Conservation Service restore the lake and build upstream flood control structures .*

**1986** *Burns-Homer-Pleasant and Winona Conservation Districts merge to form Winona County Soil & Water Conservation District.*

**1987** *The Minnesota Legislature passes the Comprehensive Local Planning and Management Act, which encourages counties to plan for the protection and management of water related resources.*

**1987** *U.S. Fish & Wildlife Service initiates an interagency project in the Middle Branch Whitewater River Watershed, helping 173 farmers develop comprehensive conservation plans and practices to save topsoil, protect water quality and enhance wildlife habitats. A landowner advisory council provides leadership.*

**1989** *The 1987 project leads to establishment of the Whitewater Watershed Joint Powers Board by Olmsted, Wabasha and Winona Counties to educate, incent, and secure funding for conservation practices.*

**2002** *Minnesota's Legislative Auditor reports 54% of major facilities discharging wastewater in the state are operating with expired permits, and the permitting process has a growing backlog. As a result, Minnesota's permitting process is improved and the number of inspections increased.*

**2003** *At the request of the Legislature, Minnesota Pollution Control Agency develops a multi-year Total Maximum Daily Load implementation and financing plan. Sixty organizations participate in an Impaired Waters Stakeholder Process, with decisions made by consensus.*

**Figure 7. A summary of progress from previous and current actions undertaken in the MRWW. Local actions are marked with gold; state and federal policy decisions influencing efforts to improve water quality in the MRWW (and elsewhere) are red.**

**2004** *Tribal representatives and Winona citizens host the first Great Dakota Gathering and Homecoming, which annually promotes healing of people and place and invites a shared conservation ethic.*

**2004** *The Minnesota Supreme Court validates a permit for a wastewater treatment plant in Annandale/Maple Lake, allowing discharge from a new facility as long as it is balanced by reductions at another facility in the same watershed. The ruling upholds MPCA's authority to interpret federal environmental law and to determine courses of action that are most beneficial to communities while not harming the environment.*

**2006** *The Clean Water Legacy Act puts Minnesota on an accellerated path to addressing impaired waters.Nearly $25 million is appropriated to increase monitoring and assessment, start new Total Maximum Daily Load studies, and undertake restoration and protection projects.*

**2008** *Minnesota voters approve the Clean Water, Land & Legacy Amendment to the State's constitution, increasing sales and use tax by three-eighths of 1% (2009-2034) and allocating 33% to the Clean Water Fund. MPCA adopts a systematic watershed approach to restoration and protection, as recommended by the Clean Water Council.*

**2011** *Local landowners form the Whitewater River Farmer-Led Council to reduce nitrogen, bacteria and erosion in waters while improving farm productivity. Active members demonstrate best practices and speak out to engage others.*

**2012** *The "One Watershed, One Plan" framework is adopted by Minnesota's Board of Water and Soil Resources to help counties, watershed districts, soil and water conservation districts, and other organizations manage surface and groundwater as one integrated resource.*

**2013** *Minnesota environmental groups lobby successfully for a bill known as the Clean Water Accountability Act, ensuring specific identification of all pollution sources, targeted funding for optimal benefit, and state reporting on progress toward clean water goals. The Act refines MPCA's Watershed Restoration and Protection (WRAPS) approach.*

**2013** *The Whitewater River Watershed becomes a pilot partner for Minnesota Department of Agriculture's Agricultural Water Quality Certification Program.*

**2012, 2013, 2014** *More than 100 citizens participate in each of three Mississippi River-Winona Watershed Citizen Summits during the Watershed Restoration & Protection Strategies process.*

***Recent citizen summits show heightened awareness, listening, and invitations to connect and participate are helping to build a community of action for urban and rural citizens, businesses and government agencies. Together we must now access the best of our resources—and a willingness to evolve—to bring surface waters into compliance with water quality standards.***

**Figure 7. A summary of progress from previous and current actions undertaken in the MRWW. Local actions are marked with gold; state and federal policy decisions influencing efforts to improve water quality in the MRWW (and elsewhere) are red.**

## 2. Watershed Conditions

This section summarizes monitoring, assessment, SID, land use simulation modeling, and trend analysis work completed by the MPCA and local partners. More information on watershed conditions can be found at: the Minnesota Nutrient Planning Portal, Mississippi River-Winona (MSU 2013), the NRCS Buffalo-Whitewater Watershed page (NRCS 2010), and by using the DNR's Watershed Health Assessment Framework.

In the MRWW, there are eight lakes (not including any Mississippi River backwater area lakes, and or man-made retention ponds) between 8 and 222 acres in size and 1,000 stream segments referred to as Assessment Unit Identifiers (AUIDs), varying in length from 0.01 miles to 49 miles.

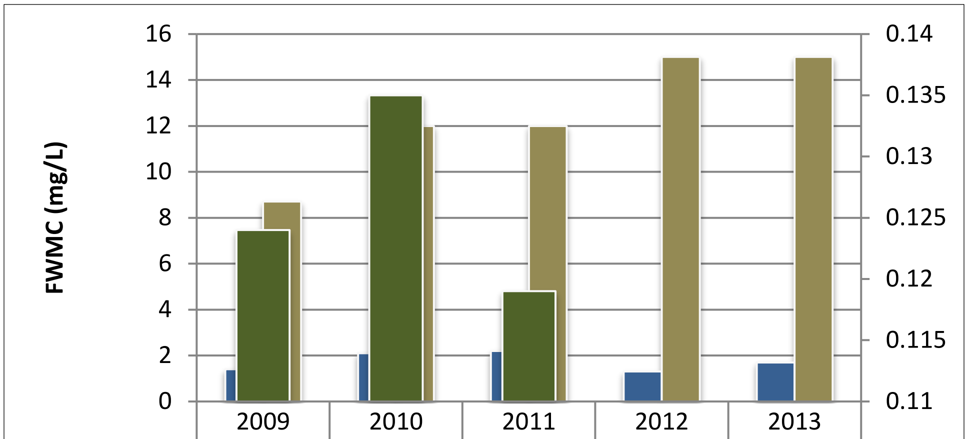
The Mississippi River-Winona Monitoring and Assessment Report contains more detailed information on assessments that were completed in 2014.

Active volunteers exist in the MRWW as part of the Citizen Stream Monitoring Program (CSMP). The CSMP combines the knowledge and commitment of interested citizens with the technical expertise and resources of the MPCA. As of 2013, 13 volunteers were collecting information at various stream locations throughout the watershed. The transparency data they collect is used as supporting information during assessment of water quality conditions. There are currently no active volunteers taking part in the Citizen Lake Monitoring Program (CLMP). Find out more on how to get involved with either the CLMP or CSMP program on their website.

As part of the Watershed Approach, Intensive Watershed Monitoring (IWM) was performed in 2010 and some additional monitoring in 2011, on the two lake basins of Lake Winona and 52 stream AUIDs throughout the MRWW. Assessment occurred in 2012, with both lake basins and 28 of the 52 stream AUIDs assessed. See the Monitoring and Assessment report for more detail.

**Watershed Pollutant Load Monitoring Network (WPLMN)**

The MPCA's WPLMN goals are tied to the Federal Clean Water Act, with goals to measure and compare regional differences in water quality and determine long-term trends in water quality. To do this, the WPLMN collects flow and water quality data near the mouth of each major watershed in Minnesota. At the time of this report, total phosphorus, sediment (TSS), and nitrate-nitrite data was available for the Mississippi River-Winona for the years 2009 through 2013 (other than total phosphorus, which was unavailable for 2012 and 2013) (Figure 8). Displayed are flow-weighted mean concentrations, which are calculated by dividing pollutant load by total flow volume. This should not be confused with Minnesota's water quality standards which are determined based on concentrations of pollutants, with a goal of describing desired condition of waterbodies. The load monitoring network goal is to determine use attainment.




| | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|
| NO2+NO3 | 1.4 | 2.1 | 2.2 | 1.3 | 1.7 |
| TSS | 8.7 | 12 | 12 | 15 | 15 |
| TP | 0.124 | 0.135 | 0.119 | | |

**Figure 8. Watershed Pollutant Load Monitoring Network results reported in flow-weighted mean concentration (FWMC) for years 2009-2013. Blue bars indicate NO3+NO2; brown bars indicate TSS; and green bars indicate phosphorus. Note: total phosphorus data is not available for 2012 or 2013.**

## 2.1 Condition Status

The purpose of this section is to summarize the condition status of streams assessed within the MRWW. Each stream may have been assessed for one or more of the following uses: aquatic recreation use parameters that include bacteria (fecal coliform or *E. coli*) (Figure 9); aquatic life use based on parameters that include fish and macroinvertebrate indices of biotic integrity (IBI), and turbidity/TSS (Figure 10); and drinking water use based on nitrate concentrations (Figure 11). Some of the waterbodies in the watershed are impaired by mercury; however, this report does not cover toxic pollutants. For more information on mercury impairments see the Statewide Mercury TMDL.

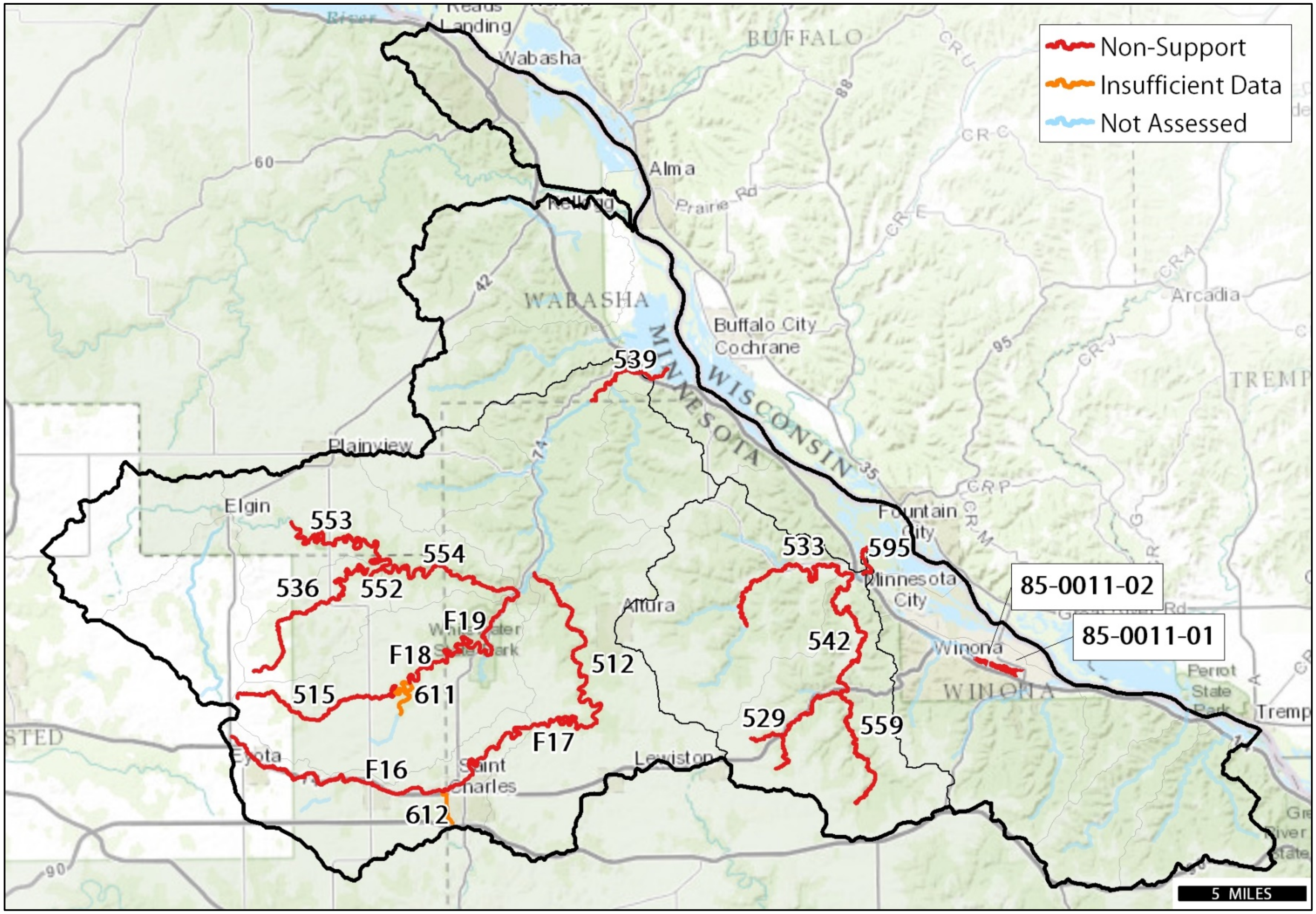



**Figure 9. The MRWW aquatic recreation assessment results based on the 2014 303(d) list. Results shown are from those lakes and stream segments with the chemical and biological data required to be assessed. Stream segment impairments are based on bacteria data, while lake impairments are based on nutrient data. Numbers on the map represent stream segment and lake basin identifiers.**

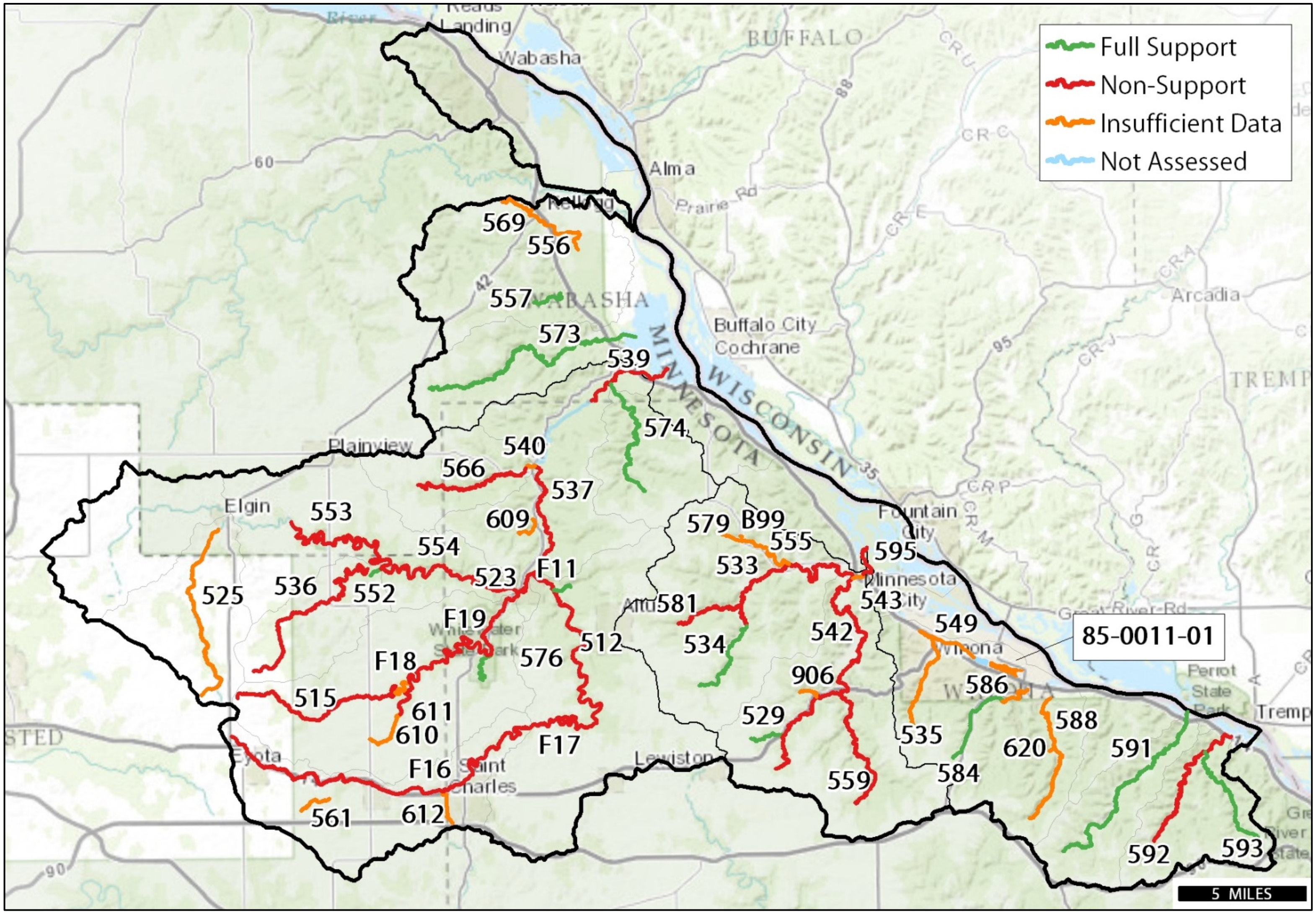



**Figure 10. The MRWW aquatic life use assessment results based on the 2014 303d list. Results shown are from those lakes and stream segments that had the dataset required to be assessed. Numbers on the map represent stream segment and lake basin identifiers. Note: Insufficient data for Lake Winona indicates chloride data was present but a full biological assessment was not able to be performed because there was not enough information. That information will be collected in the next round of sampling.**

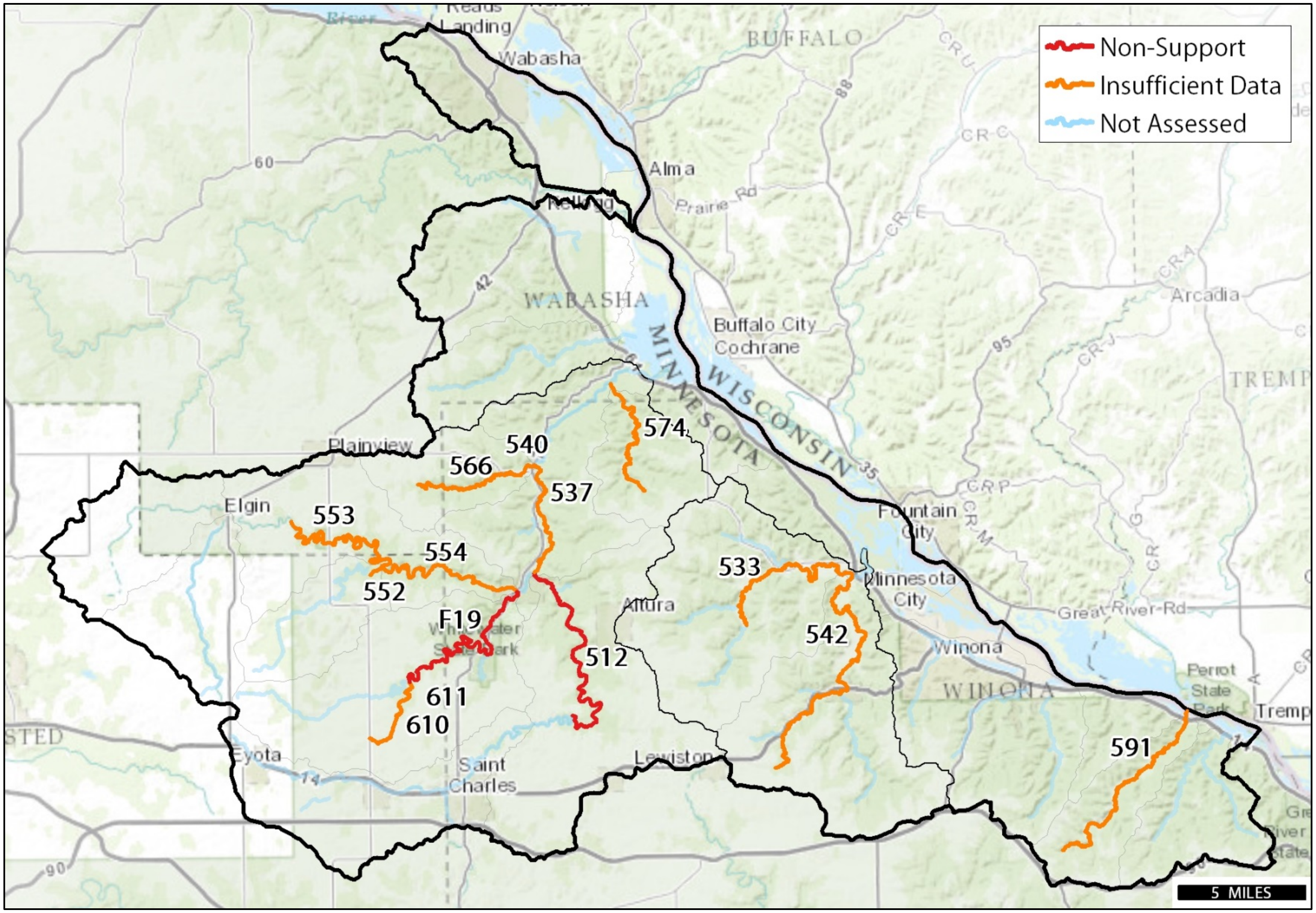



**Figure 11**. **The MRWW drinking water use assessment results based on the 2014 303d list. Results shown are from those stream segments that had the dataset required to be assessed. Note: while nitrate exceedance is enough to assess as non-support, meeting nitrate standards is not enough to state as full support because other parameters could cause non-support of the drinking water use.**

### Lakes

As part of the Intensive Watershed Monitoring (IWM) in 2010 and 2011, one lake was monitored and later assessed based on water chemistry and other data (DO, total phosphorus, secchi transparency, chlorophyll-a, and pheophytin). This lake is Lake Winona, which lies within the city of Winona. Two separate basins (Southeast Bay and Northwest Bay) exist on the lake, which were sampled and assessed independently.

Both lake basins of Lake Winona are non-supporting of aquatic recreation due to excess nutrients. Because there are not currently aquatic recreation standards in place for lakes within the Driftless Area ecoregion, the North Central Hardwood Forest (NCHF) standard was seen as most applicable (based on land use analysis) and applied to both bays of Lake Winona. Lake Winona (Southeast Bay) was determined to be a deep lake and therefore deep lake standard was applied. Lake Winona (Northwest Bay) was determined to be a shallow lake (maximum depth is less than 15 feet, or if the littoral zone-area where depth is less than 15 feet-covers at least 80% of the lake's surface) and therefore the shallow lake standard was applied (Table 1).

Fish-based IBIs for lakes did not exist at the time of data collection and assessment in the MRWW. However, development of Fish IBIs for Minnesota lakes has since taken place by the Minnesota DNR and the MPCA and will be applied when reassessed, which is anticipated to be in 2020.

**Table 1. Growing season mean TP, Chl-a, and Secchi (2010-2011)**

| Lake Name | 2010-2011 Growing Season Mean (June – September) | | |
|---|---|---|---|
| | TP (µg/L) | Chl-*a* (µg/L) | Secchi (m) |
| North Central Hardwood Forest: General | < 40 | < 14 | > 1.4 |
| Lake Winona (Southeast Bay) | 53 | 52 | 1.0 |
| North Central Hardwood Forest: Shallow Lakes | < 60 | < 20 | > 1.0 |
| Lake Winona (Northwest Bay) | 85 | 69 | 0.9 |

### Streams

A total of 52 stream AUIDs were monitored, with 28 being assessed. Two AUIDs were not assessed due to their classification as limited resource waters (Class 7, low-flow streams and ditches). Twelve AUIDs were not assessed for aquatic biology because greater than 50% of the AUID is channelized or the biological station fell on a channelized stream reach on the AUID. The remaining 10 AUIDs not assessed did not have sufficient data at the time and are essentially put on hold until next assessment round when the Tiered Aquatic Life Use Framework (TALU) can be applied. Biological criteria have only recently been developed for channelized streams and ditches in Minnesota; therefore, assessment of fish and macroinvertebrate community data for aquatic life use support was not possible for channelized streams in the MRWW when information used in this report was collected and assessed. TALU will be used to assess such streams in the next cycle, which is anticipated to start in the MRWW in 2020.

### *Aquatic life use*

The MPCA approach in assessing aquatic life use support has evolved over time. A weight of evidence approach is currently used that considers all the best information at hand – biological data and chemical data, as well as professional judgment. The current use support status indicates that we have 17 AUIDs that don't meet standards and 11 that do meet standards.

### *Aquatic recreation use*

Of the 28 AUIDs assessed, there are a total of 17 non-supporting of aquatic recreation. There were 6 AUIDs that were listed prior to 2014, utilizing older fecal coliform data. Recent *E. coli* data confirm all of these impairments. In particular, results from the North and South Forks of the Whitewater River, Rollingstone Creek, Garvin Brook, and Stockton Valley Creek indicated that excessive bacteria levels are still present.

### *Drinking water use*

Two AUIDs did not meet nitrate standards for drinking water. The small number of impairments can be attributed more so to a lack of sufficient data to assess more AUIDs than due to monitoring data meeting standards.

### *Other stream assessment information*

The four AUIDs with sufficient data for assessment for pesticides met standards. There were also no DO impairments found.

## 2.2 Water Quality Trends

In 2012, the MRWW Water Quality Data Compilation and Trend Analysis Report was completed (Olmsted County Environmental Services 2012). The primary goal was to compile existing water quality data in the watershed and statistically analyze the data for trends and other significant features. Data gaps or limitations were also identified and recommendations were made for addressing them in the future. A majority of the text in this section was excerpted from this report; some wording was changed where necessary. For detail on statistical analysis that led to the conclusions in much of this section, please refer to the original document here.

### 2.2.1 Trends in annual discharge

Five United States Geological Survey (USGS) monitoring stations had sufficient flow records to assess stream discharge trends. Two of those sites were in the same vicinity (5377500 and 5376800). Site 5377500 was discontinued in 1953 and replaced with 5376800, therefore data was merged and only the 5376800 site is reported (Table 2).

There is no continuous long term record of discharge data in the MRWW. Where discharge trends were identified, they were in all cases increasing. Relatively short records and large inter-annual variability may be masking other possible trends. Due to the lack of long-term, continuous data it cannot be determined whether flow across the entire watershed has increased or decreased in the last 10 to 20 years. However, the Palmer Drought Severity Index (PDSI) was found to correlate with annual flows and the PDSI itself is increasing. The PDSI is a measurement of dryness based on recent precipitation and temperature and is effective in identifying drought conditions. This correlation suggests that the PDSI is a good surrogate in reconstructing stream flows in the MRWW. The PDSI could be used for this purpose with the ultimate goal of estimating annual loads of sediment, nutrients, and so on.

### 2.2.2 Trends in parameters related to sediment

In Southeastern Minnesota, the patterns of suspended sediment concentration (SSC) reflect influencing factors such as climate (especially rainfall) and the properties of the rocks and soils that are exposed to erosion. Sediment loads in the MRWW streams are also largely driven by flood and other high flow events.

Water quality parameters related to SSC/TSS include total phosphorus (TP), total Kjeldahl nitrogen (TKN), transparency, biochemical oxygen demand (BOD) and turbidity. In the MRWW, these parameters were systematically measured on a consistent basis by the United States Geological Survey (USGS) at their monitoring site on the North Fork Whitewater River near Elba (05376000) from 1970 to 1993, and by the MPCA's Milestone Site Monitoring Program at two sites--Garvin Brook SW of Minnesota City (S000-828) from 1981 to 2001 and the South Fork Whitewater River site near Utica (S000-288) from 1974 to 1994.

The MPCA milestone site near Utica on the South Fork of the Whitewater River shows a decreasing trend in both TSS and biochemical oxygen demand (BOD). The overall trend at the milestone site of Garvin Brook SW of Minnesota City also shows a decrease in concentrations of TSS, total phosphorus (TP) and BOD. The USGS site on the North Fork of the Whitewater River near Elba (05376000) does not show a trend for SSC, however, the period of record ended in 1993 (Table 2).

Additionally, the MPCA manages the Citizen Stream Monitoring Program (CSMP), which encourages citizens to adopt a section of stream and regularly collect transparency readings. In 2011, there were 97 stations that had been monitored in the watershed for stream transparency. Twenty-one of those stations had sufficient data for statistical analysis, however, none of them showed a trend in transparency (MPCA 2011).

### 2.2.3 Trends in nitrate

Nitrate has the largest and most comprehensive period of record of any parameter in the watershed. Concentrations are less dependent on flow than parameters related to suspended sediment, and therefore less monitoring data is needed to reasonably estimate loads (Olmsted County Environmental Services 2012). Nitrate concentrations vary annually by only milligrams per liter (mg/L) at any of the monitoring sites examined by Olmsted County Environmental Services. At low to moderate discharge (base flow), there is a lower variability of nitrate concentrations. Higher variability and lower concentrations are seen during high flows

There were six sites with sufficient data for statistical trend analysis. All of the monitoring sites have an increasing trend in nitrate concentration. The percent increase in nitrate concentrations is similar at all of the sites in the MRWW. For example, the nitrate concentration at the South Fork Whitewater River near Utica (S000-288) has increased from 4.2 to 11 mg/L from 1974-2011 and the site on North Fork Whitewater River near Elba (S000-451) has increased from <1 mg/L to 6 mg/L from 1967 to 2010.

### 2.2.3.1 Nitrate concentration vs. Landcover

The MPCA has identified a strong correlation between nitrate concentrations and percent of row crop acres in watersheds in southeastern Minnesota (MPCA 2010). About 30 of the 100 sites used in the MPCA study were in the MRWW. The MPCA correlation indicates that a watershed with a landcover of approximately 60% corn and soybeans results in an average concentration of 10 mg/L nitrate in the stream discharge. The current MDH drinking water standard for nitrate is 10 mg/L.

Fifteen monitoring sites in the watershed had adequate nitrate data in 2008 and 2009 to statistically analyze the correlation between nitrate concentration and landcover. The 2009 National Agriculture Statistics Service (NASS) land cover was used to identify the percent of cropland in each of the 12 sub-watersheds (HUC12) that contained active monitoring locations during the 2008 and 2009 period. A high degree of correlation ($R^2$=0.51) was found between nitrate concentration and percent cropland (Appendix E). There is a correlation between stream nitrate concentrations and the percent drainage area in corn and soybean acres in the MRWW (HUC12s) (Figure 12).

Nitrate concentrations were slightly higher when analyzed by Olmsted County than the correlation found by Watkins, et al. This may be due to the focus on trout streams by Watkins, which receive larger contributions from deeper aquifers.

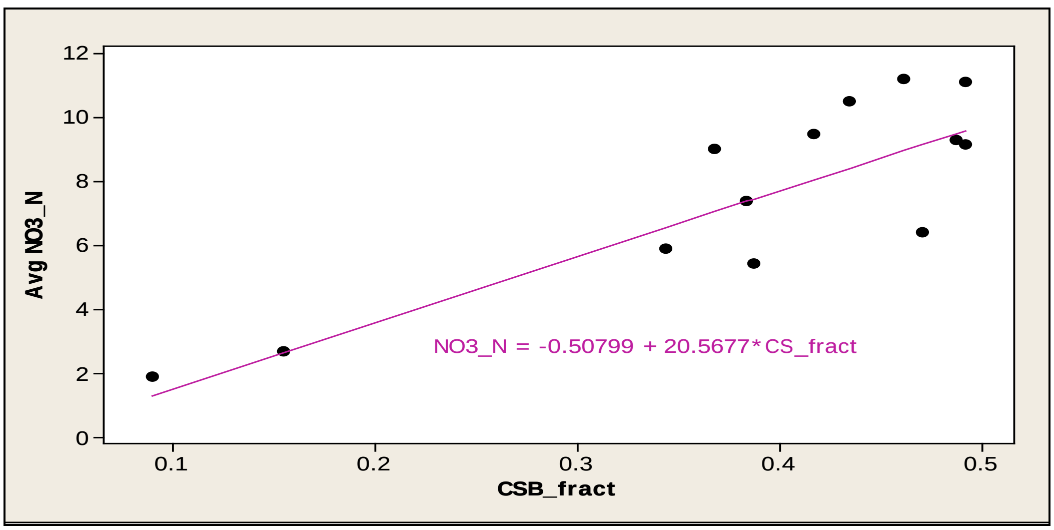



**Figure 12. Stream nitrate vs. percent drainage area in corn and soybeans. Data derived from 15 sites within the MRWW.**

Subwatersheds with higher than predicted (using the greater than 60% corn/soybean landcover relationship) stream nitrate levels include Logan Creek, Middle Fork Whitewater River north of St. Charles, and the South Fork Whitewater River sites near Utica, Altura, and Dover. These sites tend to be in the upper reaches of the watershed where there is a greater percent cropland and where groundwater contributing to streams is from shallower aquifers with higher nitrate concentrations. Sites in the lower watershed such as the North Fork Whitewater River near Elba have lower than predicted nitrate. The streams in these subwatersheds are cut into deeper bedrock layers and receive groundwater from deeper, more naturally protected aquifers.

To test the reliability of the nitrate prediction, 17 of the HUC12s in the MRWW were sampled in the winter when only baseflow should have been present (December 12, 2012). Sampling was performed at the point in which the stream discharges from the watershed into the Mississippi River. A strong correlation was found between nitrate concentration and percentage of cropland. This analysis suggests that a watershed containing 100% cropland would be expected to have a stream nitrate concentration at the stream pour point of approximately 20-30 mg/L. This concentration is comparable to that found in tile drainage under corn and soybean rotation by the University of Minnesota in southeastern Minnesota (Randall and Vetch 2010). Under current cropping practices, the tile drainage studies suggest that 20 mg/L could be approximately the maximum nitrate concentration that will be found in streams in agricultural watersheds. It also suggests that the increasing nitrate trends in MRWW streams may soon begin to level off (Olmsted County Environmental Services 2012).

### *2.2.3.2 Spatial Trends in Nitrate-N Concentrations*

The eastern streams of the MRWW that discharge directly to the Mississippi River show the lowest nitrate concentrations (Figure 13), and also the highest concentration of fully supporting aquatic life waters (Figure 10). Moving west across the watershed, the nitrate levels increase.

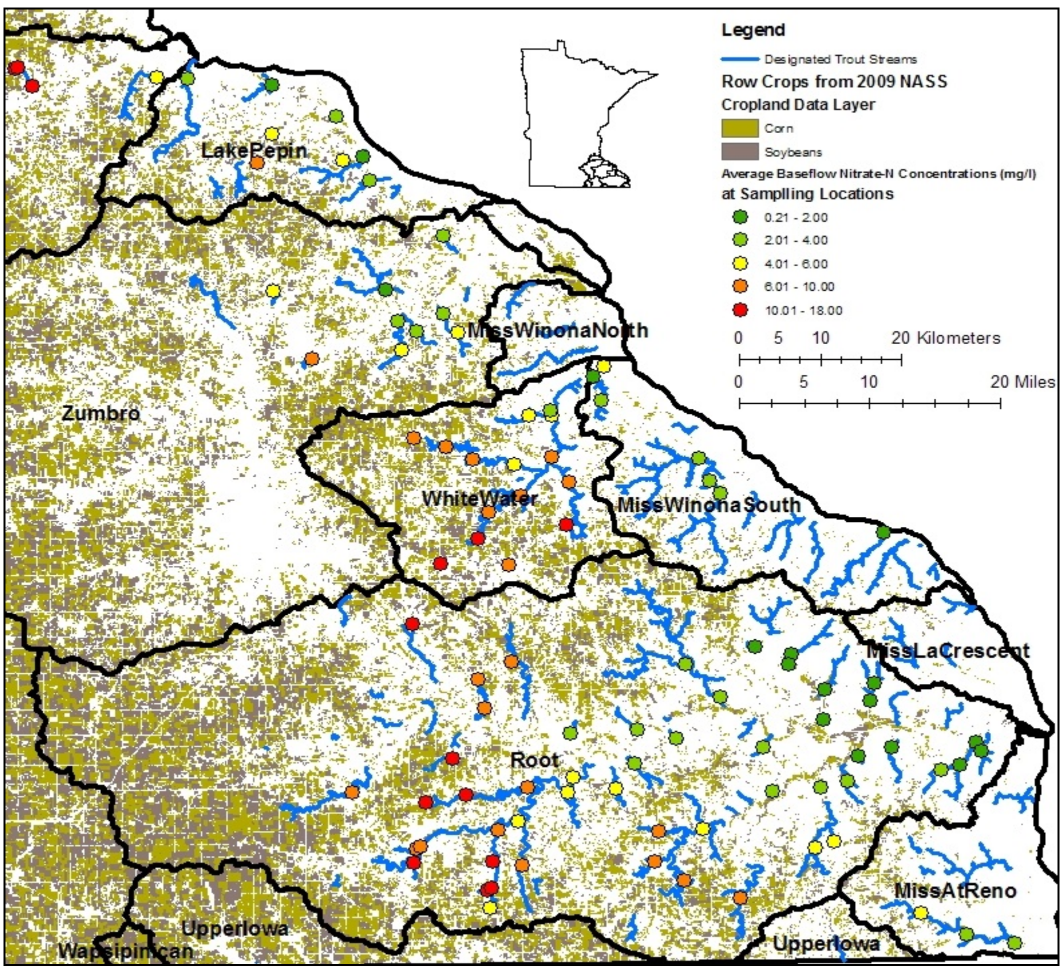



**Figure 13. Nitrate-N concentrations at various sampling locations on designated trout streams in southeast Minnesota, with green showing the lowest values, yellow showing mid values, and red showing high values above the state water quality standard of 10 mg/L (Watkins et al. 2013).**

### 2.2.4 Trends in Chloride

Water softener salt (NaCl), road salt (NaCl), and potassium chloride (KCl) fertilizer account for nearly all of the chloride used in Olmsted County (Wilson 2008). The relative contribution to stream chloride concentrations by these three sources were all of similar proportions but were found to vary by land use and season. The same is likely true for the MRWW area outside of Olmsted County.

The only sites with a significant period of chloride data are the MPCA Milestone Monitoring Program sites on the South Fork Whitewater River near Utica (S000-288) and Garvin Brook SW of Minnesota City (S000-828), the USGS monitoring site on the North Fork Whitewater River near Elba (05376000 of S000-451), and the Long Term Research Monitoring Station on the Whitewater River near Weaver on Highway 61 (LTRMP). Each site shows an increasing trend in chloride. Since the early 1980s, chloride levels have increased at the Garvin Brook Milestone site (S000-828) by about 0.2 mg/L per year and at the Utica site (S000-288) by about 0.7 mg/L per year. The Elba site was monitored by the USGS from 1967 through 1993, by Olmsted County in 1999 through 2002 and again in 2008 (S007-144). Chloride has increased at this site from 1 mg/L in the 1960s to about 20 mg/L in 2010. The chloride concentrations appear to be leveling off at this site (Table 2).

**Table 2. Long-term water quality trends in MRWW. Key: Red = degrading; green =improving; gray = no trend; blank = insufficient data.**

| Location | Whitewater R. near Beaver | South Fork near Altura | North Fork near Elba | Garvin Brook near Minnesota City | Middle Branch north of St. Charles | South Fork near Utica | Whitewater R. at Weaver (Hwy 61) |
|---|---|---|---|---|---|---|---|
| **Site ID** | 5376800 | 5376500 /S000-321 | 5376000/ S000451 | 5378235/S 000-828 | S001-831 | S000-288 | LTRMP |
| **Annual Discharge** | Red | Gray | Gray | Gray | | | |
| **Suspended Sediment** | | | Gray | | | | |
| **Total suspended solids** | | | | Green | | Green | |
| **Total phosphorus** | | | | Green | | Gray | |
| **Ammonia** | | | | Green | | Green | |
| **Biological Oxygen Demand** | | | | Green | | Green | |
| **Nitrate** | | Red | Red | Red | Red | Red | Red |
| **Chloride** | | | Red | Red | | Red | Red |
| **Sodium** | | | Red | | | | Red |
| **Sulfate** | | | Green | Gray | | Green | |

## 2.3 Pollutant/Stressors and Sources

In order to develop appropriate strategies for restoring or protecting waterbodies, the stressors and/or sources impacting or threatening them must be identified and evaluated. Biological SID is done for streams with either fish or macroinvertebrate biota impairments and encompasses both evaluation of pollutants and non-pollutant related factors as potential stressors (e.g., altered hydrology, fish passage, habitat). Pollutant source assessments are completed where a biological SID process identifies a pollutant as a stressor as well as for the conventional pollutant impairment listings.

**Stressors of Biologically-Impaired Stream Reaches**

The MPCA has increased the use of biological monitoring and assessment as a means to determine and report the condition of the state's streams. This approach centers on examination of fish and aquatic macroinvertebrate communities and related habitat conditions at multiple sites throughout a major watershed. From these data, an IBI score can be developed, which provides a measure of overall community health. In cases of aquatic life use impairment, stressors to the aquatic community must be identified in order to translate the problem from an integrative measure(s) to causal factors. This is accomplished by further examining streams (via both field work and desktop work) that show low IBI values for fish and bugs, with a focus on linking the biotic communities to probable stressors. For example, if a macroinvertebrate community sampled in a given stream reach is composed primarily of nitrate-tolerant species and the stream shows high nitrate values in baseflow a likely conclusion is that nitrate is a stressor to the invertebrate biota.

In the MRWW, 10 of 17 stream reaches with impaired aquatic life made use of biota data for assessment and were further investigated via the SID process. An additional two stream reaches (Beaver Creek and Big Trout Creek) with imminent impairments were analyzed through the SID process in anticipation that they will be listed on the 2016 list due to further information being collected.

The probable causes of aquatic life stress in the MRWW were determined by the MPCA to be: DO, temperature, nitrate, TSS, physical habitat and physical connectivity (e.g., dams or culverts blocking fish migration) (MPCA 2015) (Table 3). Pollutant stressors are addressed with TMDL calculations while non-pollutant stressors are not subject to load quantification (i.e. TMDL).

**Table 3. Stressors to aquatic life; pollutant and non-pollutant categories.**

| Pollutant Stressors (number of occurrences) | Non-pollutant stressors (number of occurrences) |
|---|---|
| dissolved oxygen (3); nitrate (7); TSS (5); temperature (2) | Physical habitat (10); physical connectivity (1) |

**Pollutant Sources**

In general, there are two forms of pollutant sources to a waterbody: non-point (non-permitted) sources and point (permitted) sources. While both point and non-point sources contribute to impairments in the MRWW, the non-point sources dominate most areas due to the low amount of developed/urbanized land (Figure 3).

### *Point Sources*

Point sources are permitted, regulated entities that are required to adhere to the language of their permits. Compliance is ensured through state and federal programs. Examples of types of permitted point sources are: There are currently 28 National Pollutant Discharge Elimination System (NPDES) permitted point sources, and one Municipal Separate Storm Sewer System (MS4), in the MRWW (Appendix B). Given that the MRWW is a predominately rural landscape, point sources account for a relatively small component of pollutant loads. However, at lower flows, point sources can play a significant role in pollutant loading and water quality conditions.

#### *Permitted Suspended Sediment, Phosphorus and Bacteria sources*

A majority of municipal permit holders in the MRWW have TSS, TP and bacteria limits set in their permits and industrial permit holders in the MRWW have TSS limits.

For feedlots in the MRWW requiring a State Disposal System (SDS) or NPDES Permit under Minn. R. ch. 7020, the construction, operation and maintenance of the feedlot are regulated under their permit. These permits require zero discharge from the facility and must contain all pollutants except in extreme weather events such as a 25 year, 24-hour rain event. Furthermore, the land application of manure generated at NPDES permitted sites are granted an agricultural stormwater discharge exemption if the facility complies with a nutrient management plan.

The MPCA currently uses the federal definition of a Concentrated Animal Feeding Operation (CAFO) in its regulation of animal feedlots. In Minnesota, the following types of livestock facilities are issued, and must operate under, a NPDES Permit: a) all federally defined CAFOs that have a discharge, some of which are under 1000 Animal Units (AUs) in size; and b) all CAFOs and non-CAFOs which have 1000 or more AUs. A SDS Permit can be issued in lieu of a NPDES Permit if the feedlot has capacity of 1,000 or more AUs and does not discharge to the waters of the United States.

#### *Stormwater (MS4)*

The city of Winona, the watershed’s largest city, is a regulated MS4 stormwater community that discharges to both bays of Lake Winona. MS4 communities are regulated by NPDES Permits. The goal of this permit is to reduce the discharge of pollutants from their storm sewer system to the maximum extent practicable. Both bays of Lake Winona were listed as impaired on the 2014, 303d list. When impaired waters fall within permit boundaries, additional information such as target dates to achieve applicable wasteload allocations (WLAs) needs to be included when the permit is reissued. The Winona MS4 was given a WLA for phosphorus in the recent MRWW TMDL Report because that is the impairment parameter (MPCA draft 2016).

#### *Permitted N Sources*

According to Nitrogen in Minnesota Surface Waters (MPCA 2013), point sources are estimated to contribute 5% of the nitrogen in the Lower Mississippi River Basin (Figure 15). According to the MPCA document titled Minnesota NPDES Wastewater Permit Nitrogen Monitoring Implementation Plan, in order to better document the actual loading from wastewater, the frequency of nitrogen series monitoring requirements in Minnesota’s industrial and municipal wastewater NPDES Permits increased, beginning with permits issued in 2014. This was done in order to develop a more complete understanding of the magnitude and dynamics of nitrogen sources and discharges from wastewater sources. On a statewide scale, it has been determined that a majority of point source nitrogen is from the 10 largest municipal facilities (MPCA 2014b). Only 1 of the 10 large facilities is in the Lower Mississippi River Basin (Rochester Wastewater Treatment Facility (WWTF)), and none are in the MRWW. The WWTFs in the MRWW do not currently have nitrate permit limits, however limits may be set in future permits pending further data collection and analysis. One example is the Whitewater Region WWTF, which discharges to the South Fork of the Whitewater, a stream reach impaired by nitrate.

*Non-Point Sources*

All sources that are not defined as point sources, including runoff from rural areas and small towns, as well as natural sources, are lumped under the category of non-point sources. Non-point sources are potential pollution contributors that are not required to have NPDES permits, such as overland runoff across all acres of the watershed other than MS4s and construction sites. They may be required in some cases to have non-federal, state, or local permits. Typically, their impact is individually incremental but can be significant when considered cumulatively and so they are often identified by being aggregated geographically by location or source type. Below, non-point sources of the main pollutants in the MRWW (sediment, nitrate, bacteria and phosphorus) are discussed.

*Sediment*

Increased erosion and acceleration of sediment transport can frequently be related to land-use changes or poor land management (Castro & Reckendorf, NRCS/OSU). Notable activities are those that increase the sources of nutrients and/or reduce the assimilative capacity of the watershed and may include: removal of established vegetation for agriculture of urban development, especially impervious surfaces (such as roads, roofs and parking lots) that prevent infiltration and cause water to move quickly to streams, water drainage systems (ditches, storm water systems, and agricultural field tiling), and increased flow that changes stream courses, increases erosion and moves chemicals and debris to streams. In Olmsted County, a map showing loss of topsoil illustrates the issue of sediment loss (Figure 14).

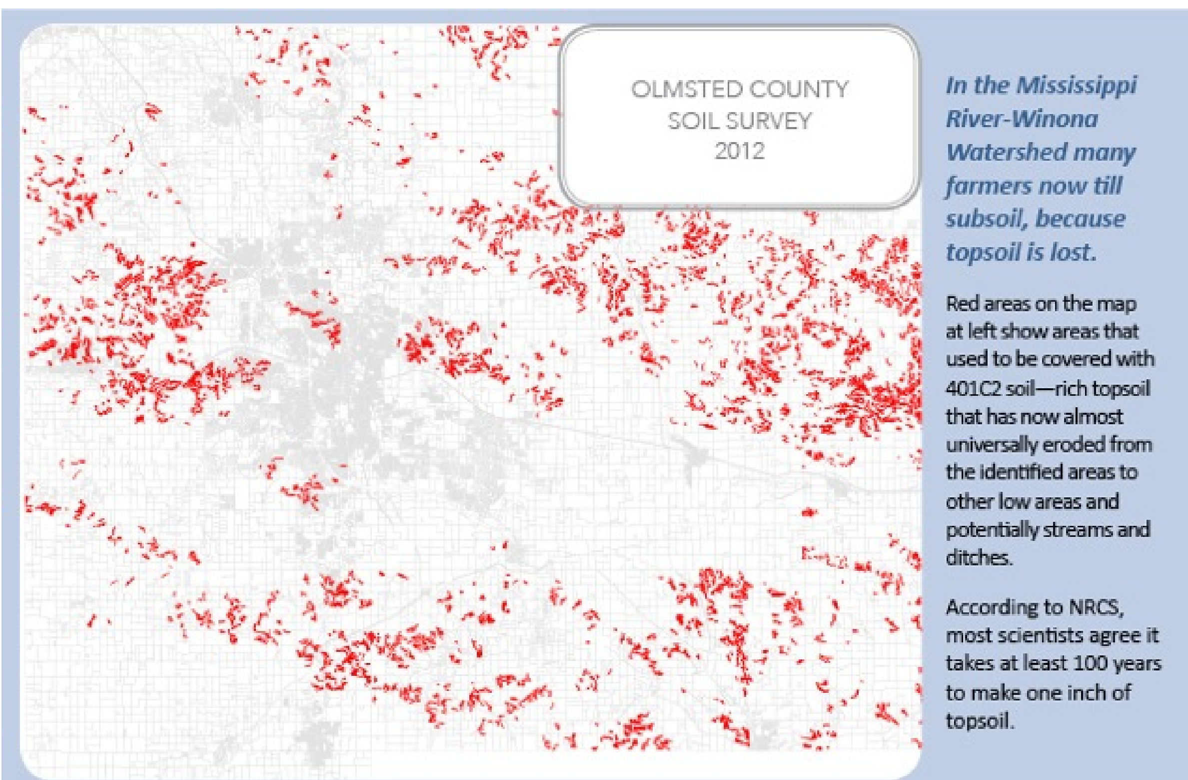



**Figure 14. Olmsted County Soil Survey map showing areas of the county (in red) where fertile topsoil has completely eroded away.**

A recent study by Stout et al. (2014) determined stream sediment sources in the Root River Watershed, which lies directly south of the MRWW and has a similar landscape, especially in the eastern portion. The goals of this study were to (1) understand the erosional and depositional history of the Root River Watershed and the implications for modern erosional processes and (2) identify potential sources and sinks distributed throughout the watershed and constrain contributions from source areas.

The study examined hydrology, geomorphology and other data from the watershed to try and determine the source of sediment. Three major sources were determined: hillslopes, agricultural fields and floodplains. Data indicated that conversion of prairie grasses and forest to agricultural fields have contributed the dominant proportion of sediment over the past 150 years since settlement, but when looking at the river's primary pollutants in today's condition, the majority of suspended sediment in transport today has moved from its origin and experienced storage in, and has recently been displaced from, floodplains and alluvial terraces.

These sources can vary by scale and location in the watershed. For example, at smaller scales, sediment has been dominated by agricultural fields, particularly in the upper parts of the watershed. The study concludes with a note that multiple lines of evidence are crucial to understand a watershed's sediment dynamics and that management and policy decisions can be based on that understanding.

Related work in the Root River watershed was a sediment budget conducted by Belmont et al. (2016). It was concluded that there is a need for targeted implementation of water storage BMPs to address sediment loads by reducing the rate and volume of runoff to the river.

Another source of sediment to the river is its banks. According to recent sediment assessment work in the MRWW conducted by the DNR, erosion rates and sediment yield from the banks of the North Fork and Middle Fork of the watershed and half that of the South Fork. These differences are due to soil type, where the North and Middle Forks are dominated by fine-grained loess and the South Fork is dominated by high sand content and glacial till. The mainstem of the river has approximately three times the sediment yield/foot than the South Fork. Increased bank heights are the main cause of this higher erosion rate. Overall, channel incision, soil parent material and watershed location are some of the important factors driving the differences in stream bank sediment yield between the major forks (Ellefson et al. In Preparation).

**Nitrate**

The major source of nitrate in the MRWW is leaching loss from row crop acres, with wastewater point sources being significant as well. The pathway for this loss is both to groundwater (GW) and to tile drainage. Additional losses from agricultural runoff and point sources such as wastewater can be significant locally and individually provide potential for reduction (MPCA 2014). The MPCA and Minnesota Department of Agriculture (MDA) monitor nitrate in surface waters. The MPCA uses these data to determine if water quality standards are being met.

Concern about N in Minnesota's surface waters has grown in recent decades due to: 1) studies showing toxic effects of nitrate on aquatic life, 2) increasing N concentrations and loads in the Mississippi River, combined with nitrogen's role in causing a large oxygen-depleted zone in the Gulf of Mexico, and 3) the discovery that some Minnesota streams exceed the 10 mg/L standard established to protect potential drinking water sources.

The MDA conducted a separate but concurrent effort in 2015 to revise the state's Nitrogen Fertilizer Management Plan, as required under Minnesota's Ground Water Protection Act (MDA 2015). The plan addresses groundwater protection from nitrate. Yet because groundwater baseflow is an important contributor to surface water nitrate, certain groundwater protection efforts will also benefit surface waters.

Minnesota (MPCA) recently initiated three state-level efforts related to N in surface waters.

1. The MPCA is developing water quality standards to protect aquatic life from the toxic effects of high nitrate concentrations. The standards development effort, which is required under a 2010 Legislative directive, draws upon recent scientific studies that identify the concentrations of nitrate harmful to fish and other aquatic life (MPCA 2013).
2. The Nitrogen in Minnesota Surface Waters study (MPCA 2013) was conducted to better understand the nitrogen conditions in Minnesota's surface waters, along with the sources, pathways, trends and potential ways to reduce nitrogen in waters.
3. In 2014, the state of Minnesota established a state-level Nutrient Reduction Strategy (NRS), with goals to provide key strategies to protect and restore Minnesota waters and to reduce loading of nitrogen and phosphorus to the waters downstream of Minnesota. A critical part of the NRS strategies is for the HUC 8 level watersheds to acknowledge their contribution to downstream nutrient concerns and to develop and apply strategies to local conditions. The MRWW is part of the Mississippi River Basin where water flows to the Gulf of Mexico. Minnesota contributes the sixth highest N load to the Gulf and is 1 of 12 member states serving on the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force. The cumulative N and phosphorus (P) contributions from the Hypoxia Task Force states are largely the cause of a hypoxic (low oxygen) zone in the Gulf of Mexico. This hypoxic zone affects commercial and recreational fishing and the overall health of the Gulf, since fish and other aquatic life cannot survive with low oxygen levels. The NRS sets targets of 20% reduction of nitrogen and 12% reduction of phosphorus from current loading for the HUC 8 watershed to the Mississippi Basin by 2025 and a longer range target of 45% reduction of nitrogen by 2040 (MPCA 2014). The NRS describes a way to sustain economically and socially needed agricultural crops while improving and restoring healthy waters that have acceptable nitrate levels. This can be done utilizing a three-pronged approach: 1) restore living cover by placing perennials on sensitive and marginal land, 2) careful management of tiled land, and 3) efficient used of nutrients where manure is properly valued and commercial fertilizer takes that manure nutrient content into account.

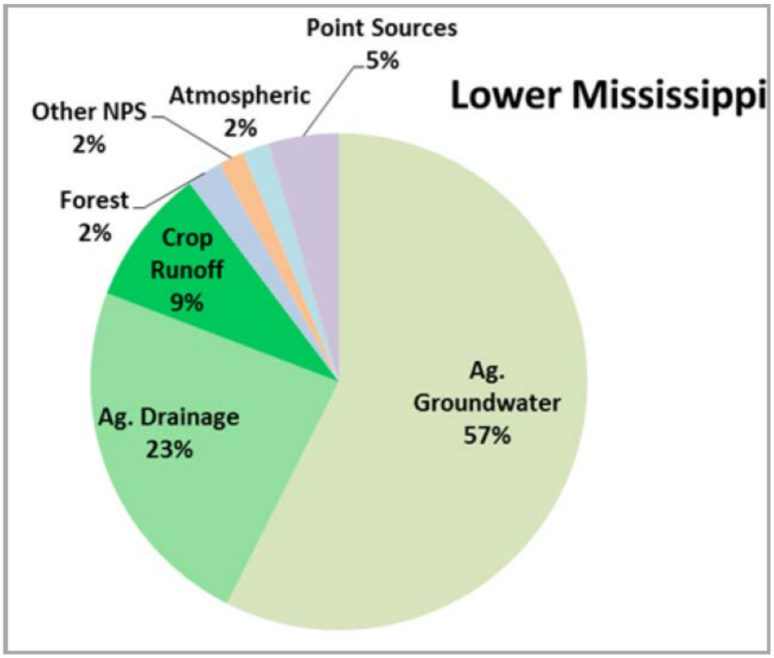



**Figure 15. Estimated nitrogen sources to surface waters from the Minnesota contributing areas of the Lower Mississippi River Basin (average precipitation year) (MPCA 2013). Note: Ag. Refers to agricultural.**

In 2013, the Minnesota Geological Survey (MGS) completed their investigation of why some hydrogeological systems function in a manner whereby changes in base flow nitrate concentrations lag behind by decades with land use practices (Tesoriero et al. 2013). The report, titled Geologic controls on groundwater and surface water flow in southeastern Minnesota and its impact on nitrate concentrations in streams (Runkel et al. 2013) had an overall scope that included the entire bedrock-dominated landscape of southeast Minnesota, with some focus areas in the Root River Watershed, just south of the MRWW. Results therefore support broader MPCA watershed planning to similar geologic setting within the Lower Mississippi River Basin in Minnesota, such as the MRWW.

Two selected conclusions from the report:

1. The most important factor that impacts both the magnitude and variability of nitrate concentration in spring water and stream baseflow is the proportion of regionally sourced, nitrate-poor water contributed from deep aquifers relative to more locally sourced, nitrate-enriched water from shallower aquifers.
2. The relative proportion of these contributions to stream baseflow can commonly be correlated with the hydrogeologic setting.

   “Results from the study have relevance for both surface and groundwater management efforts to mitigate nitrate loading. One implication is that the response time of nitrate concentrations to changes in land use practices will likely vary in different hydrogeologic settings.

   The distribution of nitrate in ground and surface water depicted in the report represents the advance of nitrate from the land surface into the ground and aquifer systems over about 60 years. The accuracy of predictions of future water quality will in part be dependent on an appreciation of the dynamic nature of the transport system. Particularly important is recognition that contaminants will be transported to progressively deeper aquifers and are likely to increase in concentration with time due to a number of natural and anthropogenic factors. Assuming nitrate input from the land surface does not decrease in the future, increased levels of contamination in progressively deeper parts of the groundwater system should be expected." (Pages 59-60)

The most significantly lagged response in southeastern Minnesota should be expected in the deep valleys incised into the Prairie du Chien Plateau, where significant baseflow is derived from deep, siliciclastic-dominated bedrock sources with one or more overlying aquitards.

The report also discussed additional work needed to better influence planning. One example is methods that could be used to predict the impact of changing land use practices on baseflow nitrate concentrations.

**Fecal Bacteria (Fecal coliform and *E. coli*)**

### *Background*

Fecal bacteria are indicators of animal or human fecal matter in waters. Fecal matter impacts the safety of aquatic recreation because contact with fecal material can lead to potentially severe illnesses.

Of the streams that have been assessed, 16 AUIDs in the MRWW have been found to be in exceedance of the standard for fecal bacteria concentration, seven of which were addressed in the Mississippi River-Winona TMDL Report (MPCA draft 2016). The other nine were addressed in the Regional Fecal Coliform TMDL (MPCA 2007). Bacteria issues are widespread across both the MRWW and much of the Lower Mississippi River Basin. A regional TMDL, the same that addressed nine impairments in the MRWW, and an associated implementation plan has been developed and projects are underway to better manage bacteria sources.

The relationship between land use and fecal coliform concentrations found in streams is complex, involving both pollutant transport and rate of survival in different types of aquatic environments. Intensive sampling at numerous sites in southeastern Minnesota shows a strong positive correlation between stream flow, precipitation, and fecal coliform bacteria concentrations. This was discussed in detail in the Revised Regional TMDL Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota (MPCA 2006). Fecal bacteria source identification is difficult due to the dynamic and living attributes of bacteria. Emmons & Olivier Resources (2009) conducted a Literature Summary of Bacteria for the MPCA. The literature review summarized factors that have either a strong or weak positive relationship to fecal bacterial contamination in streams (Table 4).

A study by Sadowsky et al., examined growth and survival of *E. coli* in ditch sediments and water in the Seven Mile Creek Watershed in south central Minnesota; their work concluded that while cattle are likely major contributors to fecal pollution in the sediments of Seven Mile Creek, it is also likely that some *E. coli* strains grow in the sediments and thus some sites probably contain a mixture of newly acquired and resident strains (Sadowsky et al. 2008-2010).

Hydrogeologic features in southeastern Minnesota may favor the survival of fecal coliform bacteria. Cold groundwater, shaded streams, and sinkholes may protect fecal coliform from light, heat, drying, and predation (MPCA 1989). For example, sampling in the South Branch of the Root River Watershed showed concentrations of up to 2,000 organisms/100 ml coming from springs, pointing to a strong connection between surface water and ground water (Fillmore County 1999 and 2000).

| **Strong** relationship to fecal bacterial contamination in water | **Weak** relationship to fecal bacterial contamination in water |
|---|---|
| • High storm flow (the single most important factor in multiple studies)<br>• % rural or agricultural areas greater than % forested areas in the landscape (entire watershed area)<br>• % urban areas greater than % forested riparian areas in the landscape<br>• High water temperature<br>• Higher % impervious surfaces<br>• Livestock present<br>• Suspended solids | • High nutrients<br>• Loss of riparian wetlands<br>• Shallow depth (bacteria decrease with depth)<br>• Amount of sunlight (increased UV-A deactivates bacteria)<br>• Sediment type (higher organic matter, clay content and moisture; finer-grained)<br>• Soil characteristics (higher temperature, nutrients, organic matter content, humidity, moisture and biota; lower pH)<br>• Stream ditching (present or when increased)<br>• Periphyton present<br>• Presence of waterfowl or other wildlife<br>• Conductivity |

**Table 4. Strong and weak relationships of various factors to bacterial contamination of surface water determined through a literature review.**

**Subsurface Sewage Treatment Systems (SSTSs)**

Nonconforming SSTSs are an important source of fecal coliform bacteria, particularly during periods of low precipitation and runoff when this continuous source may dominate fecal coliform loads. Some counties have an ordinance in place for point of sale (POS) compliance or other SSTS ordinances that meet state requirements and provide checks for compliance at various times (Table 5). These ordinances are important for ensuring SSTSs are not contributing to bacterial impairments in the watershed.

Unsewered and/or undersewered communities include older individual systems that are generally failing, and/or collection systems that discharge directly to surface water. This may result in locally high concentrations of wastewater contaminants in surface water, including fecal coliform bacteria, in locations close to population centers where risk of exposure is relatively high. The SSTS program at the MPCA keeps records of estimated non-compliant systems and imminent public health threats (IPTH).

As of 2008, 19 small communities in the watershed were identified as needing wastewater management improvements. These improvements ranged from outdated septic systems to individual and community straight pipe connections to lakes and streams. Since that time, some communities have completed necessary improvements (e.g. Minnesota City, Rollingstone Township, Marysvale).

| County | Point of Sale | Conventional |
|---|---|---|
| Olmsted | No | In Progress |
| Wabasha | No | Yes |
| Winona | Yes | Yes |

**Table 4. Summary of SSTS ordinance status as of 2014 in the three counties in the MRWW. Conventional implies the county is meeting state rule minimums.**

### Livestock Facilities and Manure Application

CAFOs with a NPDES Permit are considered point sources and are held to the limits of their permit language. However, the vast majority of livestock facilities in the Lower Mississippi River Basin in Minnesota and the MRWW are not CAFOs. Nevertheless, they are subject to state feedlot rules which include provisions for registration, inspection, permitting, and upgrading. Under usual circumstances in Minnesota, much of this work is accomplished through delegation of authority from the state to county government. However, both Olmsted and Wabasha counties are not delegated so this work is accomplished by the MPCA staff.

There are 730 MPCA registered feedlots in the MRWW. The approximate total AUs on those feedlots in the MRWW Watershed is 94,241 (according to the MPCA's Delta and GIS database at the time of this report). Just over 10% of those AUs are dairy cattle located on eight NPDES/SDS permitted facilities that are CAFOs (10,939 AUs), while the remaining 90% are located on smaller feedlots. The AUs across all feedlots in the MRWW are: bovines (86%), pigs (7%) and poultry (6%). The other categories making up the final 1% are horses, goats/sheep, deer/elk and llamas/alpacas.

Many feedlots (179 in the MRWW) have liquid manure storage areas (LMSA), which though regulated in Minn. R. ch. 7020 to limit seepage and impacts to ground water, can still be a source of bacteria if not in proper condition or if a failure were to occur (Figure 16). There are 82 dairy facilities that do not have LMSAs meaning they have daily scrape and haul type systems that apply manure year round, in all types of weather. This type of system can contribute to bacteria loads in streams if manure is not applied properly at the right time, in the proper amounts and incorporated into the soil soon after application.

Of the smaller feedlot facilities, 90% are less than 300 AUs and not required to have a manure management plan or required to test their soils for P content. Manure application records are not required to be kept on facilities that are under 100 AUs; 58% of the facilities in the MRWW are under 100 AU. Also, according to rule, facilities not containing manure from 100 AUs or more do not have to test their manure for N or P content.

The high percentage of bovines (86% of total AUs) in the MRWW can have impacts on manure management. The significance and timing of manure application depends on whether a facility has manure storage capabilities or not. For facilities that have storage:

- Application of a majority of manure tends to occur when corn silage comes off and/or on alfalfa fields are being plowed down. These applications occur late winter/early spring.

- There is a need to wait until the ground is dry enough to support tractors/tankers without getting stuck before they can empty the pits in the spring. This is weather/field condition dependent.
- Producers with limited storage (i.e. three to four months) tend to empty or partially empty pits in the late winter/early spring while the ground is still frozen. These applications tend to have a higher potential for runoff.

For facilities without storage, they are applying throughout the year including late winter/early spring. However, application involves manure produced on a daily/weekly basis and typically entire fields are not covered all at one time. Most years there is probably a 1 to 1.5 month late winter/early spring period that has a higher potential for runoff. Those facilities without storage are only applying about 8% to 13% of their manure during this time when runoff potential is at its highest.

Another item to note is that this manure is applied to get N concentrations to a desired level. Since the N:P ratio of manure is skewed towards P, this means excessive P is being applied.

There are 61 facilities located within shoreland area (within 1,000 feet of lake or 300 feet of stream) and of those, 58 have open lots. Of the 58 facilities that have open lots, 19 still have active Open Lot Agreements (OLA) which indicates they have a high potential to discharge. This paired with their location in shoreland leads to a very high probability that they are discharging to surface water. Outside of shoreland there are another 207 facilities with OLAs. Correcting these 226 OLA sites is an important strategy in addressing bacteria issues in the MRWW.

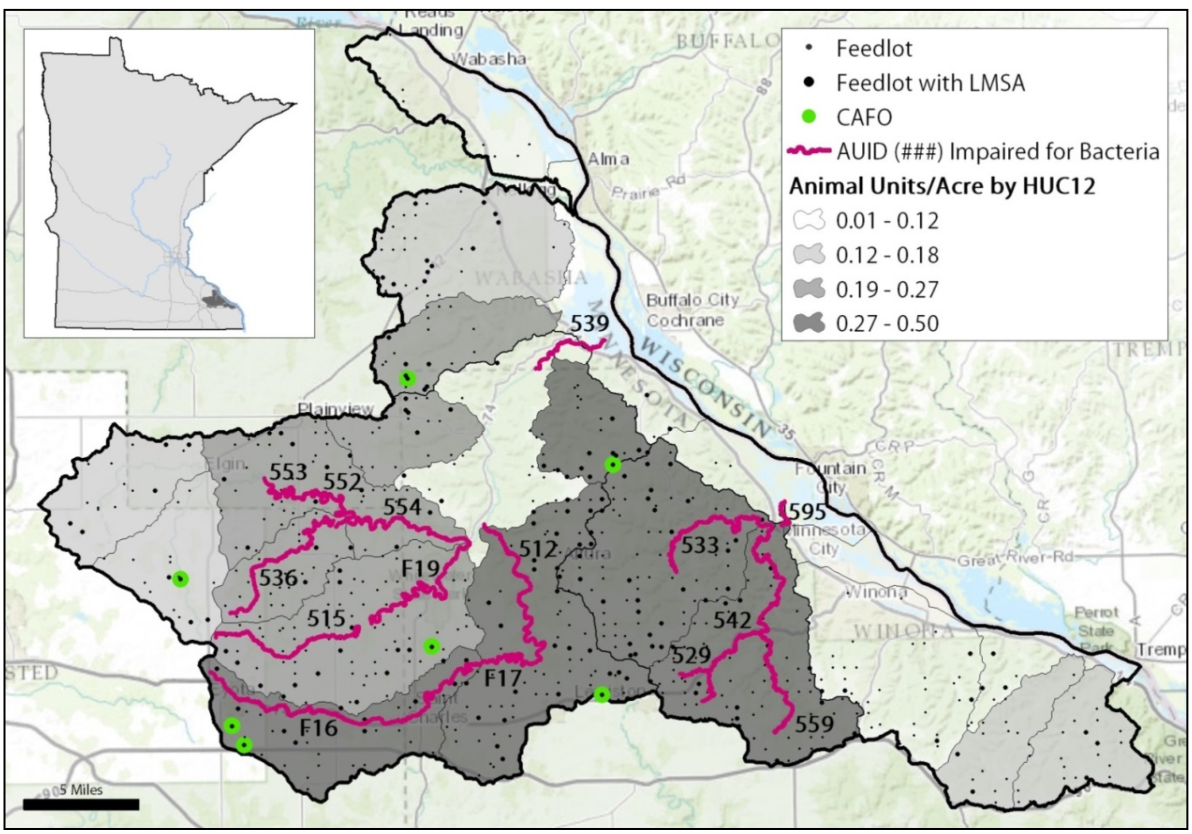



**Figure 16. Locations of stream reaches impaired for bacteria, feedlot and CAFO locations, and animal units per acre in the MRWW.**

**Phosphorus**

Under normal water flow conditions, roughly two-thirds of the total phosphorus load to state waters comes from non-point sources. The main sources of non-point phosphorus include:

- Agricultural runoff (cropland and pasture)
- Non-agricultural runoff
- Streambank erosion
- Urban runoff
- Roadway and sidewalk deicing chemicals
- Un/under sewered communities
- Atmospheric deposition

Ratios of how much these sources contribute to total loading of a stream depend on flow conditions. In the Lower Mississippi River Basin, where the MRWW is situated, streambank erosion and agricultural runoff have been found to be the highest sources of phosphorus loading. One other important note is that minor, basin-wide sources may be significant at a localized scale (BARR 2004).

**Climate Change**

A regional climate model for the Upper Mississippi River (UMR) basin (Jha et al. 2004) predicts a 51% increase in surface runoff and a 43% increase in groundwater recharge on an annual basis by the 2040's. This is mostly attributed to more intense rainfall events during summer onto soils that are at or near saturation. These potential changes in the hydrology of the UMR basin, including the MRWW, would have significant impacts on, and our current strategies to, protect and restore water quality.

## 2.4 TMDL Summary

The MRWW TMDL report was put on public notice in 2015 and received final approval by the EPA in July of 2016. It addressed 25 impairments on 19 waterbodies (2 lakes and 17 stream reaches/AUIDs) (Table 6). Lake and stream allocations and reductions needed to meet standards were developed in that TMDL report. For more detail refer to the TMDL document on the MRWW webpage.

Impairments not caused by pollutants, for example aquatic life use impairment for macroinvertebrate IBI caused by physical habitat, were not addressed through the TMDL process. Loading computations (TMDLs) are not required or appropriate for such impairments. The strategies in Section 3 cover areas with non-TMDL related impairments.

**Table 5. Summary of AUIDs and impaired parameters addressed in the MRWW TMDL Report.**

**Key: ● = conventional pollutant (addressing eutrophication, turbidity, bacteria, or nitrate impairments)**
**○ = identified through the stressor identification process**
**⦿= both conventional pollutant and SID process**

| AUID | Stream or Lake Name | Designated Use Class | *E. coli* | TSS | Nitrate | Phosphorus |
|---|---|---|---|---|---|---|
| 85-0011-01 | Lake Winona (Southeast Bay) | 2B | | | | ● |
| 85-0011-02 | Lake Winona (Northwest Bay) | 2B | | | | ● |
| 07040003-512 | Whitewater River, South Fork | 1B, 2A | | ● | ● | |
| 07040003-515 | Whitewater River, Middle Fork | 2B | ● | | | |
| 07040003-F16 | Whitewater River, South Fork | 2B | | | | |
| 07040003-F17 | Whitewater River, South Fork | 1B, 2A | | ⦿ | ○ | |
| 07040003-F19 | Whitewater River, Middle Fork | 1B, 2A | | ⦿ | ⦿ | |
| 07040003-523 | Whitewater River, North Fork | 1B, 2A | | ● | | |
| 07040003-529 | Peterson Creek | 1B, 2A | ● | | | |
| 07040003-533 | Rollingstone Creek | 1B, 2A | ● | ⦿ | | |
| 07040003-536 | Logan Branch | 2B | | ● | | |
| 07040003-537 | Whitewater River | 1B, 2A | | ● | | |
| 07040003-539 | Whitewater River | 2B | ● | ● | | |
| 07040003-552 | Logan Branch | 1B, 2A | ● | | | |
| 07040003-553 | Whitewater River, North Fork | 1B, 2A | | ● | | |

| AUID | Stream or Lake Name | Designated Use Class | *E. coli* | TSS | Nitrate | Phosphorus |
|---|---|---|---|---|---|---|
| 07040003-554 | Whitewater River, North Fork | 1B, 2A | | ● | | |
| 07040003-559 | Stockton Valley Creek | 1B, 2A | | ● | | |
| 07040003-595 | Garvin Brook | 2B | ● | ● | | |
| 07040003-611 | Crow Spring (Middle Fork Whitewater River Tributary) | 1B, 2A | ● | | ○ | |
| **Total** | | | **7** | **12** | **4** | **2** |

## 2.5 Protection Considerations

Many areas of the MRWW provide high quality habitat for aquatic life. Because of this, protection efforts need to be undertaken alongside restoration efforts in the watershed. Many efforts to restore areas of the watershed will also protect nearby areas and a variety of BMPs can be used in both instances. While areas in need of protection were determined through a prioritization process in Section 3 of this report, this section is meant to provide further information that can inform protection related activities.

**Biological Assessment**

During assessment in 2013, 11 AUIDs were found to be fully supporting for aquatic life in the MRWW. IBI scores on monitoring locations for those AUIDs were examined to determine where the best scores, those where the IBI scores were 30 to 39 points higher than the threshold, and the good scores, those where the IBI scores were 22 to 29 points higher than the threshold, were located (Figure 17).

**Mississippi River-Winona Landscape Stewardship Plan**

In 2015, the Minnesota Forest Resources Council (MFRC) directed an effort to complete a Landscape Stewardship Plan (LSP) for the MRWW. This collaborative effort involved a planning team consisting of state agency, federal agency, university and non-profit group staff. The plan was written at the same time that this WRAPS document was being drafted. While the focuses of the two documents were not identical, they shared several key goals and helped inform each other. Some data developed in the WRAPS process was used in the LSP formation and Conservation Opportunity Area (COA) selection process, and portions of the LSP are appropriate to use for protection strategies in the WRAPS.

Three COAs were identified as part of the LSP process. These areas were identified as where conservation efforts can have the greatest impact protecting habitat and water quality. They "have not been seriously degraded or developed and support quality natural communities and habitat, but lack much long term protection or management planning." (MFRC 2015) Habitat quality and risk level were the categories analyzed in determining COA locations. For habitat quality, biodiversity significance rankings, as well as Environmental Benefits Index (EBI) habitat quality and parcel density based on county parcel maps were considered. For risk level, public/private land ownership, road density, EBI water quality risk index and EBI soil erosion risk index was considered. GIS software was used to calculate scores from all of the habitat and risk layers across the MRWW and then the three COAs were identified.

Weaver, Beaver and city of Winona are the names of the three COAs. The Weaver COA covers 54,015 acres, the Beaver COA covers 83,171 acres, and the city of Winona COA, covers 67,217 acres (Figure 17). These three COAs represent places of emphasis for the conservation actions outlined in the LSP.

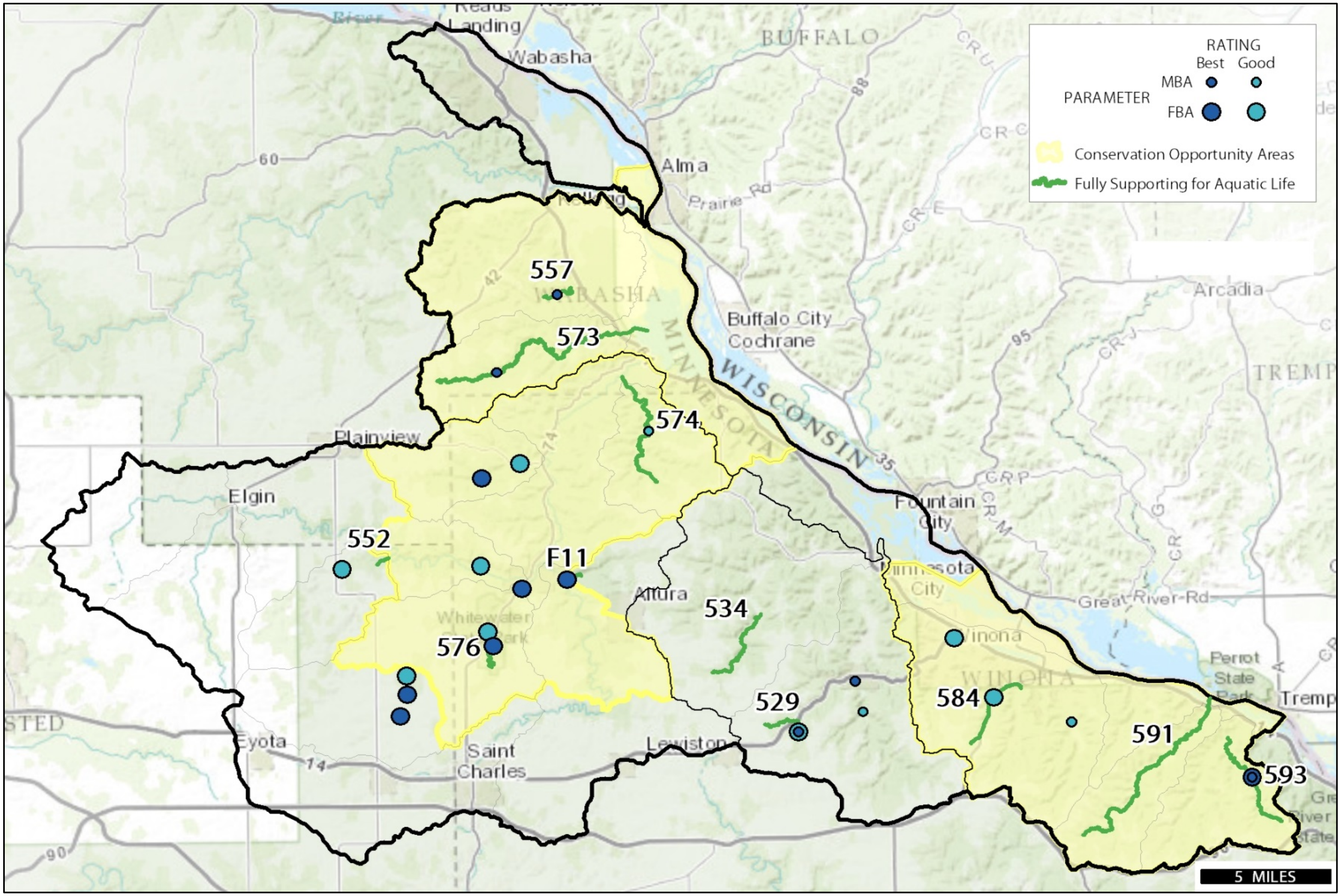



**Figure 17. Areas in the MRWW with high biodiversity and full-support for aquatic life use. River reaches in green are those assessed as fully supporting for aquatic life (last three digits of AUID number are also shown). Macroinvertebrate and fishes IBI scores shown as distance from community impairment threshold, where dark blue indicates areas where IBI scores were the best (30-36 points above threshold), and light blue indicates where IBI scores were good (22-29 points above the threshold). Conservation Opportunity Areas (indicated in yellow) from the Mississippi River-Winona Landscape Stewardship Plan were included to show any overlap**

# 3. Prioritizing and implementing Restoration and Protection

The Clean Water Legacy Act (CWLA) requires that WRAPS reports summarize priority areas for targeting actions to improve water quality, identify point sources and identify nonpoint sources of pollution with sufficient specificity to prioritize and geographically locate watershed restoration and protection actions. In addition, the CWLA requires including an implementation table of strategies and actions that are capable of cumulatively achieving needed pollution load reductions for point and nonpoint sources.

This section of the report provides the results of such prioritization and strategy development. Because many of the nonpoint source strategies outlined in this section rely on voluntary implementation by landowners, land users and residents of the watershed it is imperative to create trust, networks, and positive relationships with those who will voluntarily implement BMPs. Thus, effective ongoing civic engagement plays a significant role in the overall plan for moving forward.

The implementation strategies, including associated scales of adoption and timelines, are based on what is likely needed to meet the water quality goals for restoration and protection. Those strategies provided in this section are the result of previous watershed reports completed in the watershed approach context, watershed modeling efforts and professional judgment based on what is known at this time and, thus, should be considered approximate. Furthermore, many strategies are predicated on building social readiness and sufficient resource support including needed funding being secured. As such, the proposed actions outlined are subject to adaptive management—an iterative approach of implementation, evaluation and course correction.

Strategies presented here will be integrated into local plans, and a comprehensive watershed management plan (“One Watershed, One Plan”), to direct actions and obtain funding. The goal is waters that meet standards for aquatic life, recreation, drinking, industry, agriculture, and aesthetic enjoyment.

## 3.1 Targeting Geographic Areas

The primary purpose of this section, and the statutory language on which it is based, is to identify priority or critical areas for implementation. This section describes the selected tools, illustrates overall results/output and explains how the tools can be used over time.

**SWAT Model**

Hydrologic models were used to support decision-making for sediment and nutrient reduction strategies in the Mississippi-Winona Basin. SWAT (Soil and Water Assessment Tool) models were developed for this purpose for the Whitewater watershed and as a combined model for the Garvin Brook and Rollingstone watersheds within the Mississippi-Winona. The following describes calibration and results of these models.

The Whitewater (WW) and Garvin Brook/Rollingstone (GAR) Watersheds were subdivided into 135 and 61 subwatersheds respectively. The GAR model includes both the Garvin Brook and Rollingstone Creek streams. Each of these subwatersheds is characterized by a distinct collection of land use, soil properties, landscape scope, and proximity to meteorological stations (used by the model for hydrologic calibration). Landscape data was compiled from multiple federal, state, and local organizations including the Whitewater Farmer-led Council. Calibration in a model is an important step in model development where model predictions and representations are compared to monitored data. Overall, calibration was considered good for hydrology for both the WW and GAR Watersheds, though some complications in calibration might stem from groundwater loss via karst features and from the inaccurate timing of snowmelt hydrology. Sediment calibration in the Whitewater model was acceptable, but best between the 1975 to 1985 and 2009 to 2010 periods. SWAT loads in the 1993 to 1999 periods were found to be over-predictions. Calibration problems could stem from the likelihood that the 40%/60% split between field and non-field sediment sources, respectively based upon researched observations in similar circumstances in Minnesota (Schottler, *St. Croix Research Station*), would not be consistent over time or spatially across the watershed (Figure 18). Sediment was well calibrated in the GAR model despite issues modeling channel load for low and baseflow conditions (Figure 19). For nitrate, calibration was acceptable but under-predicted in the WW and not able to be separately calibrated in GAR due to insufficient data. Phosphorus was not calibrated, but instead considered a function of sediment.

**Model Scenarios**

Six scenarios were simulated to determine effect of land use change and varying nutrient application strategies on watershed water quality.

1. Grassed Waterways on all crop/pasture/alfalfa land with a Stream Power Index greater than or equal to four.
2. Dredging/restoration of existing ponds to design standard to increase sediment-trapping efficiency.
3. Addition of ponds so average ratio of row-crop area draining to ponds compared to row-crop drainage area is met.
4. Longer crop rotations with the addition of conserving crops in the rotation, that included a six-year rotation of corn/silage/alfalfa (two years each) on current continuous corn crop lands and six-year corn/soybean/alfalfa (two years each) on current corn-soybean rotation croplands.
5. Addition of fall winter rye as cover crops to both corn and corn-soybean croplands.
6. No-till during soybean years in corn-soybean and sweet corn-soybean rotation croplands.

All scenarios were run for the entire landscape and for the top 25% and top 50% most erodible subwatersheds, based on sediment loads that the model produced with existing conditions (Figure 18; Figure 19). For more detail on model calibration, scenario outputs, and model results refer to Appendix C.

The Agricultural Conservation Planning Framework (ACPF) (Tomer et al. 2013) can be used to identify locations in a watershed where landscape changes can positively influence water quality. To do this analysis, ACPF synthesizes multiple geographic data sources to show where landuse changes can be made. In order to determine proper placement of these landuse changes (e.g. BMPs), ACPF can be overlaid with SWAT output. This was conducted in the Middle Fork Whitewater Subwatershed area as a pilot during the WRAPS process (Figure 20). The limited spatial scope of this combined modeling prevented its use in this strategy; however, it will be useful for local action plans. Future, expanded use of this framework in our watershed will help planners more effectively place BMPs and facilitate conversation with landowners. Where the combined analysis was not available, LiDAR was used for: erosion analysis, water storage and flow analysis, siting and design of BMPs, wetland mapping and flood control mapping.

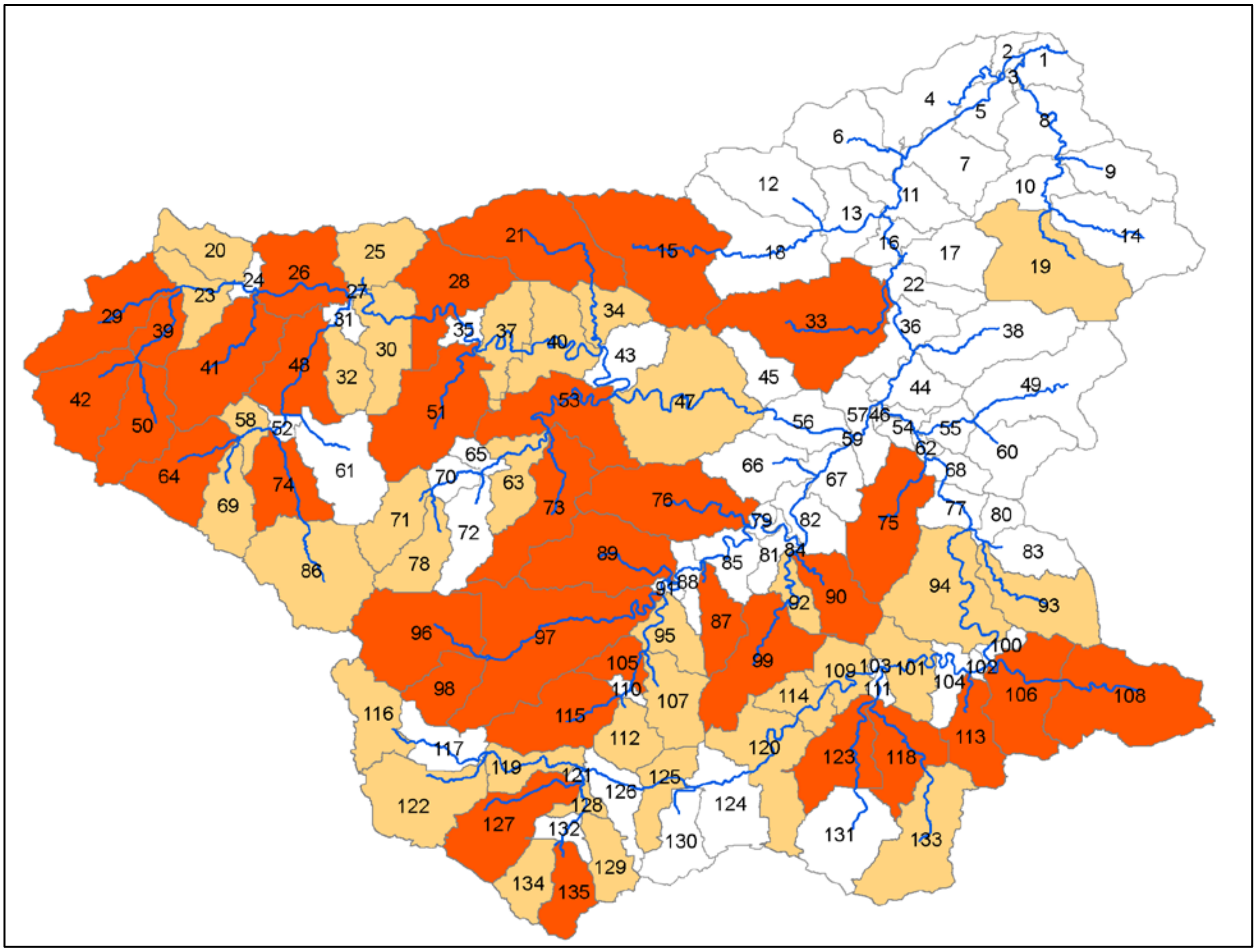



**Figure 18. Whitewater Watershed showing top 25% (dark orange) and 50% (dark + light orange) sediment loading SWAT subwatersheds (by SWAT index number).**

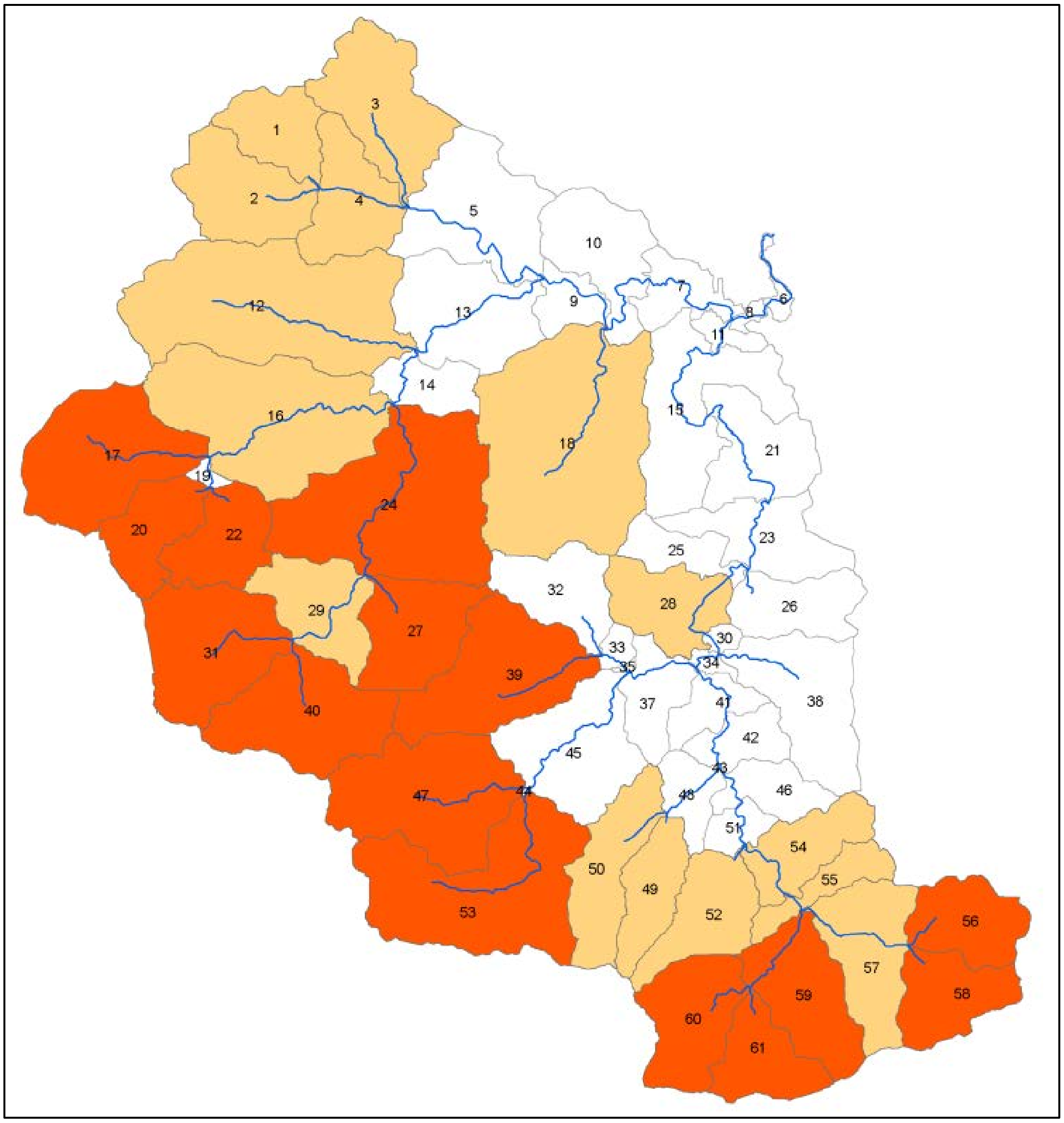



**Figure 19. Garvin Brook/Rollingstone Creek Watershed showing top 25% (dark orange) and 50% (dark + light orange) sediment loading SWAT subwatersheds (by SWAT index number).**

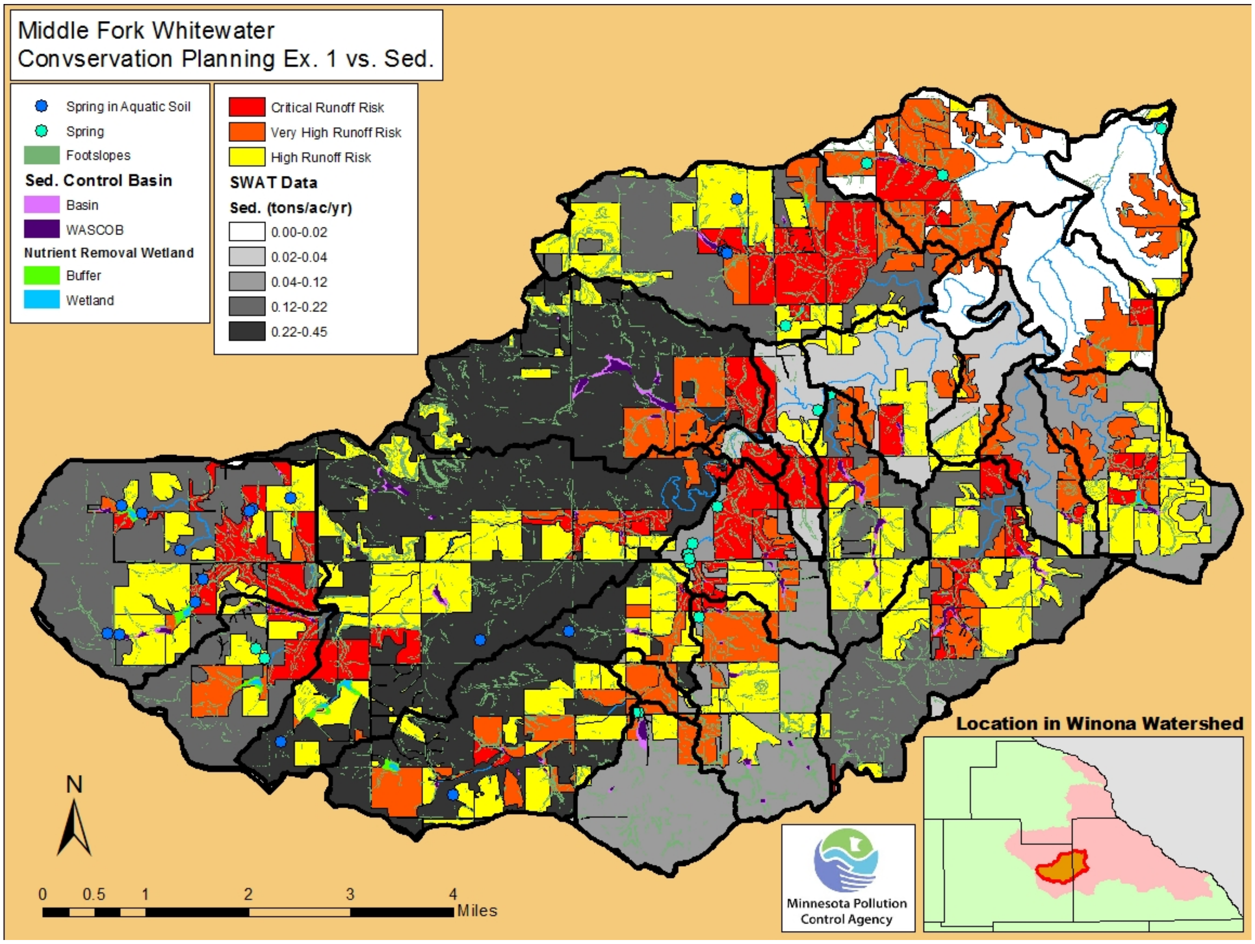



**Figure 20. SWAT model output for sediment loading areas combined with the ACPF information in the Middle Fork Whitewater Subwatershed.**

### Completed Reports/Guidance

- MRWW Monitoring and Assessment Report (MPCA 2012): referenced for assessment information and IBI scores
- MRWW Biotic SID Report (MPCA 2015): referenced for conclusions on stressed biological communities
- Aquatic Biota Stressor and BMP Selection Guide (MPCA 2015): referenced for its table that links common stressors to aquatic biota with BMPs that can positively affect them
- MRWW TMDL Report (MPCA 2016): referenced for calculated load reductions needed at various flow regimes.

### Citizen Input

On-the-ground practices are typically the focus of prioritization for improved water quality, but citizens who attended three MRWW Citizen Summits reminded leaders that water quality impairments are caused by people, and must be remedied by people.

At all three Summits, participants were provided opportunities to listen, speak and be heard in facilitated discussions. Situations for thoughtful strategic input were a major focus at the 2014 Summit, during which 109 recorded comments directed organizers to the top priority “communicate, educate and engage mixed groups of people (from various backgrounds) to act and mentor”. The second priority (69 mentions) was “use best practices on farms and woodlands.” And third priority (36 mentions) was “reduce stormwater in town with strong policy, demonstration areas, and design” (Figure 21). New funding, innovative thinking and action, and deeper collaboration will be necessary to raise the profile of issues, develop relationships, and do the civic engagement work citizens say is important (see more on citizen engagement in Section 3.2).

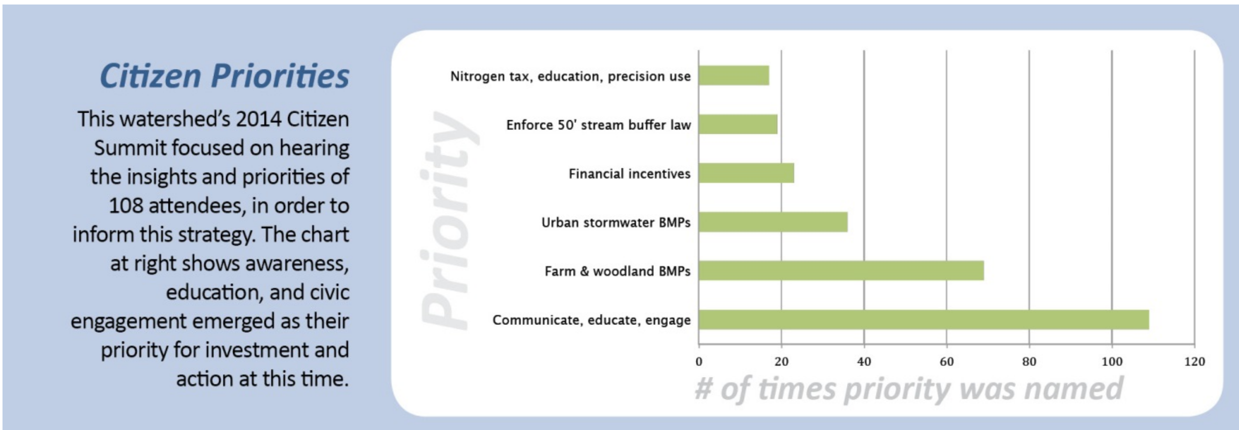



**Figure 21. Citizen input at the Citizen Summit in 2014 showed both awareness of the complexity of the issue, and the urgent need for action.**

### Technical Committee

A technical committee representing diverse agencies and perspectives met to gain understanding of the WRAPS strategy development process, watershed conservation activities, tools for choosing scale of adoption rates, and all of the 2012 to 2014 civic engagement activities and citizen input. Before the meeting, participants completed a weighting exercise that was included in a zonation model, which was reviewed at the meeting. The Technical Committee has reviewed the final zonation document, but results were not used in WRAPS development. There are plans to use them in future planning.

### Prioritization and Critical Areas

Prioritization is based on sources identified previously in this section (using various tools such as models, ACPF, LiDAR, completed reports/guidance, citizen input, technical committee input). Three categories of prioritization were developed:

1. **High Priority Restoration Areas (Critical Areas)**: identified as key contributors to pollutant loads and the presence of stressors in two reports: the MRWW Biotic SID Report (MPCA 2015) and the MRWW Monitoring and Assessment Report (MPCA 2012). These areas may also be areas identified as the top 25% sediment-loading zones by the watershed’s SWAT Report, areas that directly affect a stressor or priority area downstream, or areas defined as a social priority for certain projects, practices or strategies. One notable case where the latter applies is erosion control in the Stockton-Rollingstone-Minnesota City Watershed District (SRMCWD), where structural BMPs are a medium priority for erosion control, but a history of severe flooding creates social demand.
2. **Medium Priority Restoration Areas**: identified as contributors to the pollutant/stressor, but not necessarily the most important in the MRWW Biotic SID Report (MPCA 2015) and the MRWW Monitoring and Assessment Report (MPCA 2012). These areas may also be defined among the top

50% sediment-loading subwatersheds (SWAT) or areas with less of a social concern than in high priority areas.

3. **Low Priority Restoration /Protection Areas**: identified as either a non-contributor to impairments or area of concern, or are areas designated for protection.

Priority/critical areas in the MRWW are based on the identified key issues that need to be addressed:

1. Nutrient management (Figure 22)
2. Fecal coliform reduction (Figure 23)
3. Soil health (Figure 24)
4. Riparian corridor management (Figure 25)
5. Structural impoundment BMPs (Figure 26)
6. Streambank restoration (Figure 27)
7. Stormwater Management (Figure 28)

Each map shows high priority areas in red, where action is most urgent and will make the highest immediate impact; medium priority areas in yellow, where work is needed, but may not produce water quality improvements to the same degree as high priority areas; and low priority areas in green where restoration is of less importance, but protection is needed. With these seven key issues, the watershed's three primary pollutants are addressed: nitrogen, bacteria, and sediment. Though some maps focus on one strategy, such as nutrient management, most practices have overlapping benefits. For example, streambank restoration may be implemented primarily to reduce erosion but can also capture nitrogen in the deep roots of native plants seeded during those projects. One summary map shows the overlap of the individual maps prioritization areas (Figure 29).

These priority categories and set of maps show areas where investment has been determined to create the highest outcomes. General areas are shown, ***not specific BMPs for specific parcels***. Local planners will make those decisions during development of local plans (Local Water Management Plan/One Watershed One Plan, SWCD Annual Plans, etc.).

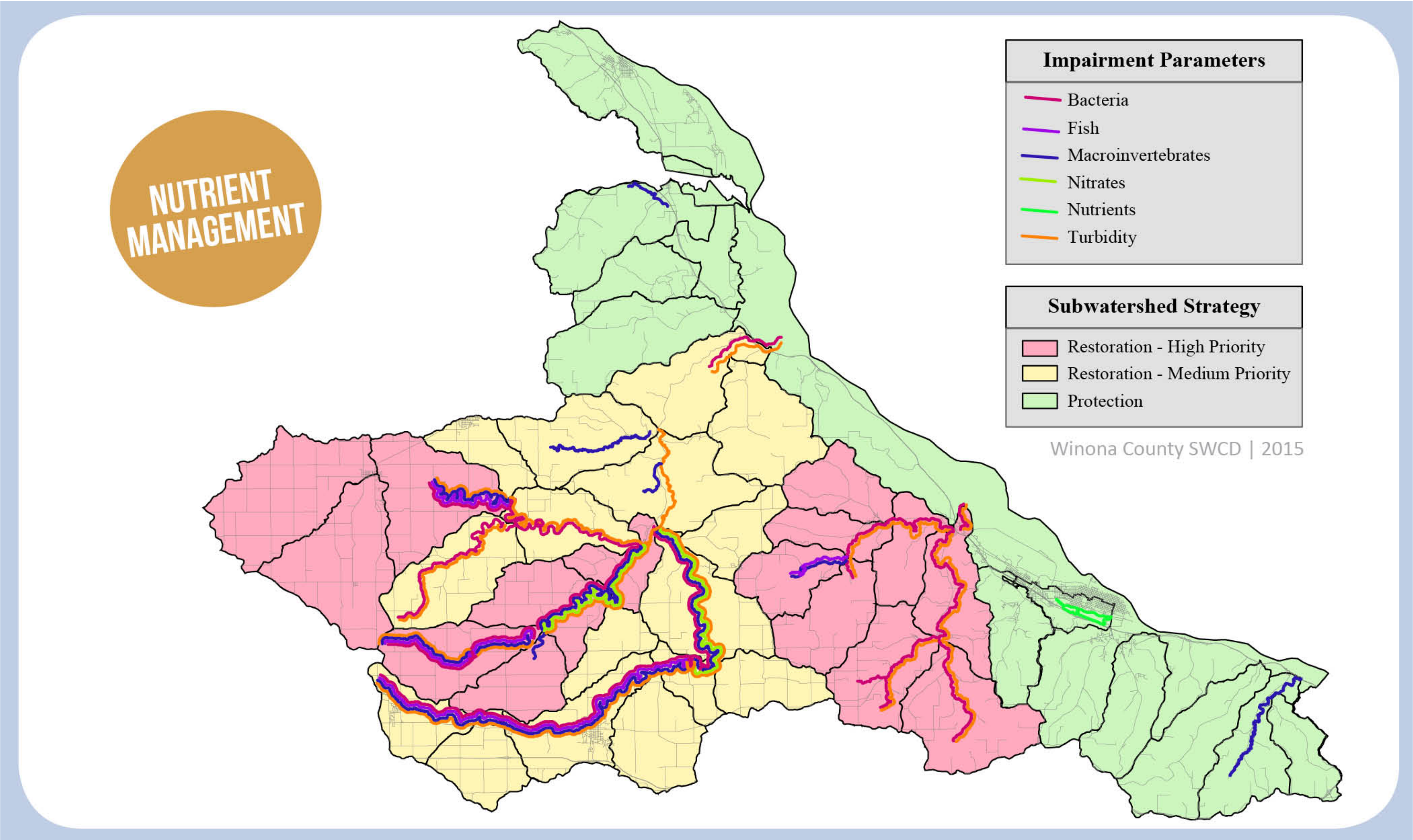



**Figure 22. Priority areas for nutrient management implementation in the MRWW. Delineations show 12HUC boundaries.**

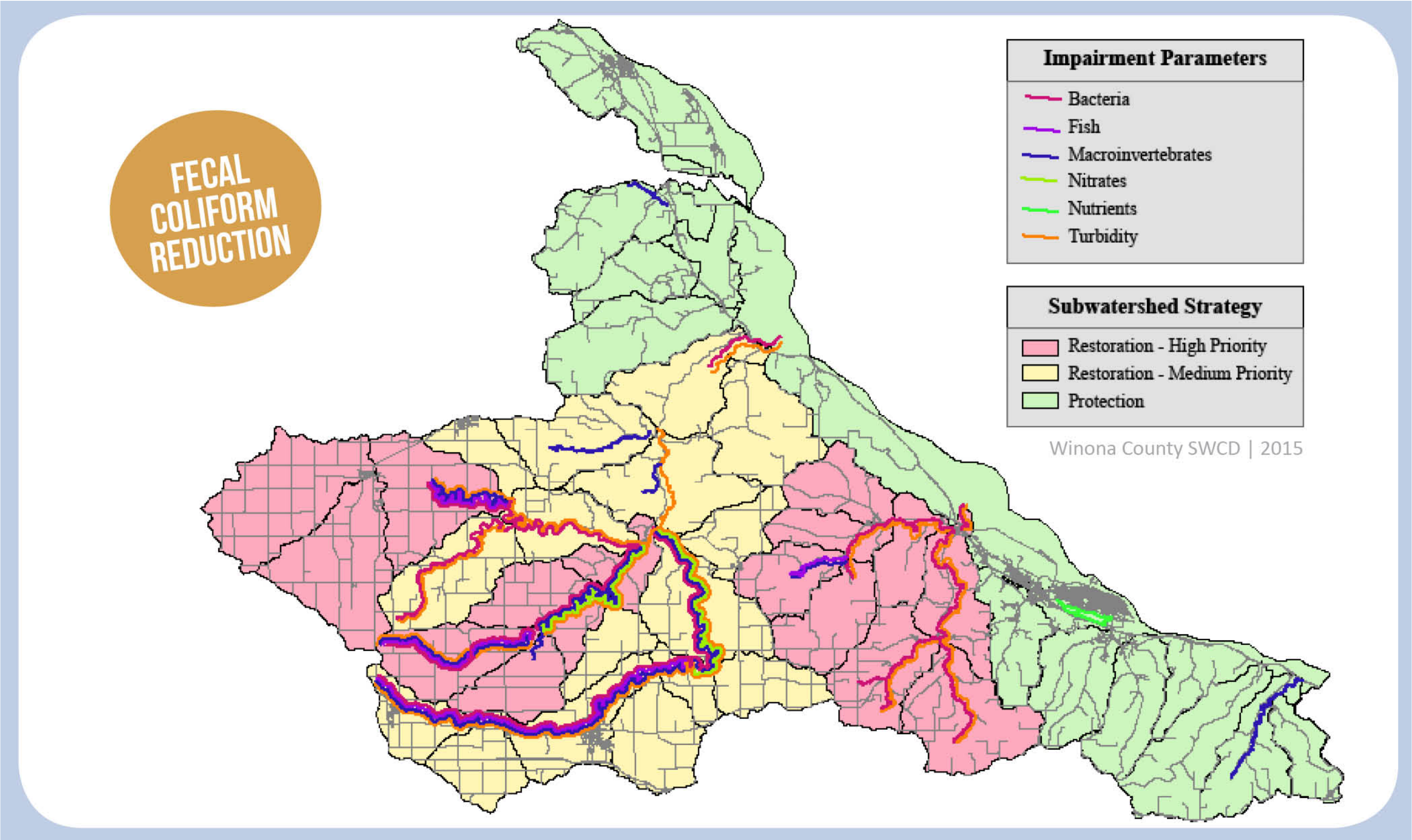



**Figure 23. Priority areas for implementation of BMPs for fecal coliform reduction in the MRWW. Delineations show 12HUC boundaries.**

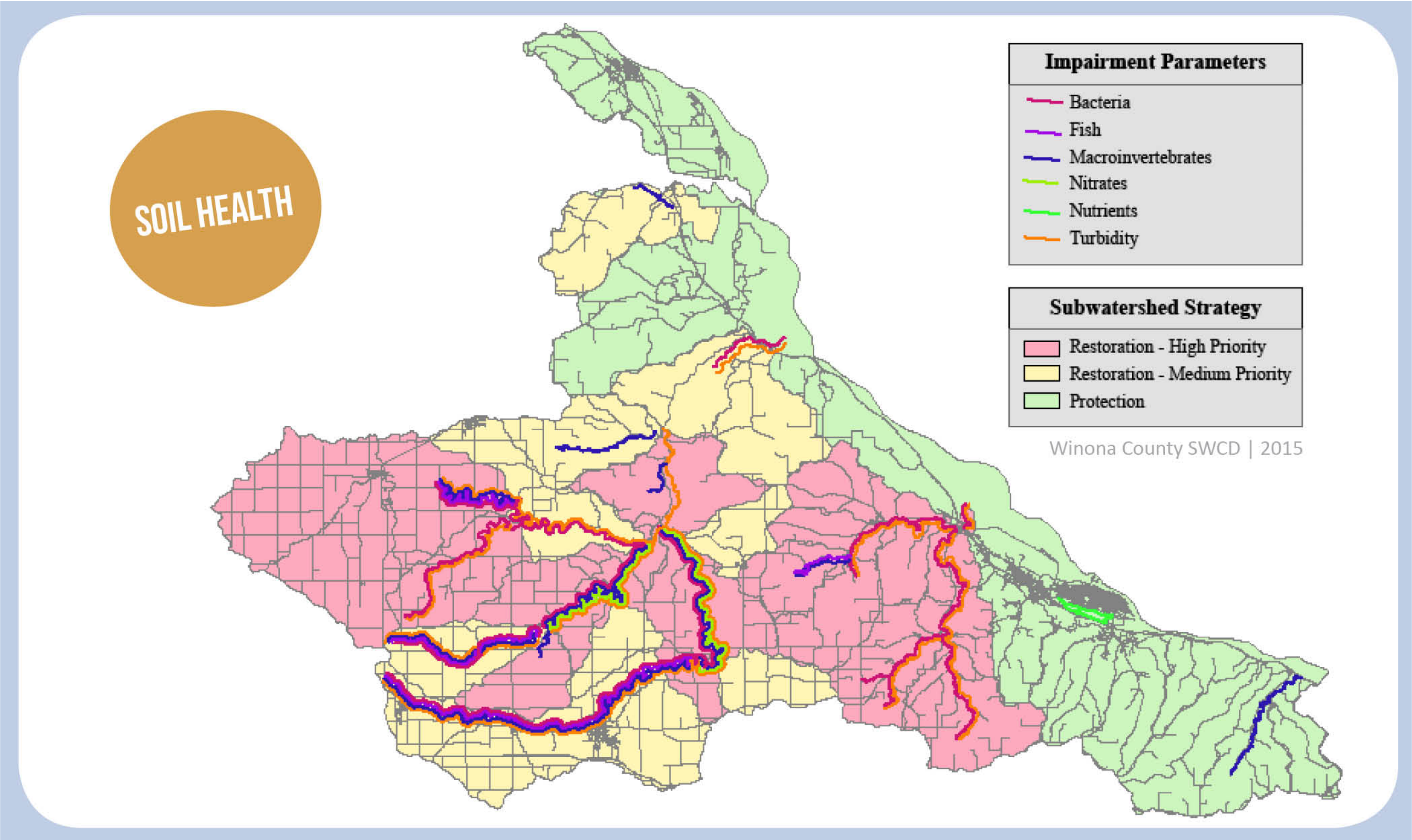



**Figure 24. Priority areas for implementation of BMPs to address soil health in the MRWW. Delineations show 12HUC boundaries.**

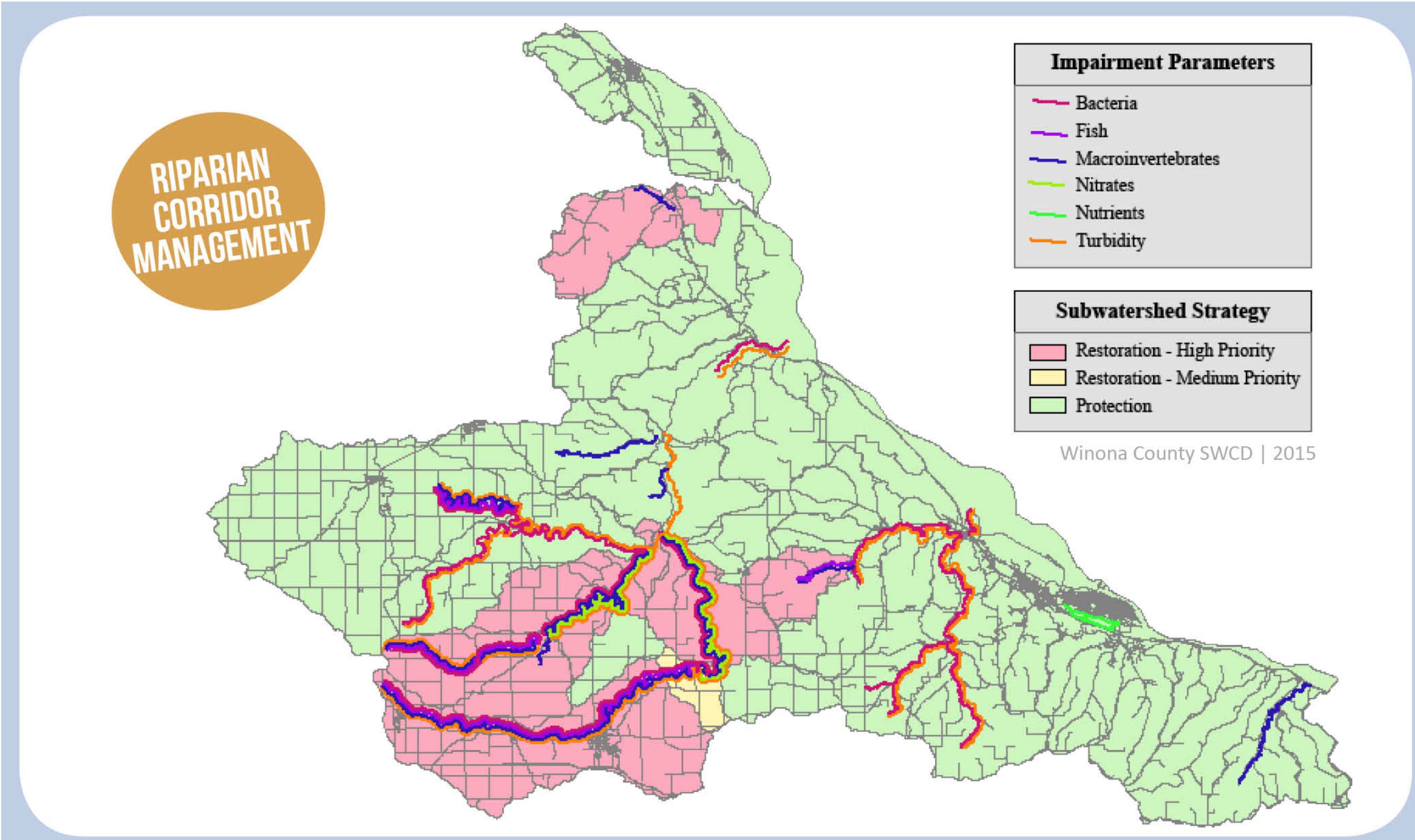



**Figure 25. Priority areas for implementation of BMPs to improve riparian corridor management in the MRWW. Delineations show 12HUC boundaries.**

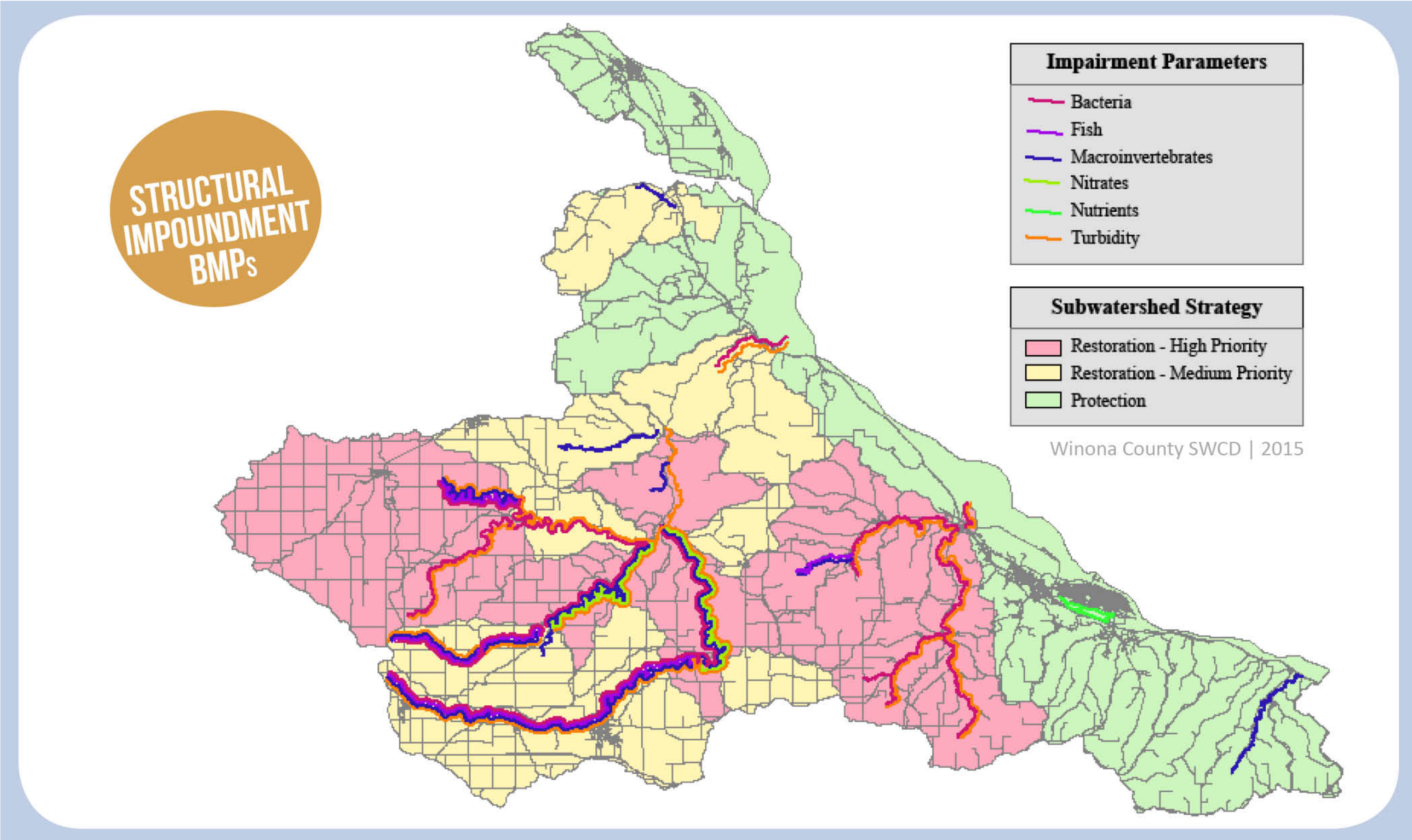



**Figure 26. Priority areas for placement of structural impoundments in the MRWW. Delineations show 12HUC boundaries.**

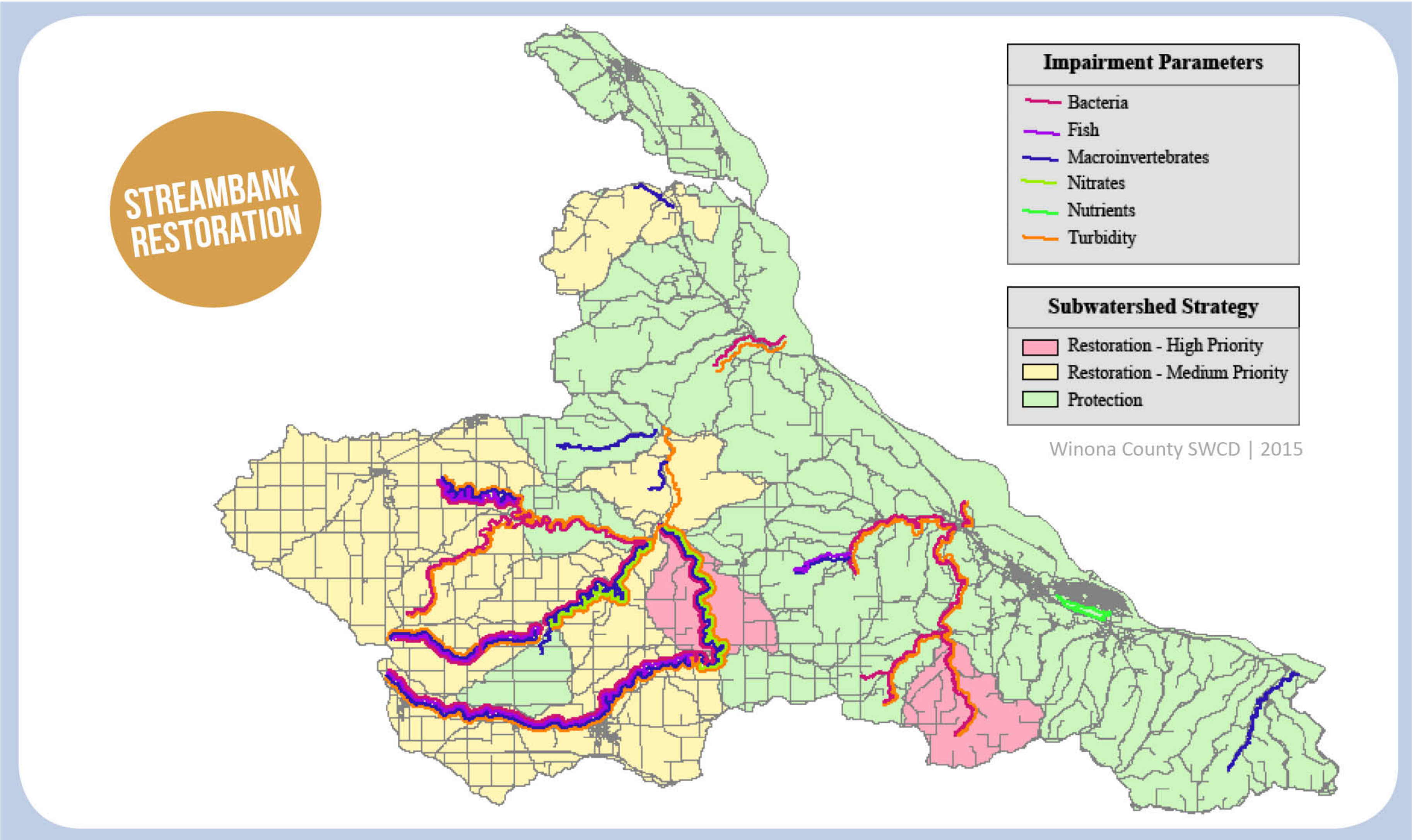



**Figure 27. Priority areas for streambank restoration and related erosion reduction in the MRWW. Delineations show 12HUC boundaries.**

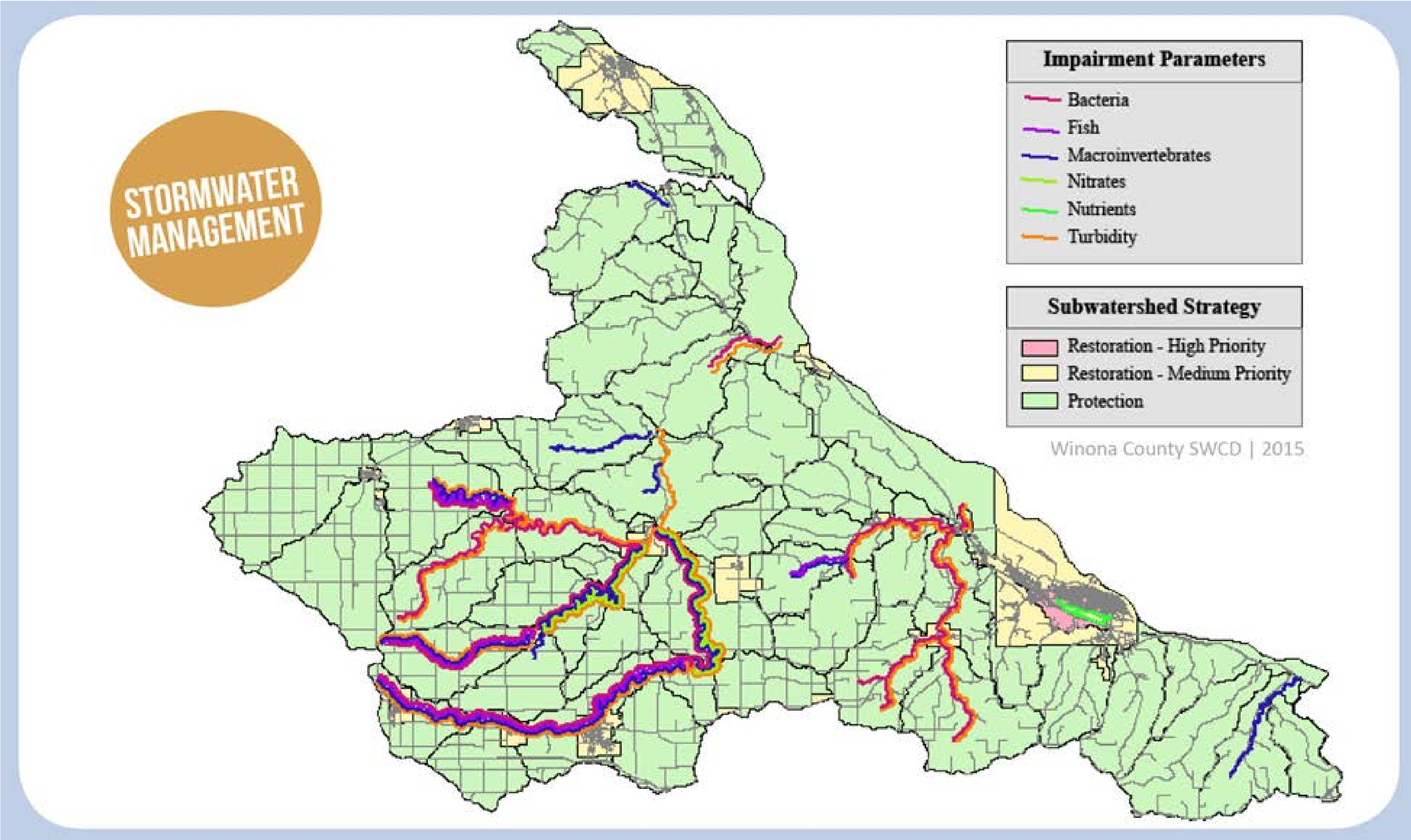



**Figure 28. Priority areas for stormwater management in the MRWW. Delineations show 12HUC boundaries.**

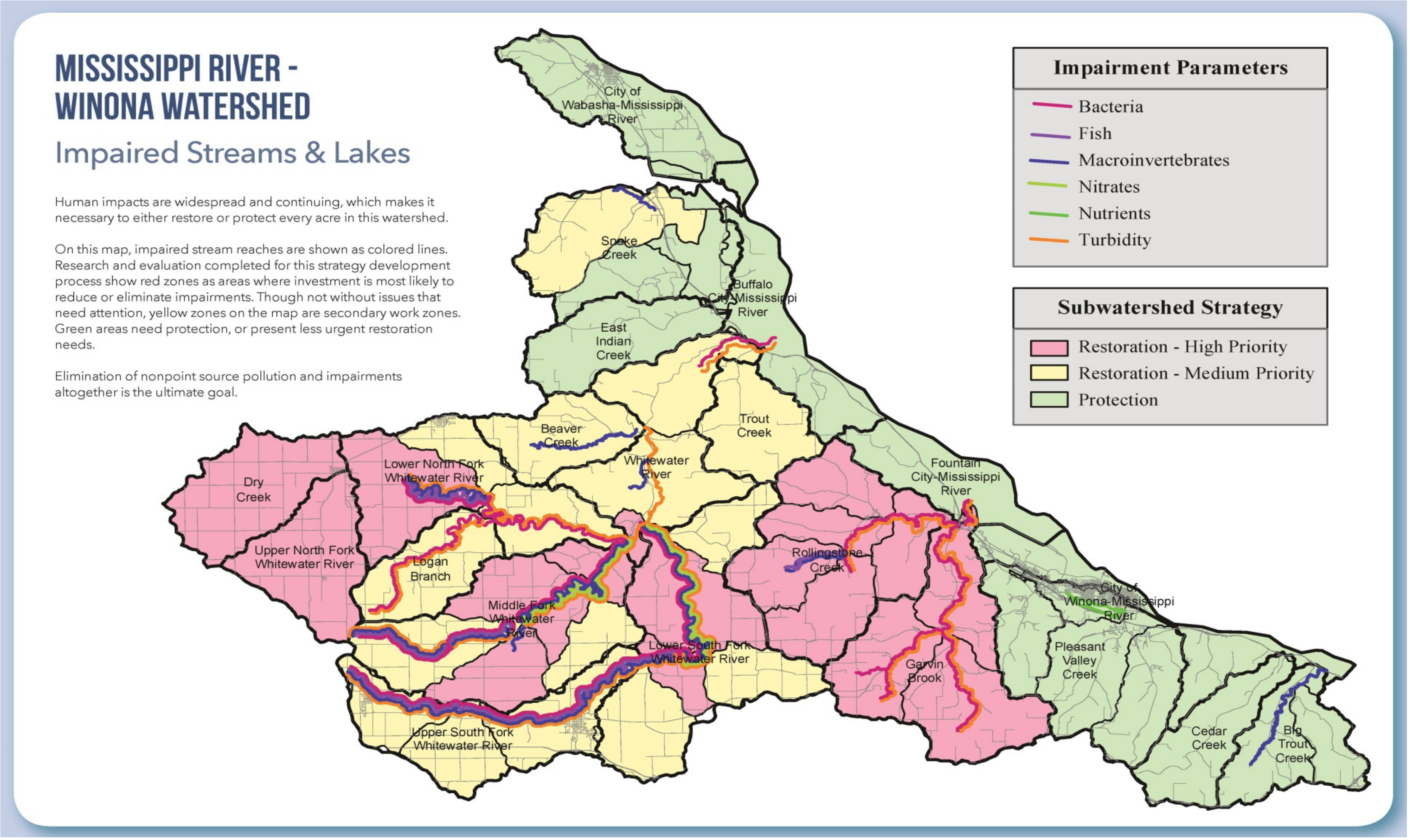



**Figure 29. Overview of priority areas based on individual parameters priority maps within this section of the MRWW WRAPS Report.**

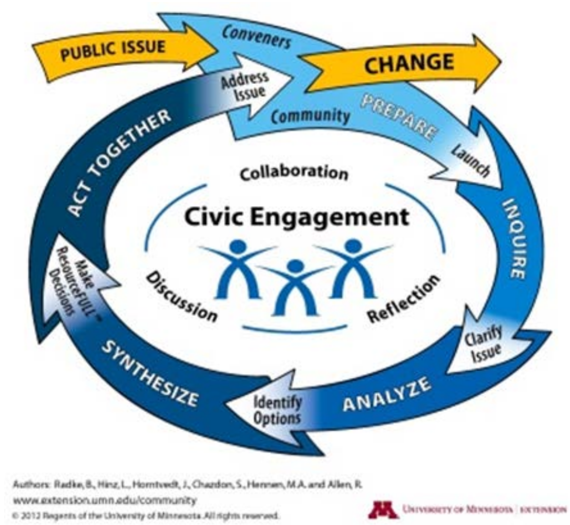
### *Due Diligence and Funding*

As part of local planning, ground-truthing will be done to prioritized areas to validate areas needing work. This will be done collaboratively between partners across the watershed, if the "One Watershed, One Plan" approach is used.

**Achievement of defined goals assumes adequate funding is available to complete the work.** Collaborations will be sought and fostered for all priorities and zones, to increase the impact and value of all funds and actions.

## 3.2 Civic Engagement

While there is much work to be done to engage citizens in improving water quality, the area's beauty, recreational attractions, connection to place, and a history of citizen engagement provide a solid foundation of interest.




Following the lead of University of Minnesota Extension and its focus on engaging citizens in "processes that involve public discussion, reflection, and collaboration", local leaders fostered respectful conversation during this strategy development process (2011 through 2014) and worked to present information clearly to all. Strategies developed from those conversations, a citizen survey, historic and current on-the-ground data, and skilled assessment are designed to help landowners, water managers and others act competently and with support. Continued conversations and involvement with citizens making land use decisions is critical to the success of proper implementation efforts.

**Accomplishments**

From 2011 to 2014, the following citizen engagement activities took place as part of MRWW WRAPS development.

- **At three watershed citizen summits participants connected, contributed, and learned more about local water quality.** The events were promoted using mail, e-mail, print and digital media, posters and personal invitations (Figure 30).

***More than 100 citizens attended each of three watershed summits.***

In facilitated conversations, citizens shared experiences related to water quality, contributed to strategy content, learned about local water conditions, and connected with each other.

**Figure 30. Pictures taken at the citizen summits held in the watershed during the WRAPS development process. Hearing from citizens and using their knowledge to inform strategy was a primary focus.**

- **A community advisory committee** met twice to provide insight for community engagement.
- **Two survey** rounds were conducted in the MRWW in the past five years. The first, conducted in 2011, gathered 117 responses from the Middle Fork and Logan Creek Subwatersheds, and the second, conducted in 2013, gathered 925 responses from across the entire watershed. It consisted of a six-page questionnaire and solicited citizen perspectives on water quality, use and practices, values, information sources, recreation, community activity, governance, and awareness. With a response rate of 31%, key findings helped formulate strategies in this WRAPS document. See the Summary of Results for more detail on these surveys.
- **Nine small group, large group and public meeting conversations were conducted** throughout the watershed with township board members, city and county elected and staff leaders, the watershed's farmer-led council, Soil & Water Conservation District staff, and city, county, state, federal and NGO technical experts.
- **Healthy Lake Winona** citizen group formed after attendees at the 2014 Citizen Summit saw a need to bring awareness to and help restore Lake Winona's two basins (Northwest and Southeast). The group is exploring impairment causes and options for removing nutrients from the lakes, studying how to strategically use local resources, and held a public event for Earth Day within three months of forming.
- **A watershed website was developed and published** as a "home base" for watershed citizens. OurWatershed.info includes information about conditions, legacy, data, action opportunities, primary pollutants, best practices to reduce them, and watershed stories.
- **A GIS story map**, DiscoverOurWatershed.com, was developed and published in collaboration with Winona County's IT department. It is linked to OurWatershed.com and community partner websites.
- **Six quarterly newsletters were published and distributed throughout the watershed**. Citizen action stories are now featured individually on OurWatershed.info, along with full newsletter issues. A story highlighting two citizen summits was distributed widely in Winona County Soil and Water Conservation District's 75-year publication (Figure 31).


**Figure 31. Example pages from the Connected newsletter that was able to be widely distributed by pooling of resources from groups across the watershed.**

- **Invited partnership with the city of Winona** made it possible **to increase newsletter distribution** from 800+ pieces per quarter (two issues) to 24,000 per quarter (four issues). It also opened doors to further collaboration.
- **Watershed citizens were featured in** four videos created in collaboration with the MPCA staff. These focus on reducing major pollutants in the watershed (nitrogen, bacteria and sediment) and the work of the farmer-led council.
- The work of developing OurWatershed.info, DiscoverOurWatershed.com, and six newsletters became **a strong tool for developing relevant connections** with watershed landowners, business owners, community organizations, visitors, and other citizens. A database of citizen and professional collaborators created to facilitate these and other activities has become a valuable ongoing resource.
- **Watershed brand identity and essential collateral were developed** to facilitate strong outreach and issue recognition (Figure 32).


**Figure 32. Examples of communication pieces used throughout the WRAPS development process. Clarity in information shared with the public is essential to make learning and engagement as easy as possible.**

- As an outgrowth of WRAPS activities, c**onversations were pursued to bring agribusiness leaders into the local water quality dialog**.
- Minnesota Forest Resources Council completed its MRWW Landscape Stewardship Plan while the WRAPS was being developed. **Developers collaborated to ensure plans address common goals and maximize resources.**

The following four activities were not directly related to WRAPS development, but took place concurrently in the watershed with strong staff and participant crossover. Effort was made to connect, share information, and learn for strategy development purposes as activities took place.

- **Farm project tours and stream walks** drew landowners and others for learning and connection.

- **The watershed's farmer-led council provided leadership at citizen summit events, strategic input for data assessment, and grew the conversation with landowners** through their activities.
- The Whitewater River Watershed (within the Mississippi River-Winona) became **a pilot project for Minnesota's Department of Agriculture's Agricultural Water Quality Certification** (MAWQCP) program in 2013. This became a way to draw attention to water quality issues and best practices.
- As a part of the MAWQCP, the **Whitewater River Watershed KAP (knowledge, attitudes and practices) survey was conducted** in 2014 to learn how producers manage their operations and information needs, and to learn their views about water quality. A report on results was compiled (Eckman 2015). This survey will be conducted again in 2016 to assess changes in KAP.

**Strategic Civic Engagement Priorities**

To engage citizens and sustain awareness to meet water quality goals, consistent, intentional, targeted outreach is necessary. Understanding, prioritizing and funding this civic engagement work has been a challenge in all watersheds. The MRWW has a basis of tools and a record of meaningful public engagement to drive future action. To further these priorities, extend funds, and expand communications and civic engagement services to the MRWW and all of southeast Minnesota watersheds, a new integrated, regional service paradigm is proposed for consideration (Figure 33).

**Public Notice**

This report was placed on public notice for open public comment from August 1 to August 31, 2016.

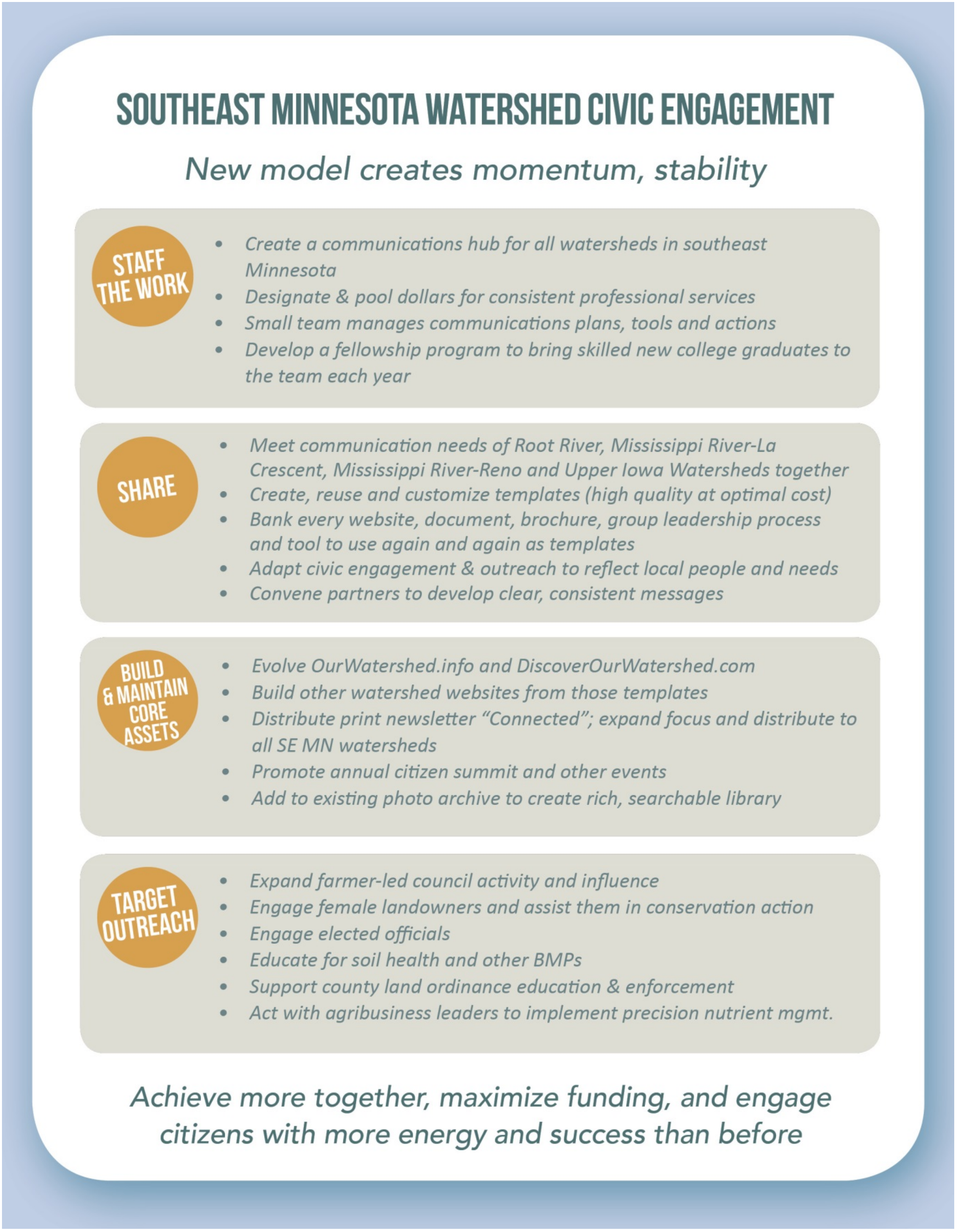



**Figure 33. Framework of proposal to expand communications and civic engagement services to all southeast Minnesota watersheds.**

## 3.3 Restoration and Protection Strategies

Strong partnerships exist in the MRWW between state agencies, local government units, the Whitewater JPB, non-profit groups and federal agencies. It is important to take into account the activity of these other groups and rely on them for professional judgment to determine what restoration and protection efforts are viable and supported in the MRWW. This was done to the extent possible throughout the WRAPS process, as was described previously in this report, to avoid redundant efforts.

The SWAT model scenarios that were developed in discussion with local government partners as well as the farmer-led council focused on effects of land use change and varying nutrient application strategies' impact on watershed water quality.

**The main issues that need to be addressed in the MRWW are:**

1. Nitrate reduction via reduction of input to and loss from corn/soy agricultural acres,
2. Reduction of sediment loss from upland areas and stabilization of flood plains, terraces and stream banks, especially on the main stem of the Whitewater Subwatershed,
3. Determination of why bacteria concentrations remain high in many streams despite numerous efforts at reduction, and
4. Addressing physical habitat issues that are affecting aquatic life communities of the streams.

For protection concerns, overlap of areas identified by the prioritization within this document, as well as the incorporation of the Mississippi River-Winona Landscape Stewardship Plan included in Section 2.5 Protection Considerations should be considered. Other information to consider includes various DNR identified areas (Outstanding Resource Value Waters, Minnesota's State Wildlife Action Plan, State Parks and Trails, etc.), and MDH identified areas (Drinking Water Supply Management Areas, water supplies vulnerable to surface contaminants, etc.).

**NBMP Tool**

According to the NRS (MPCA 2014) the main nutrient sources to the Mississippi River are phosphorus from agricultural cropland runoff, wastewater, and streambank erosion, and nitrogen from water leaving cropland via groundwater and agricultural tile. The associated phase I milestones for Mississippi River Basin N and P are 20% reduction in N loads and an additional 12% reduction in P loads from current conditions. These reductions represent a target reduction from the Mississippi River-Winona, which when combined with similar proportional loads from other Mississippi River Basin HUC 8 watersheds will meet Minnesota's combined reduction goals for the Mississippi River leaving Minnesota.

The purpose of the Nitrogen in Minnesota Surface Waters (MPCA 2013) study was to characterize N loading to Minnesota's surface waters, and assess conditions, trends, sources, pathways, and potential BMPs to achieve nitrogen reductions in our waters. Part of this study's effort was to develop a spreadsheet tool called the NBMP tool (the tool is described in more detail in the nitrogen study report chapter F1). Using the nitrogen reduction planning tool involves three steps. Since the NBMP tool and the later developed PBMP tool only evaluate agricultural practices, which will be less than the total watershed acreage, the first step is to acknowledge the total number of cropland acres being considered, along with the total number of suitable acres that are applicable for each BMP being considered, enter proposed target adoption rates for each selected BMP, and compare the effectiveness and cost of the individual BMPs. The second step is to compare suites of the BMPs that would attain any given reduction in the N load noting the associated estimated cost. The third step is to “drill down” to the details and assumptions behind the models of effectiveness and costs of any particular BMP and make any adjustments to reflect a particular situation.

The NBMP tool was introduced to a technical committee at a meeting in the MRWW in 2014. Local partners can use this tool to view various scenarios approximating acres of BMP adoption necessary to achieve a 20% reduction in N (per the downstream goal). Figure 34 provides an example of BMP adoption and associated costs it would take to get to the recommended 20% reduction in N. This aligns with the NRS phase 1 reduction goal for N. The MPCA is available to assist with further use of the tool if requested since the tool is now capable of being applied to the 10HUC level subwatersheds.

0.414 million acres in watershed or state

Watershed: Mississippi River - Winona

| | % suitable | % adoption | % treated | % treated, combined | acres treated (000), combined |
|---|---|---|---|---|---|
| Corn acres receiving target N rate, no inhibitor or timing shift | 24.9% | 60% | 15.0% | 13.6% | 56.16 |
| Fall N target rate acres receiving N inhibitor | 1.5% | 55% | 0.8% | 0.8% | 3.17 |
| Fall N applications switched to spring, % of fall-app. acres | 1.5% | 45% | 0.7% | 0.3% | 1.17 |
| Fall N switch to split spring/sidedressing, % of fall acres | 1.5% | 45% | 0.7% | 0.3% | 1.17 |
| Restored wetlands | 0.8% | 50% | 0.4% | 0.4% | 1.73 |
| Tile line bioreactors | 0.4% | 20% | 0.1% | 0.0% | 0.00 |
| Controlled drainage | 0.4% | 50% | 0.2% | 0.1% | 0.46 |
| Saturated buffers | 0.4% | 50% | 0.2% | 0.2% | 0.92 |
| Riparian buffers | 2.5% | 90% | 2.3% | 2.3% | 9.33 |
| Corn grain &soybean acres planted w/cereal rye cover crop | 34.3% | 55% | 18.8% | 17.5% | 72.21 |
| Short season crops planted to a cereal rye cover crop | 2.5% | 50% | 1.8% | 1.2% | 4.82 |
| Perennial crop % of corn & soybean area (marginal only) | 3.7% | 10% | 0.4% | 0.4% | 1.48 |

Weather scenario: Wet year- 30% of preplant N is lost, yield reduced

For wet spring scenario 2, fertilizer & manure N lost: 30%

The rate of sidedressed N is increased to offset the lost preplant N.

N load reduction with these adoption rates: 20.9% of all nonpoint source load; 22.1% of cultivated ag land source load

More results===>

| | | |
|---|---|---|
| Treatment cost before fertilizer cost savings & corn yield impacts | $7.11 | million/year |
| N fertilizer cost savings & corn yield impacts | -$1.24 | |
| Net BMP treatment cost | $5.86 | million/year |

**Figure 34. Mississippi River-Winona scenario from the NBMP tool illustrating a potential strategy to achieve the 20% nitrate reduction interim goal.**

## *Implementation Strategies Table*

Specific goals and practices to be implemented in each impaired stream reach to address issues in the MRWW are described in the Implementation Strategies Tables. The first table shows strategies applicable to the entire MRWW (Table 7). Following that table is a table for each of the three HUC10 subwatersheds (Figure 2): Whitewater River (Table 8); Garvin Brook (Table 9); and city of Winona (Table 10). These tables should serve as a compact reference for watershed planners, technical staff and other leaders to direct and focus watershed work.

## *Using the Table*

Starting at the far left, the table identifies each waterbody and its location. Reading left to right the table goes on to define current conditions of waterbodies, and goals. It goes on to lay out strategies to attain goals, estimated scale of adoption needed to meet the minimal water quality target, and interim milestones to reach those goals. Responsible organizations and their roles are listed at far right. To understand the symbols in the roles and responsibilities section, as well as details on BMPs for each strategy, see the Key to Strategies Table (Appendix D).

### *Goals*

To be consistent with Minnesota's NRS (MPCA 2014), a 45% nitrogen reduction target by 2040 with interim goal of 20% by 2025, and phosphorus goal of 12% reduction target by 2025, were selected.

While TSS and pathogen goals are described in the table, in most cases the strategies for addressing these pollutants are shared with those for phosphorus. This is consistent with other WRAPS in southeast Minnesota (e.g. the approved Mississippi River Lake Pepin WRAPS grouped Strategies for addressing volume, sediment, phosphorus and pathogens) in that the BMPs address runoff-driven pollutant loads. The Root River Field to Stream Partnership has found via five years of monitoring at numerous field edges in rural southeast Minnesota that approximately 90% of the runoff and associated nutrient and sediment losses often occur together over the four-month span of March through June (Kuehner 2016). Further, there is no available tool to estimate scales of adoption specific to TSS or pathogen goal attainment at small scales (e.g. HUC-10).

**Watershed Wide Strategies**

Across the entire MRWW, restoration and protection strategies to address sediment, nitrate, bacteria and aquatic communities would improve the landscape. Steps should be taken beyond those needed in specific sections of the watershed to reduce the amounts of sediment, phosphorus, and nitrates leaving the mouth and entering the Mississippi River to assist with reduction of nutrients and the resulting hypoxic zone in the Gulf of Mexico (Table 6).

**Table 6. Implementation table showing an example of strategies and actions proposed across the entire MRWW that could achieve water quality targets. Primary responsibility columns key: $=financial, T=technical and implementation, P=policy/rule/ordinance, C=capacity building/civic engagement/education, A=All**

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality | | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones (By year 2020) | Primary Responsibility | | | | | | | | | | | | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Local | | | | | | | Region | | | State | | | | | | National | | | |
| | | | | Current Condition | Goals/Targets or Estimated % Reduction | | | | Landowner/Occupier | Private Consultants | Cities & Townships | SRMC WD | Whitewater JPB | SWCDs | County | Ag/Cons Orgs | SE WRB | SE Tech JPB | MDA | MPCA | DNR | BWSR | UM Extension | Legislators | Legislators | NRCS | FWS | |
| Strategies to Address Downstream Goals | ALL | ALL | Phosphorus and Sediment | No local phosphorus stream impairments; separate from local sediment-driven impairments. Downstream impairments: Mississippi River, Gulf of Mexico 2009: 2885 kg TP 2010: 9250 kg TP 2011: 3898 kg TP Measured at Wells Creek outlet | 45% phosphorus load reduction per NRS (which would meet Pepin goal too); some progress already documented<br><br>20% TSS load reduction per South Metro Mississippi TMDL | Nutrient Reduction Strategy (NRS) | Saturation effort in upland segments of each subwatershed with focus provided by local partners. | Phosphorus and sediment loads continue to decrease; examine in 2025 (first NRS milestone). Subwatersheds with the lowest treatment percentage, increased to >20% treated (end goal of 40%) | | | | | | T | | | | | T, P | | | $ T | | | | $ T | | 2025 |
| | | | | | | Local Land Use Ordinance Administration | 100% compliance as it applies to shoreland, blufflands, feedlots, wetlands, mining | | T | | T P | | | T | T P | | | | T | T | T | T | | P | P | T | T | |
| | | | | | | Stream and Streambank Restoration | Focus efforts in subwatersheds that have sufficient upland treatment (see Figure 27) | | T | T C | P C | | $ C | $ T C | | $ C | | T | | | $ T C | $ | | $ | $ | $ T | $ T | |
| | | | | | | Structural Impoundment BMPs | Sub-watersheds with minimal upland treatment (see Figure 26) and higher % of land in Row Crop | | T | | | | $ C | $ T C | P C | | | T | | | | $ | | $ | $ | $ T C | | |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality: Current Condition | Water Quality: Goals/Targets or Estimated % Reduction | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones (By year 2020) | Landowner/Occupier | Private Consultants | Cities & Townships | SRMC WD | Whitewater JPB | SWCDs | County | Ag/Cons Orgs | SE WRB | SE Tech JPB | MDA | MPCA | DNR | BWSR | UM Extension | Legislators | Legislators | NRCS | FWS | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Primary Responsibility: Local | | | | | | | Region | | | State | | | | | | National | | | |
| | | | | | | Land Retirement/Acquisition | Focus easement, acquisition, stewardship planning, etc. on areas delineated in the Landscape Stewardship Plan (DNR, 2014). | | | | | | C | T | $ T | | | | | $ T | $ T | | | | | | |
| | ALL | ALL | Nitrogen | Separate from local nitrogen-driven impairments; Downstream impairments: Gulf of Mexico 2009: 85147 kg NOx 2010: 97815 kg NOx 2011: 121046 kg NOx Measured at Wells Creek outlet | 45% load reduction per NRS | Nutrient Reduction Strategy (NRS ) | Saturation effort in upland segments of each subwatershed with focus provided by local partners. | Decreased N loads by 2025 (first NRS milestone); observed change in nitrate trend at wells/springs (per MGS lag time analysis) | | | | | | T | | | | | T , P | | | $ T | | | | $ T | | 2045 |
| | | | | | | Local Land Use Ordinance Administration | 100% compliance as it applies to shoreland, blufflands, feedlots, wetlands, mining | | T | | T P | | | T | T P | | | | T | T | T | T | | P | P | T | T | |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality | | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones (By year 2020) | Primary Responsibility | | | | | | | | | | | | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Local | | | | | | | Region | | | State | | | | | | National | | | |
| | | | | Current Condition | Goals/Targets or Estimated % Reduction | | | | Landowner/Occupier | Private Consultants | Cities & Townships | SRMC WD | Whitewater JPB | SWCDs | County | Ag/Cons Orgs | SE WRB | SE Tech JPB | MDA | MPCA | DNR | BWSR | UM Extension | Legislators | Legislators | NRCS | FWS | |
| | | | | | | Land Retirement/Acquisition | Focus easement, acquisition, stewardship planning, etc. on areas delineated in the Landscape Stewardship Plan (DNR, 2014). | | | | | | C | T | | $ T | | | | | $ T | $ T | | | | | | |
| Protection Strategies for all subwatersheds | All unimpaired streams | All | Suspended Sediment, *E. coli*, Nitrate, Fish and Macroinvertebrates | Varies | Maintain and Enhance | Maintain land use; use strategies laid out for restoration to enhance these areas. | Watershed Wide in assessed unimpaired watershed areas | NA | T | | | $ C | $ C | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | Ongoing |
| | | Wabasha, Winona | Landscape Protection | High quality native vegetation and high biodiversity in watershed | Maintain and Enhance | Mississippi River-Winona Landscape Stewardship Plan | Focus on Conservation Opportunity Areas: Weaver, Beaver, and City of Winona | See Plan for more details (MFRC, 2015) | T | T C | T C | $ T C | $ T C | $ T C | A | T C | T C | T | $ C | $ C | $ T P | $ P C | T C | $ P | $ P | $ T | $ T | |
| All subwatersheds | ALL | ALL | - | - | - | Civic Engagement (1,2) | Watershed Wide | 1) Hire communications coordinator; 2) meet needs of SE MN watersheds together; 3) integrate clear communications/engagement into all projects; 4) expand/promote farmer-led council influence | | T C | A | A | A | C | C | | | | | T C | | $ | C | $ P | | | | Ongoing |

**Whitewater River Subwatershed Strategies**

In the Whitewater River Subwatershed, there are impairments for aquatic life use based on turbidity, fish and macroinvertebrate communities, as well as impairments for aquatic recreation based on high bacteria levels, and impairments for drinking water based on high nitrate levels (Figure 35).

There are critical areas in this subwatershed for various BMPs to be installed: nutrient management, fecal coliform reduction, soil health, riparian corridor management, and structural impoundment restoration (Table 7).

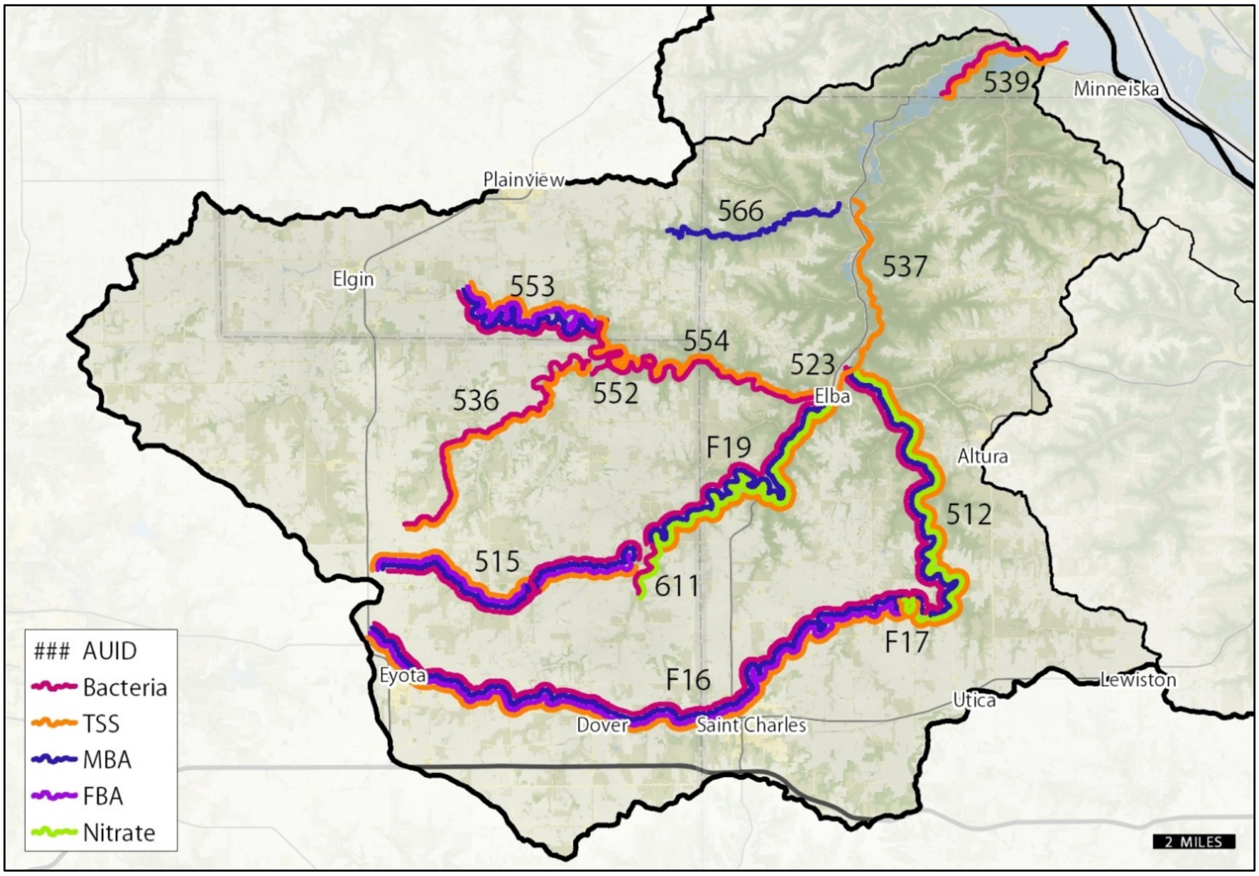



**Figure 35. Impairments for bacteria, TSS, aquatic macroinvertebrates bioassessment (MBA), fish bioassessment (FBA) and nitrate in the Whitewater River Subwatershed. Last three digits of the impaired AUID appear next to the stream reach.**

**Table 7. Implementation table showing an example of strategies and actions proposed for the Whitewater River Subwatershed that could achieve water quality targets. Primary responsibility columns key: $=financial, T=technical and implementation, P=policy/rule/ordinance, C=capacity building/civic engagement/education, A=All**

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality | | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Primary Responsibility | | | | | | | | | | | | | | | | | | | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Local | | | | | | | Region | | | State | | | | | | National | | | | |
| | | | | Current Condition | Goals/ Targets | | | | Landowner/Occupier | Private Consultants | Cities & Townships | SRMC WD | Whitewater JPB | SWCDs | County | Ag/Cons. Orgs. | SE WRB | SE Tech JPB | MDA | MPCA | DNR | BWSR | UM Extension | Legislators | Legislators | NRCS | FWS | | |
| South Fork Whitewater | South Fork Whitewater (warmwater) | Olmsted, Winona | Fish & Macroinvertebrates (Physical Habitat; DO; nitrate; suspended sediment) | Fish IBI: 42.5 (2004); 44 (2010); Threshold: 45. Macroinvertebrate IBI: 29.7 (2004), 36.3 (2010); Threshold: 35.9 | Increase quality of habitat to improve IBI scores to above threshold levels | Stream Remeandering & Floodplain Reattachment | Localized within the riparian corridor | Work with resource professionals to develop a plan | T | T C | P C | | $ C | $ T C | | $ C | | T | | | $ T C | $ | | $ | $ | $ T | $ T | 2045 | M |
| | F16 | | | | | Stream & Streambank Restoration (10) | Localized; sites of excessive or accelerated streambank erosion | Work with resource professionals to develop a plan | T | T C | P C | | $ C | $ T C | | $ C | | T | | | $ T C | $ | | $ | $ | $ T | $ T | | M |
| | Headwaters to St Charles Twp Rd 8 | | | | | Riparian Corridor Management (5) | Compliance with shoreland setback rules and all pastures managed through implemented rotational grazing and/or livestock exclusion plans within the riparian buffer area of the F16 & F17 drainage areas | Inventory compliance, increase compliance by 30%, implement 2 grazing and/or livestock exclusion plans | T | T C | | | $ C | $ T C | P C | T C | | T | | | $ T P | $ P C | C | $ P | $ | $ T | | | H |
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices | Increased education | T | | | | $ C | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | M |
| | South Fork Whitewater (coldwater) | Winona, Olmsted | Nitrate (water quality & macroinvertebrates) | Loads vary by flow regime; 1,196 kg/day seasonal average | less than 10 mg/L met 99% of the time | Nutrient Management BMPs (4) | See Nitrogen Strategies and Scale of Adoption for "All Watersheds" | | T | T C | | | $ C | $ T C | P C | C | $ C | T | T | A | | $ | T C | $ P | $ | $ T C | | 2045 | M |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality | | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Primary Responsibility | | | | | | | | | | | | | | | | | | | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Local | | | | | | | Region | | | State | | | | | | National | | | | |
| | | | | Current Condition | Goals/ Targets | | | | Landowner/Occupier | Private Consultants | Cities & Townships | SRMC WD | Whitewater JPB | SWCDs | County | Ag/Cons. Orgs. | SE WRB | SE Tech JPB | MDA | MPCA | DNR | BWSR | UM Extension | Legislators | Legislators | NRCS | FWS | | |
| | | | | | | Riparian Corridor Management (focus upstream) (5) | Compliance with shoreland setback rules and all pastures managed through implemented rotational grazing and/or livestock exclusion plans within the riparian buffer area of the F16 & F17 drainage areas | Inventory compliance, increase compliance by 30%; implement 2 grazing and/or livestock exclusion plans within the F16 & F17 drainage areas | T | T C | | | $ C | $ T C | P C | T C | | T | | | $ T P | $ P C | C | $ P | $ | $ T | | | M |
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices | Increased education | T | | | | $ C | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | H |
| | F17 | | Suspended Sediment (water quality & macroinvertebrates) | Loads vary by flow regime; 952 kg/day seasonal average | 10 mg/L met 90% of time Apr-Sep | Structural Impoundment BMPs (8) | Install 20 structures within the drainage area of this section of stream | Install 3 structures | H U | | | | $ C | $ T C | P C | | | T | | | | $ | | $ | $ | $ T C | | 2025 | H |
| | | | | | | Stream & Streambank Restoration (10) | Localized in the upstream (F16) section of stream | Work with resource professionals to develop a plan | T | T C | P C | | $ C | $ T C | | $ C | | T | | | $ T C | $ P | | $ | $ | $ T | $ T | | M |
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices | Increased education | T | | | | $ C | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | H |
| | | | Macroinvertebrates (Temperature) | Average temp in July, Aug was >19 deg.C | Reduce avg in July, Aug <19 deg.C | Urban Stormwater Practices | St. Charles, Dover, Eyota | Increased education to small communities | T | | T P C | | T | | | | | | | T $ | | T | | | | | | 2045 | L |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality | | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Primary Responsibility | | | | | | | | | | | | | | | | | | | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Local | | | | | | | Region | | | State | | | | | | National | | | | |
| | | | | Current Condition | Goals/ Targets | | | | Landowner/Occupier | Private Consultants | Cities & Townships | SRMC WD | Whitewater JPB | SWCDs | County | Ag/Cons. Orgs. | SE WRB | SE Tech JPB | MDA | MPCA | DNR | BWSR | UM Extension | Legislators | Legislators | NRCS | FWS | | |
| | South Fork Whitewater (coldwater) | Olmsted, Winona | Macroinvertebrates (Physical Habitat) | Macroinvertebrate IBI:38 (2004) and 38.6 (2010); Threshold: 46.1 | Increase quality of habitat to improve IBI scores to above threshold levels | Riparian Corridor Management (5) | Compliance with shoreland setback rules and all pastures managed through implemented rotational grazing and/or livestock exclusion plans within the riparian buffer area | Inventory compliance, increase by 30% and implement 2 grazing and/or livestock exclusion plans within this section of stream | T | T C | | | $ C | $ T C | P C | T C | | T | | | $ T P | $ P C | C | $ P | $ | $ T | | 2045 | H |
| | | | | | | Stream & Streambank Restoration (10) | Localized within the riparian corridor | Work with resource professionals to develop a plan | T | T C | P C | | $ C | $ T C | | $ C | | T | | | $ T C | $ P | | $ | $ | $ T | $ T | | H |
| | | | | | | Remove or Reconstruct Bridge at Crystal Springs | Localized: remove or reconstruct bridge | Work with DOT on the feasibility and/or to develop a plan for this project | | | | | | | $ T | | | | | | | | | $ | | | | | H |
| | 512 | | Nitrate | Loads vary by flow regime; 4,979 kg/day seasonal average | less than 10 mg/L met 100% of the time | Nutrient Management BMPs (4) | See Nitrogen Strategies and Scale of Adoption for "All Watersheds" | Prevent further degradation | T | T C | | | $ C | $ T C | P C | C | $ C | T | T | A | | $ | T C | $ P | $ | $ T C | | 2045 | M |
| | | | | | | Riparian Corridor Management (5) | Compliance with shoreland setback rules and all pastures managed through implemented rotational grazing and/or livestock exclusion plans within the riparian buffer area | Inventory compliance, increase by 75% and implement 1 grazing and/or livestock exclusion plan within this stream section | T | T C | | | $ C | $ T C | P C | T C | | T | | | $ T P | $ P C | C | $ P | $ | $ T | | | M |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality: Current Condition | Water Quality: Goals/ Targets | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Local: Landowner/Occupier | Local: Private Consultants | Local: Cities & Townships | Local: SRMC WD | Local: Whitewater JPB | Local: SWCDs | Local: County | Region: Ag/Cons. Orgs. | Region: SE WRB | Region: SE Tech JPB | State: MDA | State: MPCA | State: DNR | State: BWSR | State: UM Extension | State: Legislators | National: Legislators | National: NRCS | National: FWS | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices | Increased education | T | | | | $ C | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | M |
| | T106 R10W S1, west line to N Fk Whitewater R | | Suspended Sediment | Loads vary by flow regime; 5,150 kg/day seasonal average | 10 mg/L met 90% of time Apr-Sep | Structural Impoundment BMPs (8) | Install 15 structures within this subwatershed in addition to all planned structures in upstream watersheds | Install 2 structures | T | | | | $ C | $ T C | P C | | | T | | | | $ | | $ | $ | $ T C | | 2025 | H |
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices | Increased education | T | | | | $ C | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | H |
| Middle Fork Whitewater | Middle Fork Whitewater (warmwater) | Olmsted, Winona | Fish & Macroinvertebrate IBI (Physical Habitat) | Fish IBI: Macroinvertebrate IBI: 30.9; Threshold: 46.8 | Increase quality of habitat to improve IBI scores to above threshold levels | Riparian Corridor Management (5) | Compliance with shoreland setback rules and all pastures managed through implemented rotational grazing and/or livestock exclusion plans within the riparian buffer area | Inventory compliance, increase by 30% and implement 2 grazing and/or livestock exclusion plans within this stream section | T | T C | | | $ C | $ T C | P C | T C | | T | | | $ T P | $ P C | C | $ P | $ | $ T | | 2025 | H |
| | | | Macroinvertebrate (Nitrate) | 71% nitrate tolerant taxa | Diversify community to include more nitrate intolerant species | Nutrient Management BMPs (4) | See Nitrogen Strategies and Scale of adoption for "All Watersheds" | | T | T C | | | $ C | $ T C | P C | C | $ C | T | T | A | | $ | T C | $ P | $ | $ T C | | 2045 | H |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality | | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Primary Responsibility | | | | | | | | | | | | | | | | | | | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Local | | | | | | | Region | | | State | | | | | | National | | | | |
| | | | | Current Condition | Goals/ Targets | | | | Landowner/Occupier | Private Consultants | Cities & Townships | SRMC WD | Whitewater JPB | SWCDs | County | Ag/Cons. Orgs. | SE WRB | SE Tech JPB | MDA | MPCA | DNR | BWSR | UM Extension | Legislators | Legislators | NRCS | FWS | | |
| | **515** | | Fish and Macroinvertebrates (Suspended Sediment) | High percentage of TSS tolerant macroinvertebrate and fish taxa | Diversify community to include more TSS intolerant species | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices. | Increased education | T | | | | $ C | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | 2025 | M |
| | | | Fish and Macroinvertebrates (Dissolved Oxygen) | Daily DO flux as high as 12.1 mg/L. and high phosphorus values | Reduction of daily DO flux and phosphoru s levels | Riparian Corridor Management (5) | Compliance with shoreland setback rules and all pastures managed through implemented rotational grazing and/or livestock exclusion plans within the riparian buffer area | Inventory compliance, increase by 30% and implement 1 grazing and/or livestock exclusion plan within this stream section | T | T C | | | $ C | $ T C | P C | T C | | T | | | $ T P | $ P C | C | $ P | $ | $ T | | 2025 | H |
| | **Headwaters to T107 R11W S34, east line** | | *E. coli* | Loads vary by flow regime; 640.4 billion orgs/day seasonal average | 126 cfu/ 100 mL seasonal geomean | Lower Mississippi River Basin Fecal Coliform Implementation Plan (3) | See "Key to all tables" | See "Key to all tables" | T | T C | | | $ C | $ T C | P C | T C | $ C | T C | | A | | $ | C | $ P | $ | $ T C | | 2045 | H |
| | **Crow Spring (coldwater)** | **Winona, Olmsted** | Macroinvertebrates (Physical Habitat) | Macroinvertebrate IBI: 27.1; Threshold: 46.1; habitat loss is due to excessive bedded sediment | Improved habitat to improve IBI scores above the threshold and specifically, improved pasture manageme nt upstream to reduce | Stream Habitat Improvement (9) | Maintain existing habitat improvement structures | Evaluate maintenance needs | T | T C | P C | | $ C | $ T C | | $ C | | T | | | $ T C | $ P | | $ | $ | $ T | $ T | 2045 | M |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality: Current Condition | Water Quality: Goals/ Targets | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Local: Landowner/Occupier | Local: Private Consultants | Local: Cities & Townships | Local: SRMC WD | Local: Whitewater JPB | Local: SWCDs | Local: County | Region: Ag/Cons. Orgs. | Region: SE WRB | Region: SE Tech JPB | State: MDA | State: MPCA | State: DNR | State: BWSR | State: UM Extension | State: Legislators | National: Legislators | National: NRCS | National: FWS | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | sedimentation. | Riparian Corridor Management (5) | Compliance with shoreland setback rules and all pastures managed through implemented rotational grazing and/or livestock exclusion plans within the riparian buffer area | 30% compliance and 1 implemented grazing and/or livestock exclusion plan within this stream section | T | T<br>C | | | $<br>C | $<br>T<br>C | P<br>C | T<br>C | | T | | | $<br>T<br>P | $<br>P<br>C | C | $<br>P | $ | $<br>T | | | H |
| | 611 (Middle Fork Whitewater River Tributary), Unnamed cr to M Fk Whitewater R | | *E.coli* | Loads vary by flow regime; 66.1 billion orgs/day seasonal average | 126 cfu/mL seasonal geomean | Lower Mississippi River Basin Fecal Coliform Implementation Plan (3) | See "Key to all tables" | See "Key to all tables" | T | T<br>C | | | $<br>C | $<br>T<br>C | P<br>C | T<br>C | $<br>C | T<br>C | | A | | $ | C | $<br>P | $ | $<br>T<br>C | | 2045 | H |
| | | | Nitrate | Loads vary by flow regime; 155 kg/day seasonal average | less than 10 mg/L met 99% of the time | Nutrient Management BMPs (4) | See Nitrogen Strategies and Scale of adoption for "All Watersheds" | | T | T<br>C | | | $<br>C | $<br>T<br>C | P<br>C | C | $<br>C | T | T | A | | $ | T<br>C | $<br>P | $ | $<br>T<br>C | | 2045 | H |
| | | | | | | Riparian Corridor Management (5) | Compliance with shoreland setback rules and all pastures managed through implemented rotational grazing and/or livestock exclusion plans within the riparian buffer area | Inventory compliance, increase by 30% and implement grazing and/or livestock exclusion plan within this stream section | T | T<br>C | | | $<br>C | $<br>T<br>C | P<br>C | T<br>C | | T | | | $<br>T<br>P | $<br>P<br>C | C | $<br>P | $ | $<br>T | | | H |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality: Current Condition | Water Quality: Goals/ Targets | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Local: Landowner/Occupier | Local: Private Consultants | Local: Cities & Townships | Local: SRMC WD | Local: Whitewater JPB | Local: SWCDs | Local: County | Region: Ag/Cons. Orgs. | Region: SE WRB | Region: SE Tech JPB | State: MDA | State: MPCA | State: DNR | State: BWSR | State: UM Extension | State: Legislators | National: Legislators | National: NRCS | National: FWS | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices | Increased education | T | | | | $ C | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | H |
| | Middle Fork Whitewater (coldwater) | | Nitrate | Loads vary by flow regime; 862 kg/day seasonal avg. | less than 10 mg/L met 99% of the time | Nutrient Management BMPs | See Nitrogen Strategies and Scale of adoption for "All Watersheds" | | T | T C | | | $ C | $ T C | P C | C | $ C | T | T | A | | $ | T C | $ P | $ | $ T C | | 2045 | H |
| | | | | | | Riparian Corridor Management (5) | Compliance with shoreland setback rules and all pastures managed through implemented rotational grazing and/or livestock exclusion plans within the riparian buffer area | Inventory compliance, increase by 30% and implement 1 grazing and/or livestock exclusion plan within this stream section | T | T C | | | $ C | $ T C | P C | T C | | T | | | $ T P | $ P C | C | $ P | $ | $ T | | | H |
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices | Increased education | T | | | | $ C | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | H |
| | F19 | | Suspended Sediment | Loads vary by flow regime; 1,243 kg/day seasonal average | 10 mg/L met 90% of time Apr-Sep | Structural Impoundment BMPs (8) | Install 20 structures within this subwatershed | Install 3 structures | T | | | | $ C | $ T C | P C | | | T | | | | $ | | $ | $ | $ T C | | 2025 | H |
| | Crow Spring to N Fk Whitewater R | | | | | Stream and Streambank Restoration (10) | Localized; sites of excessive or accelerated streambank erosion | Work with resource professionals to develop a plan | T | T C | P C | | $ C | $ T C | | $ C | | T | | | $ T C | $ P | | $ | $ | $ T | $ T | | M |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality | | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Primary Responsibility | | | | | | | | | | | | | | | | | | | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Local | | | | | | | Region | | | State | | | | | | National | | | | |
| | | | | Current Condition | Goals/ Targets | | | | Landowner/Occupier | Private Consultants | Cities & Townships | SRMC WD | Whitewater JPB | SWCDs | County | Ag/Cons. Orgs. | SE WRB | SE Tech JPB | MDA | MPCA | DNR | BWSR | UM Extension | Legislators | Legislators | NRCS | FWS | | |
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices. | Increased education | T | | | | $ C | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | H |
| North Fork Whitewater | **Logan Branch (warmwater) 536**<br><br>**Headwaters to T107 R11W S4, east line** | **Olmsted** | Suspended Sediment | Loads vary by flow regime; 607 kg/day seasonal average | 65 mg/L met 90% of time Apr-Sep | Structural Impoundment BMPs (8) | Install 10 structures within this subwatershed. | Install 2 structures | T | | | | $ C | $ T C | P C | | | T | | | | $ | | $ | $ | $ T C | | 2025 | H |
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices. | Increased education | T | | | | $ C | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | H |
| | **Logan Branch (warmwater)**<br><br>**552**<br><br>**Unnamed cr to N Fk Whitewater R** | **Olmsted** | *E. coli* | 9,896 billion orgs/day seasonal average | 126 org/ 100 mL seasonal geomean | Lower Mississippi River Basin Fecal Coliform Implementation Plan (3) | See "Key to all tables" | See "Key to all tables" | T | T C | | | $ C | $ T C | P C | T C | $ C | T C | | A | | $ | C | $ P | $ | $ T C | | 2045 | M |
| | **Upper North Fork** | **Olmsted & Wabasha** | - | - | - | Protection (11) | See "Key to all tables" | | T | T C | T C | $ T C | $ T C | $ T C | A | T C | T C | T | $ C | $ C | $ T P | $ P C | T C | $ P | $ P | $ T | $ T | | |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality – Current Condition | Water Quality – Goals/ Targets | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Primary Responsibility – Local – Landowner/Occupier | Local – Private Consultants | Local – Cities & Townships | Local – SRMC WD | Local – Whitewater JPB | Local – SWCDs | Local – County | Region – Ag/Cons. Orgs. | Region – SE WRB | Region – SE Tech JPB | State – MDA | State – MPCA | State – DNR | State – BWSR | State – UM Extension | State – Legislators | National – Legislators | National – NRCS | National – FWS | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Dry Creek** | **Olmsted & Wabasha** | - | - | - | Protection (11) | See "Key to all tables" | | T | T C | T C | $ T C | $ T C | $ T C | A | T C | T C | T | $ C | $ C | $ T P | $ P C | T C | $ P | $ P | $ T | $ T | | |
| | **North Branch Whitewater (coldwater)** | **Wabasha, Olmsted, Winona** | Fish & Macroinvertebrates (Physical Habitat) | Macroinvertebrate IBI: 27; Threshold: 46.1 | Improve habitat to improve IBI scores, specifically, reduce erosion upstream | Structural Impoundment BMPs (8) | Install 15 structures within this subwatershed. | Install 3 structures | T | | | | $ C | $ T C | P C | | | T | | | | $ | | $ | $ | $ T C | | 2045 | H |
| | **North Branch Whitewater (coldwater)** | **Wabasha, Olmsted, Winona** | Fish & Macroinvertebrates (Physical Habitat) | Macroinvertebrate IBI: 27; Threshold: 46.1 | Improve habitat to improve IBI scores, specifically, reduce erosion upstream | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices. | Increased education | T | | | | $ C | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | 2045 | H |
| | **North Branch Whitewater (coldwater)** | **Wabasha, Olmsted, Winona** | Macroinvertebrates (Nitrate) | 76.5% nitrate tolerant species | Diversify community to include more | Nutrient Management BMPs (4) | See Nitrogen Strategies and Scale of adoption for "All Watersheds" | | T | T C | | | $ C | $ T C | P C | C | $ C | T | T | A | | $ | T C | $ P | $ | $ T C | | 2045 | H |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality | | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Primary Responsibility | | | | | | | | | | | | | | | | | | | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Current Condition | Goals/ Targets | | | | Local | | | | | | | Region | | | State | | | | | | National | | | | |
| | | | | | | | | | Landowner/Occupier | Private Consultants | Cities & Townships | SRMC WD | Whitewater JPB | SWCDs | County | Ag/Cons. Orgs. | SE WRB | SE Tech JPB | MDA | MPCA | DNR | BWSR | UM Extension | Legislators | Legislators | NRCS | FWS | | |
| | 553 | | | | nitrate intolerant species | Riparian Corridor Management (5) | Compliance with shoreland setback rules and all pastures managed through implemented rotational grazing and/or livestock exclusion plans within the riparian buffer area. | Increased education and awareness. | T | T C | | | $ C | $ T C | P C | T C | | T | | | $ T P | $ P C | C | $ P | $ | $ T | | | L |
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices. | Increased education | T | | | | $ C | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | H |
| | T108 R11W S30, west line to Unnamed Cr | | Suspended Sediment | Loads vary by flow regime; 4,060 kg/day seasonal average | 10 mg/L met 90% of time Apr-Sep | Structural Impoundment BMPs (8) | Install 15 structures within this subwatershed as discussed in the Physical Habitat stressor of this watershed. | Install 3 structures as discussed in the Physical Habitat stressor of this watershed. | T | | | | $ C | $ T C | P C | | | T | | | | $ | | $ | $ | $ T C | | 2025 | H |
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices. | Increased education | T | | | | $ C | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | H |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality: Current Condition | Water Quality: Goals/ Targets | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Primary Responsibility: Local | | | | | | | Region | | | State | | | | | | National | | | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Landowner/Occupier | Private Consultants | Cities & Townships | SRMC WD | Whitewater JPB | SWCDs | County | Ag/Cons. Orgs. | SE WRB | SE Tech JPB | MDA | MPCA | DNR | BWSR | UM Extension | Legislators | Legislators | NRCS | FWS | | |
| | North Fork Whitewater River 554 Unnamed cr to M Fk Whitewater R | Wabasha, Olmsted, Winona | Suspended Sediment | Loads vary across flow regimes; 7,978 kg/day seasonal average | 10 mg/L met 90% of time Apr-Sep | Structural Impoundment BMPs (8) | Install 10 structures within this subwatershed in addition to all planned structures in upstream watersheds. | Install 2 structures | T | | | | $ C | $ T C | P C | | | T | | | | $ | | $ | $ | $ T C | | 2025 | M |
| | | | | | | Stream and Streambank Restoration (10) | Localized; sites of excessive or accelerated streambank erosion. | Work with resource professionals to develop a plan | T | T C | P C | | $ C | $ T C | | $ C | | T | | | $ T C | $ P | | $ | $ | $ T | $ T | | L |
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices. | Increased education | T | | | | $ C | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | M |
| | North Fork Whitewater River 523 M Fk Whitewater R to S Fk Whitewater R | Wabasha, Olmsted, Winona | Suspended Sediment | Loads vary by flow regime; 22,790 kg/day seasonal average | 10 mg/L met 90% of time Apr-Sep | Structural Impoundment BMPs (8) | See Scale of Adoption for all North Fork and Middle Fork Whitewater River sections. | See Interim 10-yr. Milestones for all North Fork and Middle Fork Whitewater River sections. | T | | | | $ C | $ T C | P C | | | T | | | | $ | | $ | $ | $ T C | | 2025 | M |
| | | | | | | Stream and Streambank Restoration (10) | Localized; sites of excessive or accelerated streambank erosion. | Work with resource professionals to develop a plan | T | T C | P C | | $ C | $ T C | | $ C | | T | | | $ T C | $ P | | $ | $ | $ T | $ T | | M |
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices. | Increased education | T | | | | $ C | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | M |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality: Current Condition | Water Quality: Goals/ Targets | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Local: Landowner/Occupier | Local: Private Consultants | Local: Cities & Townships | Local: SRMC WD | Local: Whitewater JPB | Local: SWCDs | Local: County | Region: Ag/Cons. Orgs. | Region: SE WRB | Region: SE Tech JPB | State: MDA | State: MPCA | State: DNR | State: BWSR | State: UM Extension | State: Legislators | National: Legislators | National: NRCS | National: FWS | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Whitewater Main Branch | **Whitewater River** | **Wabasha, Olmsted, Winona** | Suspended Sediment | Loads vary by flow regime; 42,784 kg/day seasonal average | 10 mg/L met 90% of time Apr-Sep | Structural Impoundment BMPs (8) | Install 10 structures within this subwatershed in addition to all planned structures in upstream watersheds. | Install 2 structures | T | | | | $ C | $ T C | P C | | | T | | | | $ | | $ | $ | $ T C | | 2025 | M |
| | **537** | | | | | Stream and Streambank Restoration (10) | Localized; sites of excessive or accelerated streambank erosion. | Work with resource professionals to develop a plan | T | T C | P C | | $ C | $ T C | | $ C | | T | | | $ T C | $ P | | $ | $ | $ T | $ T | | M |
| | **S Fk Whitewater R to Beaver Cr** | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices. | Increased education | T | | | | $ C | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | M |
| | **Unnamed Creek (Marnach Trib)** | **Winona,** Wabasha | Macroinvertebrates (Physical Habitat) | Macroinvertebrate IBI: 29.0; Threshold: 35.9 | Improve habitat to improve IBI scores, specifically, hold water back to help with the steep slope of the stream | Structural Impoundment BMPs (8) | Install 5 structures within the drainage area of this section. | Install 1 structure | T | | | | $ C | $ T C | P C | | | T | | | | $ | | $ | $ | $ T C | | 2025 | H |
| | **609** **Unnamed Cr to Whitewater R** | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices. | Increased education | T | | | | $ C | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | H |
| | **Beaver Creek (coldwater) 566** | **Wabasha, Winona** | Macroinvertebrate (Physical Habitat) | Macroinvertebrate IBIs: 65.1, 65.5, 43.4, 27.4; Threshold: 46.1 | Improve habitat to improve IBI scores | Stream and Streambank Restoration (10) | Address sedimentation issues | Work with resources professionals to develop a plan | T | T C | P C | | $ C | $ T C | | $ C | | T | | | $ T C | $P | | $ | $ | $ T C | $ T | 2025 | M |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality | | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Primary Responsibility | | | | | | | | | | | | | | | | | | | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Local | | | | | | | Region | | | State | | | | | | National | | | | |
| | | | | Current Condition | Goals/ Targets | | | | Landowner/Occupier | Private Consultants | Cities & Townships | SRMC WD | Whitewater JPB | SWCDs | County | Ag/Cons. Orgs. | SE WRB | SE Tech JPB | MDA | MPCA | DNR | BWSR | UM Extension | Legislators | Legislators | NRCS | FWS | | |
| | T108 R11W S24, west line to Unnamed cr | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices. | Increased education | T | | | | $<br>C | $<br>T<br>C | P<br>C | $<br>T<br>C | $<br>C | T<br>C | $<br>C | | | $ | T<br>C | $<br>P | $<br>P | $<br>T<br>C | | | |
| | Whitewater River (coldwater) 539 T109 R10W S36, south line to Mississippi R | Winona, Wabasha, Olmsted | *E. coli* | 7,453 billion orgs/day seasonal average | 126 org/ 100 mL seasonal geomean | Lower Mississippi River Basin Fecal Coliform Implementation Plan (3) | See "Key to all tables" | See "Key to all tables" | T | T<br>C | | | $<br>C | $<br>T<br>C | P<br>C | T<br>C | $<br>C | T<br>C | | A | | $ | C | $<br>P | $ | $<br>T<br>C | | 2045 | M |
| | | | Suspended Sediment | Loads vary by flow regime; 258,999 kg/day seasonal average | 65 mg/L met 90% of time Apr-Sep | Structural Impoundment BMPs (8) | Install 10 structures within this subwatershed and Trout Creek watershed. | Install 1 structure | T | | | | $<br>C | $<br>T<br>C | P<br>C | | | T | | | | $ | | $ | $ | $<br>T<br>C | | 2025 | M |
| | | | | | | Stream and Streambank Restoration (10) | Localized; sites of excessive or accelerated streambank erosion | | T | T<br>C | P<br>C | | $<br>C | $<br>T<br>C | | $<br>C | | T | | | $<br>T<br>C | $<br>P | | $ | $ | $<br>T | $<br>T | | M |
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices. | Increased education | T | | | | $<br>C | $<br>T<br>C | P<br>C | $<br>T<br>C | $<br>C | T<br>C | $<br>C | | | $ | T<br>C | $<br>P | $<br>P | $<br>T<br>C | | | M |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality | | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Primary Responsibility | | | | | | | | | | | | | | | | | | | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Local | | | | | | | Region | | | State | | | | | | National | | | | |
| | | | | Current Condition | Goals/ Targets | | | | Landowner/Occupier | Private Consultants | Cities & Townships | SRMC WD | Whitewater JPB | SWCDs | County | Ag/Cons. Orgs. | SE WRB | SE Tech JPB | MDA | MPCA | DNR | BWSR | UM Extension | Legislators | Legislators | NRCS | FWS | | |
| **Trout Creek 070400030** | **Trout Creek** | **Winona & Wabasha** | **-** | - | - | Protection and continued monitoring of temperature (11) | See "Key To All Tables" | | T | T C | T C | $ T C | $ T C | $ T C | A | T C | T C | T | $ C | $ C | $ T P | $ P C | T C | $ P | $ P | $ T | $ T | | |

**Garvin Brook Subwatershed Strategies**

In the Garvin Brook Subwatershed, there are impairments for aquatic life use based on turbidity, fish and macroinvertebrate communities, as well as aquatic recreation based on high bacteria levels (Figure 36).

There are critical areas in this subwatershed for various BMPs to be installed: nutrient management, fecal coliform reduction, soil health, riparian corridor management, and structural impoundment restoration (Table 8).

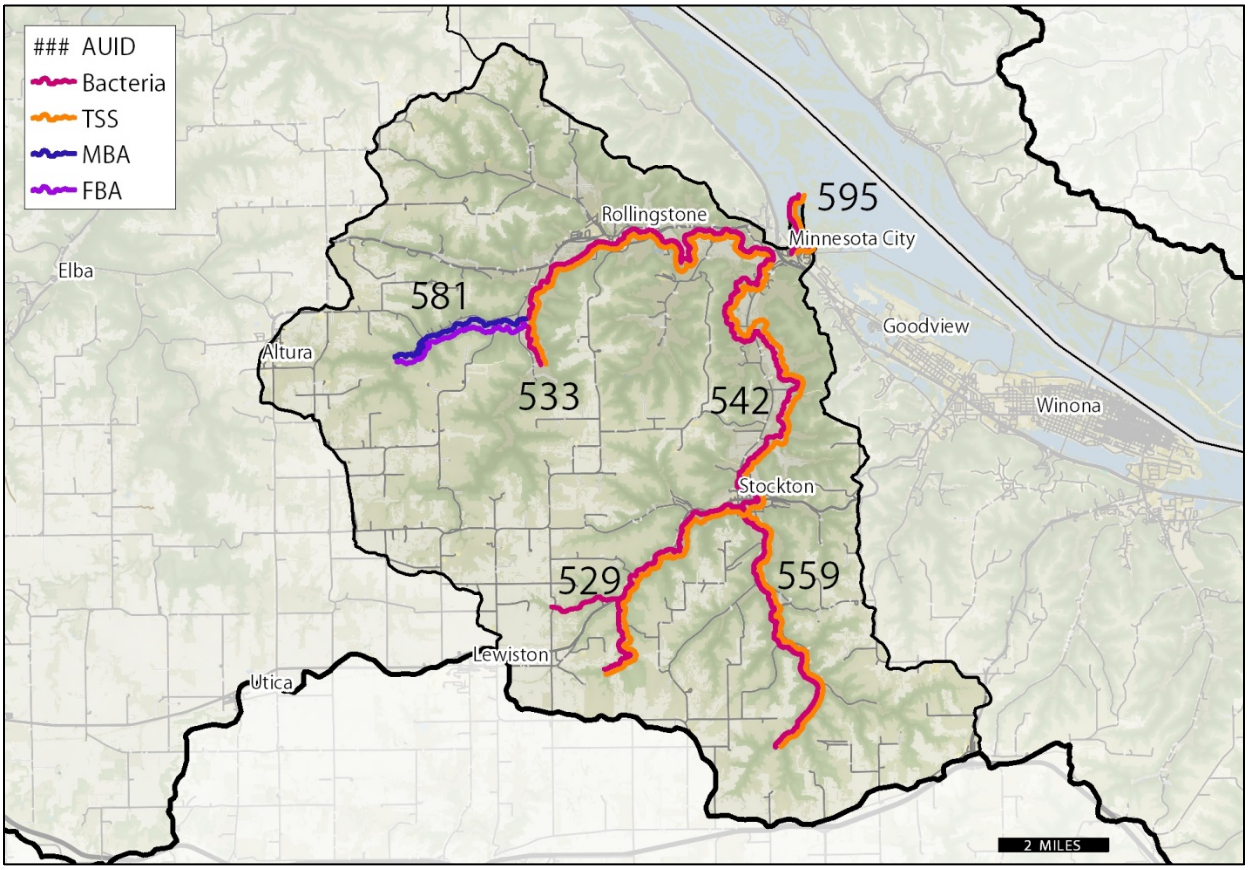



**Figure 36. Impairments for bacteria, TSS, aquatic macroinvertebrates bioassessment (MBA), and fish bioassessment (FBA) in the Garvin Brook Subwatershed. Last three digits of the impaired AUID appear next to the stream reach.**

**Table 8. Implementation table showing an example of strategies and actions proposed for the Garvin Brook Subwatershed that could achieve water quality targets. Primary responsibility columns key: $=financial, T=technical and implementation, P=policy/rule/ordinance, C=capacity building/civic engagement/education, A=All**

| | | | | Water Quality | | | | | Primary Responsibility | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Local | | | | | | | Region | | | State | | | | | | National | | | | |
| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Current Condition | Goals/Targets | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Landowner/Occupier | Private Consultants | Cities & Townships | SRMC WD | Whitewater JPB | SWCDs | County | Ag/Cons. Orgs. | SE WRB | SE Tech JPB | MDA | MPCA | DNR | BWSR | UM Extension | Legislators | Legislators | NRCS | FWS | Estimated Year to Achieve Water Quality Target | Priority |
| Garvin Brook 0704000306 | Bear Creek 581 | Winona | Fish and Macroinvertebrates (Physical Habitat) | Fish IBI: 46 (2010), 39 (2012); Threshold: 45. Macroinvertebrate IBI: 27.3 (2010); 32.9 (2012); Threshold: 46.1 | Increase quality of habitat to improve IBI scores to above threshold levels | Stream Habitat Improvement (9) | Watershed Wide | Work with resource professionals to develop a plan | T | T C | P C | $ C | | $ T C | | $ C | | T | | | $ T C | $ P | | $ | $ | $ T | $ T | 2045 | H |
| | | | | | | Structural Impoundment BMPs (8) | Install 10 structures within the drainage area of this section of stream | Install 2 structures | T | | | $ C | | $ T C | P C | | | T | | | | $ | | $ | $ | $ T C | | | H |
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices | Increased education | T | | | $ C | | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | H |
| | | | Macroinvertebrates (Nitrate) | 74% average of nitrate tolerant species | Diversify community to include more nitrate intolerant species | Nutrient Management BMPs (4) | See Nitrogen Strategies and Scale of Adoption for "All Watersheds" | | T | T C | | $ C | | $ T C | P C | C | $ C | T | | A | | $ | T C | $ P | $ | $ T C | | 2045 | H |
| | | | | | | Riparian Corridor Management (5) | Compliance with shoreland setback rules and all pastures managed through implemented rotational grazing and/or livestock exclusion plans within the riparian buffer area. | Inventory compliance, increase by 75% and implement 1 grazing and/or livestock exclusion plan within this stream section | T | T C | | $ C | | $ T C | P C | T C | | T | | | $ T P | $ P C | C | $ P | $ | $ T | | | H |
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices | Increased education | T | | | $ C | | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | H |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality: Current Condition | Water Quality: Goals/Targets | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Local: Landowner/Occupier | Local: Private Consultants | Local: Cities & Townships | Local: SRMC WD | Local: Whitewater JPB | Local: SWCDs | Local: County | Region: Ag/Cons. Orgs. | Region: SE WRB | Region: SE Tech JPB | State: MDA | State: MPCA | State: DNR | State: BWSR | State: UM Extension | State: Legislators | National: Legislators | National: NRCS | National: FWS | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unnamed cr to Rollingstone cr | | Fish (Dissolved Oxygen) | Daily flux of DO is as high as 4.48 mg/L (proposed water quality standard for DO flux in the central region of the state is 3.5 mg/L) | Diversify fish species to include DO daily flux intolerant species. | Riparian Corridor Management (5) | Compliance with shoreland setback rules and all pastures managed through implemented rotational grazing and/or livestock exclusion plans within the riparian buffer area | Inventory compliance, increase by 75% and implement 1 grazing and/or livestock exclusion plan within this stream section | T | T C | | $ C | | $ T C | P C | T C | | T | | | $ T P | $ P C | C | $ P | $ | $ T | | 2025 | L |
| | | | | | | Structural Impoundment BMPs (8) | Install 10 structures within this subwatershed as discussed in the Physical Habitat stressor of this watershed | Install 2 structures as discussed in the Physical Habitat stressor of this watershed | T | | | $ C | | $ T C | P C | | | T | | | | $ | | $ | $ | $ T C | | | L |
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices | Increased education | T | | | $ C | | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | L |
| | | | Fish and Macroinvertebrates (Temperature) | General lack of coldwater fish species. Fair number of coldwater macroinvertebrate species. | Increase coldwater fish and coldwater tolerant macroinvertebrate species by increasing riparian shading, | Riparian Corridor Management (5) | Compliance with shoreland setback rules and all pastures managed through implemented rotational grazing and/or livestock exclusion plans within the riparian buffer area | Inventory compliance, increase by 75% and implement 1 grazing and/or livestock exclusion plan within this stream section | T | T C | | $ C | | $ T C | P C | T C | | T | | | $ T P | $ P C | C | $ P | $ | $ T | | 2025 | L |
| | | | | | | Structural Impoundment BMPs (8) | Install 10 structures within this subwatershed as discussed in the Physical Habitat stressor of this watershed | Install 2 structures as discussed in the Physical Habitat stressor of this watershed | T | | | $ C | | $ T C | P C | | | T | | | | $ | | $ | $ | $ T C | | | L |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality | | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Primary Responsibility | | | | | | | | | | | | | | | | | | | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Local | | | | | | | Region | | | State | | | | | | National | | | | |
| | | | | Current Condition | Goals/Targets | | | | Landowner/Occupier | Private Consultants | Cities & Townships | SRMC WD | Whitewater JPB | SWCDs | County | Ag/Cons. Orgs. | SE WRB | SE Tech JPB | MDA | MPCA | DNR | BWSR | UM Extension | Legislators | Legislators | NRCS | FWS | | |
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices | Increased education | T | | | $ C | | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | L |
| | Rollingstone Creek | | *E. coli* | 1,514 billion orgs/day seasonal average | 126 org/ 100 mL seasonal geomean | Lower Mississippi River Basin Fecal Coliform Implementation Plan (3) | See "Key to all tables" | See "Key to all tables" | T | T C | | | $ C | $ T C | P C | T C | $ C | T C | | A | | $ | C | $ P | $ | $ T C | | 2045 | H |
| | 533 | | | | | Structural Impoundment BMPs (8) | Install 20 structures within the drainage area of this section of stream | Install 3 structures | T | | | $ C | | $ T C | P C | | | T | | | | $ | | $ | $ | $ T C | | | H |
| | | Winona | | | | Stream and Streambank Restoration (10) | Localized; sites of excessive or accelerated streambank erosion | Work with resource professionals to develop a plan | T | T C | P C | $ C | | $ T C | | $ C | | T | | | $ T C | $ P | | $ | $ | $ T | $ T | | L |
| | Unnamed cr to Garvin Bk | | Suspended Sediment | Loads vary by flow regime; 8,512 kg/day seasonal average | 10 mg/L met 90% of time Apr-Sep | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices. | Increased education | T | | | $ C | | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | 2025 | H |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality: Current Condition | Water Quality: Goals/Targets | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Primary Responsibility – Local: Landowner/Occupier | Local: Private Consultants | Local: Cities & Townships | Local: SRMC WD | Local: Whitewater JPB | Local: SWCDs | Local: County | Region: Ag/Cons. Orgs. | Region: SE WRB | Region: SE Tech JPB | State: MDA | State: MPCA | State: DNR | State: BWSR | State: UM Extension | State: Legislators | National: Legislators | National: NRCS | National: FWS | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Peterson Creek**<br>529<br>T106 R8W S7, west line to Garvin Bk | **Winona** | *E. coli* | 14.8 billion orgs/day | 126 cfu/ 100 mL seasonal geomean | Lower Mississippi River Basin Fecal Coliform Implementation Plan (3) | See "Key to all tables" | See "Key to all tables" | T | T C | | | $ C | $ T C | P C | T C | $ C | T C | | A | | $ | C | $ P | $ | $ T C | | 2045 | H |
| | **Stockton Valley Creek**<br>559<br>T106 R8W S23, south line to Garvin Bk | **Winona** | Suspended Sediment | Loads vary by flow regime; 790 kg/day seasonal average | 10 mg/L met 90% of time Apr-Sep | Structural Impoundment BMPs (8) | Install 20 structures within the drainage area of this section of stream | Install 3 structure | T | | | $ C | | $ T C | P C | | | T | | | | $ | | $ | $ | $ T C | | 2025 | H |
| | | | | | | Stream & Streambank Restoration (10) | Localized; sites of excessive or accelerated streambank erosion | | T | T C | P C | $ C | | $ T C | | $ C | | T | | | $ T C | $ P | | $ | $ | $ T | $ T | | H |
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices | Increased education | T | | | $ C | | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | H |
| | **Garvin Brook**<br>542 and 595 | **Winona** | *E. coli* | 3,811 billion orgs/day seasonal average | 126 org/ 100 mL seasonal geomean | Lower Mississippi River Basin Fecal Coliform Implementation Plan (3) | See "Key to all tables" | See "Key to all tables" | T | T C | | | $ C | $ T C | P C | T C | $ C | T C | | A | | $ | C | $ P | $ | $ T C | | 2045 | H |
| | | | Suspended Sediment | Loads vary by flow regime; 16,591 kg/day seasonal average | 65 mg/L met 90% of time Apr-Sep | Structural Impoundment BMPs (8) | Install 20 structures within the Garvin Brook (HUC 10) Watershed in addition to all planned structures in upstream watersheds | Install 2 structures | T | | | $ C | | $ T C | P C | | | T | | | | $ | | $ | $ | $ T C | | 2025 | H |
| | | | | | | | Cleanout and rehab of existing structures throughout the Garvin Brook (HUC 10) Watershed | 10 cleanouts and rehabs | T | | | $ C | | $ T C | P C | | | T | | | | $ | | $ | $ | $ T C | | | H |

| | | | | Water Quality | | | | | Primary Responsibility | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Local | | | | | | | Region | | | State | | | | | | National | | | | |
| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Current Condition | Goals/Targets | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Landowner/Occupier | Private Consultants | Cities & Townships | SRMC WD | Whitewater JPB | SWCDs | County | Ag/Cons. Orgs. | SE WRB | SE Tech JPB | MDA | MPCA | DNR | BWSR | UM Extension | Legislators | Legislators | NRCS | FWS | Estimated Year to Achieve Water Quality Target | Priority |
| | T107 R8W S2, south line to Mississippi R (Burleigh Slough) | | | | | Stream & Streambank Restoration (10) | Localized; sites of excessive or accelerated streambank erosion | Work with resource professionals to develop a plan | T | T C | P C | $ C | | $ T C | | $ C | | T | | | $ T C | $ P | | $ | $ | $ T | $ T | | H |
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices | Increased education | T | | | $ C | | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | H |

### City of Winona Subwatershed Strategies

In the city of Winona Subwatershed, there are impairments for aquatic life based on macroinvertebrate communities and impairments for aquatic recreation in two lake basins based on excess nutrient levels (Figure 37).

There are not any critical areas identified within this subwatershed (Table 9).


**Figure 37. Impairments for aquatic macroinvertebrates bioassessment (MBA), and nutrients in the city of Winona Subwatershed. Last three digits of the impaired AUID appear next to the stream reach**

**Table 9. Implementation table showing an example of strategies and actions proposed for the city of Winona Subwatershed that could achieve water quality targets. Primary responsibility columns key: $=financial, T=technical and implementation, P=policy/rule/ordinance, C=capacity building/civic engagement/education, A=All**

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality: Current Condition | Water Quality: Goals/Targets | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Local: Landowner/Occupier | Local: Private Consultants | Local: Cities & Townships | Local: SRMC WD | Local: Whitewater JPB | Local: SWCDs | Local: County | Region: Ag/Cons. Orgs. | Region: SE WRB | Region: SE Tech JPB | State: MDA | State: MPCA | State: DNR | State: BWSR | State: UM Extension | State: Legislators | National: Legislators | National: NRCS | National: FWS | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| City of Winona | Gorman Creek 569 | Wabasha | Macroinvertebrates (Physical Habitat) | Macroinvertebrate IBI: 36.4; Threshold: 46.8 | Increase quality of habitat to improve IBI scores to above threshold levels | Structural Impoundment BMPs (8) | Install 10 structures within the drainage area of this section of stream | Install 1 structure | T | | | | | $ T C | P C | | | T | | | | $ | | $ | $ | $ T C | | 2045 | M |
| | | | | | | Stream & Streambank Restoration (10) | Localized; sites of excessive or accelerated streambank erosion | Work with resource professionals to develop a plan | T | T C | P C | | | $ T C | | $ C | | T | | | $ T C | $ P | | $ | $ | $ T | $ T | | M |
| | | | | | | Soil health BMPs (6) | Increased education on soil health and a 25% increase in landowner adoption of soil health practices | Increased education | T | | | | | $ T C | P C | $ T C | $ C | T C | $ C | | | $ | T C | $ P | $ P | $ T C | | | M |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality | | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Primary Responsibility | | | | | | | | | | | | | | | | | | | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Local | | | | | | | Region | | | State | | | | | | National | | | | |
| | | | | Current Condition | Goals/Targets | | | | Landowner/Occupier | Private Consultants | Cities & Townships | SRMC WD | Whitewater JPB | SWCDs | County | Ag/Cons. Orgs. | SE WRB | SE Tech JPB | MDA | MPCA | DNR | BWSR | UM Extension | Legislators | Legislators | NRCS | FWS | | |
| | T110 R10W S27, west line to Unnamed Cr | | | | | Riparian Corridor Management (5) | Compliance with shoreland setback rules and all pastures managed through implemented rotational grazing and/or livestock exclusion plans within the riparian buffer area | Inventory compliance, increase by 30% and implement 1 grazing and/or livestock exclusion plan within this stream section | T | T C | | | | $ T C | P C | T C | | T | | | $ T P | $ P C | C | $ P | $ | $ T | | | H |
| | | | Macroinvertebrates (Connectivity) | 2 small dams contributing to sediment deposition | Potential dam removal to reduce sediment deposition | Additional Monitoring & Evaluation | Determine extent of impact and feasibility of removal; remove if needed and feasible | Determine extent of impact | | | | | | | | | | | | C | $ T C | | | $ | | | | | M |
| | **Snake Creek** | **Wabasha** | - | | | Protection (11) | See "Key to all tables" | | T | T C | T C | $ T C | $ T C | $ T C | A | T C | T C | T | $ C | $ C | $ T P | $ P C | T C | $ P | $ P | $ T | $ T | | |
| | **East Indian Creek** | **Wabasha & Winona** | - | - | - | Protection (11) | See "Key to all tables" | | T | T C | T C | $ T C | $ T C | $ T C | A | T C | T C | T | $ C | $ C | $ T P | $ P C | T C | $ P | $ P | $ T | $ T | | |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality | | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Primary Responsibility | | | | | | | | | | | | | | | | | | | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Local | | | | | | | Region | | | State | | | | | | National | | | | |
| | | | | Current Condition | Goals/Targets | | | | Landowner/Occupier | Private Consultants | Cities & Townships | SRMC WD | Whitewater JPB | SWCDs | County | Ag/Cons. Orgs. | SE WRB | SE Tech JPB | MDA | MPCA | DNR | BWSR | UM Extension | Legislators | Legislators | NRCS | FWS | | |
| | **Winona (Southeast Bay)** | **Winona** | Excess Nutrients /Eutrophication | 901 kg seasonal load | 635 kg seasonal load | Engagement, education (1, 2) | See "Key to all tables" | Grow "Healthy Lake Winona" campaign and related work, including storm drain stenciiing | | T C | A | | | C | C | | | | | T C | | | C | $ P | | | | 2025 | H |
| | 85-0011-01 | | | | | Urban stormwater management (7) | Reduce peak runoff and improve water quality in runoff from lawns, streets and business areas; see "Key to all tables." | | T | T C | A | | | $ T C | C | | | | | T C | | $ | C | $ P | | | | | M |
| | **Winona (Northwest Bay)** | **Winona** | Excess Nutrients /Eutrophication | 947 kg seasonal load | 643 kg seasonal load | Engagement, education (1,2) | See "Key to all tables" | Grow "Healthy Lake Winona" campaign and related work, including storm drain stenciiing | | T C | A | | | C | C | | | | | T C | | | C | $ P | | | | 2025 | H |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality | | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Primary Responsibility | | | | | | | | | | | | | | | | | | | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Local | | | | | | | Region | | | State | | | | | | National | | | | |
| | | | | Current Condition | Goals/Targets | | | | Landowner/Occupier | Private Consultants | Cities & Townships | SRMC WD | Whitewater JPB | SWCDs | County | Ag/Cons. Orgs. | SE WRB | SE Tech JPB | MDA | MPCA | DNR | BWSR | UM Extension | Legislators | Legislators | NRCS | FWS | | |
| | 85-0011-02 | | | | | Urban stormwater management (7) | Reduce peak runoff and improve water quality in runoff from lawns, streets and business areas; see "Key to all tables." | | T | T C | A | | | $ T C | C | | | | | T C | | $ | C | $ P | | | | | H |
| | | | | | | Remove nutrient laden soils/sludge from bottom of lake | - | Conduct a feasibility study | | | $ P C | | | C | C | | C | | | T C | T C | | C | $ P | | | T | | H |
| | **Homer Valley** | **Winona** | **-** | - | - | Protection (11) | See "Key To All Tables" | | T | T C | T C | $ T C | $ T C | $ T C | A | T C | T C | T | $ C | $ C | $ T P | $ P C | T C | $ P | $ P | $ T | $ T | | |
| | **Pleasant Valley, East Burns, West Burns and Gilmore Creek** | **Winona** | **-** | - | - | Protection (11) | See "Key To All Tables" | | T | T C | T C | $ T C | $ T C | $ T C | A | T C | T C | T | $ C | $ C | $ T P | $ P C | T C | $ P | $ P | $ T | $ T | | |
| | **Cedar Creek** | **Winona** | **-** | - | - | Protection (11) | See "Key To All Tables" | | T | T C | T C | $ T C | $ T C | $ T C | A | T C | T C | T | $ C | $ C | $ T P | $ P C | T C | $ P | $ P | $ T | $ T | | |

| HUC-10 Subwatershed | Waterbody | Location & Upstream Influence Counties | Parameter (pollutant, stressor & non-pollutant) | Water Quality | | Strategies | Estimated scale of adoption needed to meet minimal water quality target | Interim 10-yr. Milestones | Primary Responsibility | | | | | | | | | | | | | | | | | | | Estimated Year to Achieve Water Quality Target | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Local | | | | | | | Region | | | State | | | | | | National | | | | |
| | | | | Current Condition | Goals/Targets | | | | Landowner/Occupier | Private Consultants | Cities & Townships | SRMC WD | Whitewater JPB | SWCDs | County | Ag/Cons. Orgs. | SE WRB | SE Tech JPB | MDA | MPCA | DNR | BWSR | UM Extension | Legislators | Legislators | NRCS | FWS | | |
| | **Big Trout Creek 592** | **Winona** | **Macroinvertebrates (Physical Habitat)** | Macroinvertebrate IBI: 55.7, 81.2, 34.3; Threshold: 46.1 | Increase quality of habitat to improve IBI scores to above threshold levels | Stream & Streambank Restoration (10) | Focus on headwater area | Work with resource professionals to develop a plan | T | T C | P C | | | $ T C | | $ C | | T | | | $ T C | $ P | | $ | $ | $ T | $ T | 2045 | L |
| | **Little Trout Creek (Pickwick Valley)** | **Winona** | **-** | - | - | Protection (11) | See "Key To All Tables" | | T | T C | T C | $ T C | $ T C | $ T C | A | T C | T C | T | $ C | $ C | $ T P | $ P C | T C | $ P | $ P | $ T | $ T | | |

# 4. Monitoring Plan

Future monitoring in the MRWW will be according to the watershed approach framework. The IWM strategy utilizes a nested watershed design allowing the aggregation of watersheds from a coarse to a fine scale. The foundation of this comprehensive approach is the 80 major watersheds within Minnesota. Streams are segmented by HUC. The IWM occurs in each major watershed once every 10 years (MPCA 2012). The MRWW Monitoring and Assessment Report provides detailed discussion of IWM and how it will be applied going forward. IWM is scheduled to occur in the MRWW again in 2020.

Watershed pollutant load monitoring at three locations (two gages to monitor 10 HUC level watershed, and one at the 8 HUC outlet) in the MRWW is on-going and will be used to track implementation effectiveness of sediment, nitrogen, and phosphorus loads in the MRWW; these sites are instrumented and gauged to track flow volumes, and are intensively monitored by the MPCA staff and local government partners.

For bacteria, the Revised Regional TMDL Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota (MPCA 2007) includes a monitoring section that describes activities and responsibilities pertaining to the greater regional examination of pathogens in surface water, of which the MRWW is a part. Also, the Revised Regional TMDL Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota Implementation Plan notes that to fully understand the cause of pathogen issues in this portion of Minnesota, research needs to include, but are not limited to:

- Study of sources of pathogens in cities and urban areas;
- Better understanding of load reduction capabilities for applicable structural and non-structural BMPs;
- Models to evaluate loading sources and track load reductions;
- Methods to evaluate pollutant migration pathways and delivery mechanisms from pathogen sources to surface waters, both generally and in karsted landscapes;
- DNA “fingerprinting” to identify pathogen sources.

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# Appendices

## Appendix A. Information from the Minnesota Department of Health's database on public and private wells within subdivisions of the MRWW.

Overview Information on drinking water wells within the MRWW:

| Private Wells with Known Locations | Private Wells Depth Range, Average Depth, Median Depth (ft) (1) | Private Wells in Highly Vulnerable Settings | Public Wells with Known Locations | Public Wells Depth Range, Average Depth, Median Depth (ft) (1) | Public Wells in Highly Vulnerable Settings |
|---|---|---|---|---|---|
| **1,870** | Range: **20-775;** Average: **260;** Median: **180** | **846** | **110** | Range: **53-1,077;** Average: **381;** Median: **400** | **58** |

(1) = Wells Depth Range, Average Depth, and Median Depth based on wells with valid 'Depth Completed' information in County Well Index.

Further information on drinking water wells within HUC12 subdivisions of the MRWW:

| HUC 12 Watershed Code | HUC 12 Watershed Name | Private Wells with Known Locations | Private Wells Depth Range, Average Depth, Median Depth (ft) (1) | Private Wells in Highly Vulnerable Settings | Public Wells with Known Locations | Public Wells Depth Range, Average Depth, Median Depth (ft) (1) | Public Wells in Highly Vulnerable Settings |
|---|---|---|---|---|---|---|---|
| 070400030308 | Beaver Creek | **15** | Range: **116-725;** Average: **424;** Median: **375** | **7** | 0 | n/a | 0 |
| 070400030104(*) | Big Creek | 0 | n/a | 0 | 0 | n/a | 0 |
| 070400030609 | Big Trout Creek | **69** | Range: **81-653;** Average: **321;** Median: **180** | **10** | **5** | **630** | **4** |
| 070400030604 | Buffalo City-Mississippi River | **61** | Range: **55-635;** Average: **137;** Median: **100** | **37** | **5** | Range: **83-307;** Average: **204;** Median: **223** | **3** |

| HUC 12 Watershed Code | HUC 12 Watershed Name | Private Wells with Known Locations | Private Wells Depth Range, Average Depth, Median Depth (ft) (1) | Private Wells in Highly Vulnerable Settings | Public Wells with Known Locations | Public Wells Depth Range, Average Depth, Median Depth (ft) (1) | Public Wells in Highly Vulnerable Settings |
|---|---|---|---|---|---|---|---|
| 070400030608 | Cedar Creek | **58** | Range: **85-775;** Average: **322;** Median: **225** | **10** | **6** | Range: **353-630;** Average: **447;** Median: **359** | **3** |
| 070400030601 | City of Wabasha-Mississippi River | **179** | Range: **53-605;** Average: **104;** Median: **70** | **153** | **7** | Range: **65-200;** Average: **124;** Median: **87** | **7** |
| 070400030610 | City of Winona-Mississippi River | **183** | Range: **43-770;** Average: **170;** Median: **120** | **117** | **13** | Range: **110-517;** Average: **443;** Median: **493** | **8** |
| 070400030401(*) | Danuser Valley-Waumaundee River | 0 | n/a | 0 | 0 | n/a | 0 |
| 070400030302 | Dry Creek | **43** | Range: **60-730;** Average: **324;** Median: **318** | **27** | **1** | **420** | 0 |
| 070400030404(*) | Eagle Creek | 0 | n/a | 0 | 0 | n/a | 0 |
| 070400030603 | East Indian Creek | **25** | Range: **53-680;** Average: **343;** Median: **355** | **7** | 0 | n/a | 0 |
| 070400030202(*) | Elk Creek | 0 | n/a | 0 | 0 | n/a | 0 |

| HUC 12 Watershed Code | HUC 12 Watershed Name | Private Wells with Known Locations | Private Wells Depth Range, Average Depth, Median Depth (ft) [1] | Private Wells in Highly Vulnerable Settings | Public Wells with Known Locations | Public Wells Depth Range, Average Depth, Median Depth (ft) [1] | Public Wells in Highly Vulnerable Settings |
|---|---|---|---|---|---|---|---|
| 070400030606 | Fountain City-Mississippi River | **41** | Range: **58-650;** Average: **146;** Median: **108** | **27** | **5** | **69** | **5** |
| 070400030502 | Garvin Brook | **217** | Range: **70-675;** Average: **228;** Median: **156** | **49** | **13** | Range: **145-660;** Average: **389;** Median: **380** | **4** |
| 070400030107[*] | Harvey Creek | 0 | n/a | 0 | 0 | n/a | 0 |
| 070400030204[*] | Hutchinson Creek-Buffalo River | 0 | n/a | 0 | 0 | n/a | 0 |
| 070400030403[*] | Irish Valley-Waumaundee River | 0 | n/a | 0 | 0 | n/a | 0 |
| 070400030402[*] | Little Waumaundee Creek | 0 | n/a | 0 | 0 | n/a | 0 |
| 070400030303 | Logan Branch | **46** | Range: **60-675;** Average: **343;** Median: **350** | **35** | 0 | n/a | 0 |
| 070400030304 | Lower North Fork Whitewater River | **79** | Range: **45-635;** Average: **378;** Median: **380** | **51** | **9** | Range: **303-710;** Average: **437;** Median: **418** | **3** |

| HUC 12 Watershed Code | HUC 12 Watershed Name | Private Wells with Known Locations | Private Wells Depth Range, Average Depth, Median Depth (ft) [(1)] | Private Wells in Highly Vulnerable Settings | Public Wells with Known Locations | Public Wells Depth Range, Average Depth, Median Depth (ft) [(1)] | Public Wells in Highly Vulnerable Settings |
|---|---|---|---|---|---|---|---|
| 070400030307 | Lower South Fork Whitewater River | **113** | Range: **57-698;** Average: **400;** Median: **400** | **60** | **6** | Range: **175-550;** Average: **379;** Median: **395** | **4** |
| 070400030305 | Middle Fork Whitewater River | **128** | Range: **35-694;** Average: **308;** Median: **300** | **84** | **11** | Range: **53-407;** Average: **203;** Median: **201** | **7** |
| 070400030205[(*)] | Mill Creek-Buffalo River | 0 | n/a | 0 | 0 | n/a | 0 |
| 070400030101[(*)] | North Fork of the Buffalo River | 0 | n/a | 0 | 0 | n/a | 0 |
| 070400030106[(*)] | Peeso Creek | 0 | n/a | 0 | 0 | n/a | 0 |
| 070400030103[(*)] | Pine Creek-Buffalo River | 0 | n/a | 0 | 0 | n/a | 0 |
| 070400030607 | Pleasant Valley Creek | **257** | Range: **20-715;** Average: **255;** Median: **170** | **44** | **8** | Range: **445-1,077;** Average: **777;** Median: **794** | **4** |
| 070400030501 | Rollingstone Creek | **106** | Range: **75-609;** Average: **286;** Median: **202** | **16** | **5** | Range: **372-703;** Average: **494;** Median: **410** | **2** |
| 070400030605[(*)] | Rose Valley Creek | 0 | n/a | 0 | 0 | n/a | 0 |

| HUC 12 Watershed Code | HUC 12 Watershed Name | Private Wells with Known Locations | Private Wells Depth Range, Average Depth, Median Depth (ft) [(1)] | Private Wells in Highly Vulnerable Settings | Public Wells with Known Locations | Public Wells Depth Range, Average Depth, Median Depth (ft) [(1)] | Public Wells in Highly Vulnerable Settings |
|---|---|---|---|---|---|---|---|
| 070400030108[(*)] | Rossman Creek-Buffalo River | 0 | n/a | 0 | 0 | n/a | 0 |
| 070400030602 | Snake Creek | **45** | Range: **62-617;** Average: **209;** Median: **118** | **21** | **4** | Range: **104-141;** Average: **126;** Median: **129** | **2** |
| 070400030201[(*)] | South Fork of Elk Creek | 0 | n/a | 0 | 0 | n/a | 0 |
| 070400030102[(*)] | South Fork of the Buffalo River | 0 | n/a | 0 | 0 | n/a | 0 |
| 070400030203[(*)] | Tamarack Creek | 0 | n/a | 0 | 0 | n/a | 0 |
| 070400030105[(*)] | Trout Creek-Buffalo River | 0 | n/a | 0 | 0 | n/a | 0 |
| 070400030309 | Trout Creek | **20** | Range: **20-620;** Average: **331;** Median: **398** | **2** | **1** | **100** | 0 |
| 070400030302 | Upper North Fork Whitewater River | **43** | Range: **60-730;** Average: **324;** Median: **318** | **27** | **1** | **420** | 0 |
| 070400030306 | Upper South Fork | **93** | Range: **60-705;** Average: | **45** | **7** | Range: **490-736;** Average: | **1** |

| HUC 12 Watershed Code | HUC 12 Watershed Name | Private Wells with Known Locations | Private Wells Depth Range, Average Depth, Median Depth (ft) [(1)] | Private Wells in Highly Vulnerable Settings | Public Wells with Known Locations | Public Wells Depth Range, Average Depth, Median Depth (ft) [(1)] | Public Wells in Highly Vulnerable Settings |
|---|---|---|---|---|---|---|---|
| | Whitewater River | | **344;** Median: **386** | | | **621;** Median: **612** | |
| 070400030405[(*)] | Waumaundee Creek | 0 | n/a | 0 | 0 | n/a | 0 |
| 070400030309 | Whitewater River | **20** | Range: **20-620;** Average: **331;** Median: **398** | **2** | **1** | **100** | 0 |
| 070400030310 | Whitewater River | **29** | Range: **56-620;** Average: **272;** Median: **146** | **15** | **2** | Range: **142-326;** Average: **234;** Median: **234** | **1** |

# Appendix B. Permitted point sources in the Mississippi River-Winona Watershed that have continuous or controlled flow leaving the site.

Refer to the MRWW TMDL Report (MPCA 2016) for more information. All stormwater permit holders other than the one MS4 in the watershed, were omitted.

| HUC-10 Subwatershed (Number and Name) | Point Source | | |
|---|---|---|---|
| | Name | Permit # | Type |
| **0704000303** | Altura WWTP | MN0021831 | Municipal |
| | Plainview Elgin Sanitary District | MN0055361 | Municipal |
| | Utica WWTP | MN0022055 | Municipal |
| | Whitewater River Regional WWTP | MN0046868 | Municipal |
| | Lakeside Foods Inc - Plainview | MN0047465 | Industrial |
| | Gar-Lin Dairy Site 1 | MNG440496 | CAFO |
| **Whitewater River** | Gar-Lin Dairy Site 2 | MNG440496 | CAFO |
| | Daley Farms of Lewiston LLP | MN0067652 | CAFO |
| | Holden Farms Inc - St Charles | MNG440331 | CAFO |
| | Shea Dairy Inc | MN0070181 | CAFO |
| | Diamond K Dairy Inc | MN0064629 | CAFO |
| | MDNR Crystal Springs State Fish Hatchery | MN0004421 | Industrial |
| | Bennett & Sons Sand & Gravel: Elgin Pit | MNG490308 | Industrial (Mining) |
| | Plainview Milk Products Coop | MN0000311 | Industrial |
| **0704000305** | Minnesota City WWTP | MN0069817 | Municipal |
| | Rollingstone WWTP | MNG580078 | Municipal |
| **Garvin Brook** | Stockton WWTP | MNG580079 | Municipal |
| | Technical Die-Casting Inc. | MNG250065 | Industrial |
| **0704000306** | Wabasha WWTP | MN0025143 | Municipal |
| | Winona WWTP | MN0030147 | Municipal |
| | Whitewater Dairy LLC | MN0070696 | CAFO |

| HUC-10 Subwatershed (Number and Name) | Point Source | | |
|---|---|---|---|
| | Name | Permit # | Type |
| **City of Winona-Mississippi River** | Bennett & Sons Sand & Gravel: Bennett-Graner Pit and Bennett-Hager Pit | MNG490308 | Industrial (Mining) |
| | Biesanz Stone Co Inc: Biesanz Quarry and Biesanz Stone Company Site #2 | MNG490124 | Industrial (Mining) |
| | Badger Foundry Co | MNG250010 | Industrial |
| | Cytec Engineered Materials Inc | MN0003441 | Industrial |
| | Peerless Chain Co | MN0001325 | Industrial |
| | Winona GW/Leaf Services | MNG790164 | Industrial |
| | Winona City MS4 | MS400247 | Stormwater MS4 |

## Appendix C. Summary of Mississippi River-Winona SWAT Models. (MPCA)

Hydrologic models were used to support decision-making for sediment and nutrient reduction strategies in the Mississippi-Winona Basin. SWAT (Soil and Water Assessment Tool) models were developed for this purpose for the Whitewater Watershed and as a combined model for the Garvin Brook and Rollingstone Watersheds within the Mississippi-Winona. The following describes calibration and results of these models.

**SWAT Development**

SWAT models simulate landscape and hydrologic processes in a basin and are noted for accuracy in agricultural land management simulations. The model is based on and calibrated using multiple sources of temporal and observed data. The Mississippi-Winona models were created by Emmons & Oliver Resources, Inc. (EOR), an environmental consulting company and completed in 2014 and then updated in 2016. The Whitewater Farmer-Led Council (WFLC) provided critical input in the development of model scenarios and provided commentary on model performance. For any questions regarding these models, please contact Ben Roush (Benjamin.Roush@state.mn.us) or Chuck Regan (Chuck.Regan@state.mn.us) at the MPCA.

**Subwatershed Creation and Delineation**

The Whitewater (WW) and Garvin Brook/Rollingstone (GAR) Watersheds were subdivided into 135 and 61 subwatersheds respectively. The GAR model includes both the Garvin Brook and Rollingstone Creek streams. Each of these subwatersheds is characterized by a distinct collection of land use, soil properties, landscape scope, and proximity to meteorological stations (used by the model for hydrologic calibration). Landscape data was compiled from multiple federal, state, and local organizations including the WFLC and included:

- Streamflow network
- Soil information
- Generalized farm pond locations
- Soil type (hydric properties, sand/silt/clay content, erodibility etc.)
- Crop type and rotation
- Grassed waterways
- Crop management options (fertilization, tillage, manure application)
- Point sources

**Modeled Period**

Land use data was collected between 2007 and 2011, however the because of the greater availability of flow data, the Whitewater model was simulated for the periods 1975 through 1985, 1993 through 1999, 2008 through 2010. This allowed greater calibration with observed hydrologic data during annual changes in meteorology. Because of lack of data availability in the Garvin Brook and Rollingstone Watersheds, the GAR model was simulated only for the period between 2009 and 2012.

**Calibration – Hydrology**

Five flow monitoring stations were used for calibration of hydrologic flow in the Whitewater model with the primary calibration point at Beaver, Minnesota. The GAR model was calibrated at the outlets of the Garvin Brook and the Rollingstone Creek Subbasins.

Hydrologic calibration in the Whitewater model was considered good overall by EOR staff, but the model results matched most appropriately between the 1975 and 1985-time period and the 2008 through 2010-time period. There were also issues in under-predicting storm peaks in the Middle Branch of the Whitewater. Complications in calibration might stem from groundwater loss via karst features and from the inaccurate timing of snowmelt hydrology. Figures 38-40 show calibration results in the Whitewater Watershed during different historical periods.

**Figure 38: Whitewater Watershed Hydrologic Calibration (1975-1985). "MPCA" data includes all observed data and was provided to EOR by the MPCA**

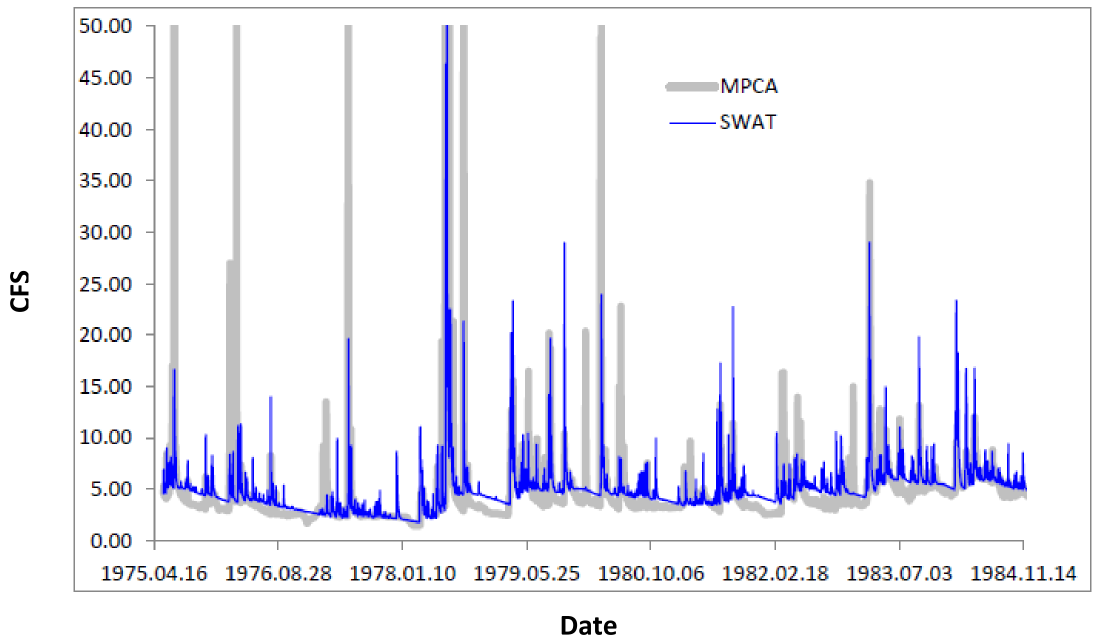


**Figure 39: Whitewater Watershed Hydrologic Calibration (1993-1999). "MPCA" data includes all observed data and was provided to EOR by the MPCA.**

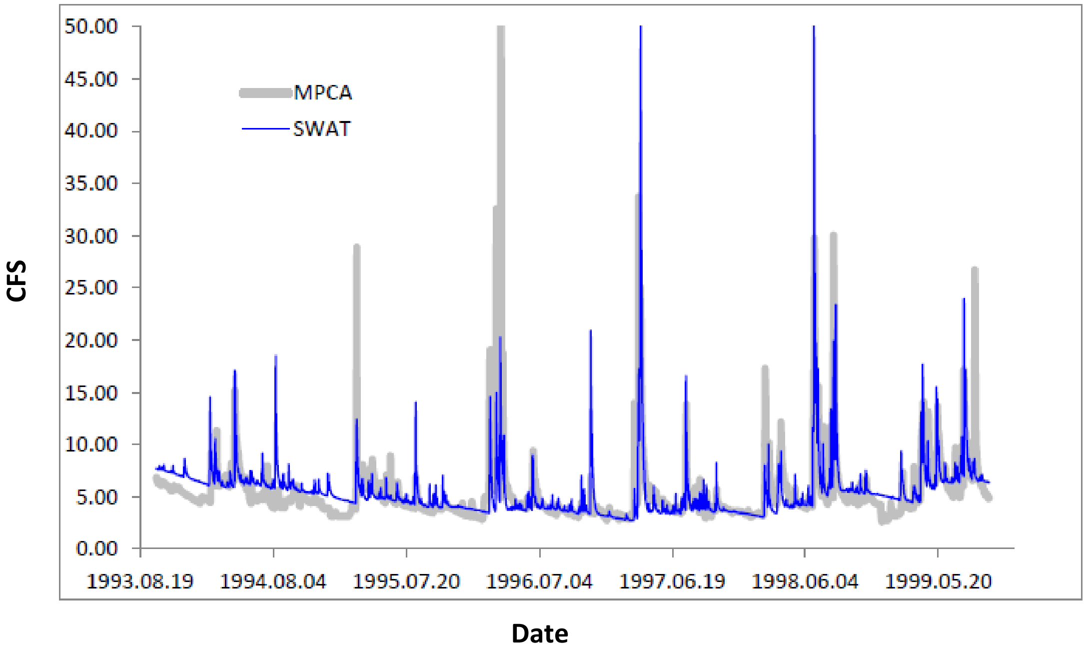
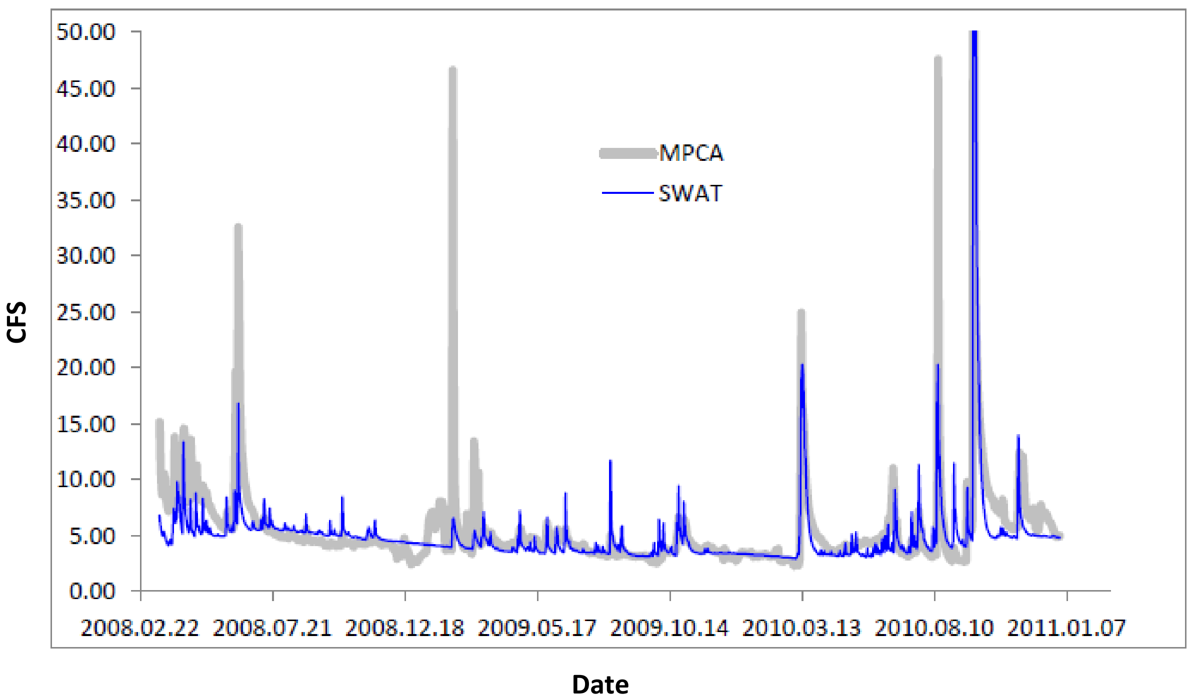



**Figure 40: Whitewater Watershed Hydrologic Calibration (2008-2010). "MPCA" data includes all observed data and was provided to EOR by the MPCA.**



The GAR model calibration was also considered acceptable by EOR staff, but as with the Whitewater, simulation of the karsted groundwater component of flow was challenging. Monthly water balance calibrations were stronger than daily and monthly comparisons with observed flows.

**Calibration – Sediment**

In the Whitewater model, the primary calibration point for sediment was also at Beaver, Minnesota. Total suspended sediment concentrations were developed in the model differently based on different flow ranges (either greater or less than 535 cfs). Sediment was calibrated independently in the GAR model when the model was updated in 2016.

The model adhered to a 40%/60% split between field and non-field sediment sources, respectively based upon researched observations in similar circumstances in Minnesota (Schottler, St. Croix Research Station). Non-field sediment included bank and bluff erosion activities. Calibration was meant to highlight the importance of the potential for BMPs to reduce sediments, so in-channel deposition and erosion were 'turned off,' or removed from model simulation, so all field sediment transport to the stream would be continue to downstream areas and be represented in model output data. Baseflow sediment transport was also not included in this model.

EOR staff considered sediment calibration in the Whitewater model acceptable, but best between the 1975 to 1985 and 2009 to 2010 periods. SWAT loads in the 1993 to 1999 periods were found to be over-predictions. Calibration problems could stem from the likelihood that the 40%/60% split would not be consistent over time or spatially across the watershed. Sediment was well calibrated in the GAR model despite issues modeling channel load for low and baseflow conditions.

**Calibration – Nitrate**

Nitrate data used in calibration of the Whitewater model was mostly collected during 2009 at Beaver, Minnesota. This set of data had a 5.28 mg/L flow-weighted mean concentration which was fairly consistent annually. Because of this observed data, and because fertilizer and manure application data was not available before 2008, the model was only calibrated during the time period between 2008 and 2010. There was insufficient observed data in the Garvin Brook Watershed to calibrate for nitrate in the GAR model.

Calibration was acceptable, but under-predicted nitrate in the Whitewater Watershed because of unknown/missing nitrate source. Low atmospheric deposition of nitrate in the simulation could account for the under-prediction of nitrate as could vertical transport of nitrate through shallow karst systems.

**Phosphorus**

There was no calibration for phosphorus in either the Whitewater or GAR models. Phosphorus was considered a function of sediment. The model simulated that 6% of phosphorus was dissolved, 47% was mineral-attached, and the remaining 47% was accounted for by organic particulates.

**Model Scenarios**

Along with base observed data, the models were simulated with six scenarios designed to determine the effect of land use management change and varying nutrient application strategies on watershed water quality. BMP parameters within SWAT were adjusted based on various values found in literature. These were:

1. Grassed Waterways: Grassed waterways on all crop/pasture/alfalfa land with Stream Power Index* greater or equal to four. This would likely include areas where grassed waterways are already present on the landscape.
2. Ponds (Dredged): Dredging of existing ponds to design standard, thereby increasing sediment-trapping efficiency of existing ponds. Note: There was significant under-prediction of nitrate, phosphorus, and sediment reductions with this scenario, stemming from pond volume insensitivity compared to drainage area. This made the scenario largely unusable for strategy development and land management purposes.
3. Ponds (Avg. Conditions): Adding ponds so that the average ratio of row-crop area draining to ponds compared to row-crop drainage area is met. Subbasins at ratios already greater than this average ratio were not adjusted. In the Whitewater, 36% of cropland should drain to ponds, while 34% of Garvin Brook cropland should drain to ponds.
4. Longer Crop Rotations: Six-year corn/silage/alfalfa (two years each) on current continuous corn crop lands and six-year corn/soybean/alfalfa (two years each) on current corn-soybean rotation croplands.
5. Cover Crops: Adding fall winter rye to both corn and corn-soybean croplands.
6. No-Till: No-till during soybean years in corn-soybean and sweet corn-soybean rotation croplands.

*Stream Power Index measures the erosive power of overland water flow as a function of local slope and upstream drainage area (University of Minnesota – Duluth NRRI). In this model, the value of four was chosen as the cutoff for further analysis of grassed waterway placement.

**Model Results and Notes**

All scenarios were run for the entire landscape, and for the top 25% and top 50% most erodible subwatersheds based on sediment load that the model produced with existing conditions. Table 1 shows the reductions in sediment, nitrate, and total phosphorus (TP) load for Whitewater and the Garvin Brook/Rollingstone Watersheds for each scenario under top 25%, top 50%, and full implementation. Note that in many cases, there is minimal reduction between implementation on the top 50% level and full implementation.

**Table 10: Scenario Reductions at the watershed outlet; "Row-crop Conv. to Grasses" represents maximum reductions. 'SED' = sediment; "NO3" = nitrate; "TP" = total phosphorus.**

| | Whitewater | | | Garvin Brook | | |
|---|---|---|---|---|---|---|
| **Conservation Scenario** | **SED** | **NO3** | **TP** | **SED** | **NO3** | **TP** |
| Row-crop Conv. to Grasses | 37% | 78% | 35% | 38% | 65% | 36% |
| Grassed Waterways (SPI>=4) | | | | | | |
| All | 5% | <1% | 4% | 6% | <1% | 6% |
| top 25% | 4% | <1% | 4% | 4% | <1% | 4% |
| top 50% | 5% | <1% | 4% | 4% | <1% | 4% |
| Ponds (Dredged) | | | | | | |
| All | <1% | <1% | <1% | <1% | <1% | <1% |
| top 25% | <1% | <1% | <1% | <1% | <1% | <1% |
| top 50% | <1% | <1% | <1% | <1% | <1% | <1% |
| Ponds (avg condition) | | | | | | |
| All | 4% | 6% | 10% | 3% | 4% | 3% |
| top 25% | 3% | 2% | 8% | 2% | 1% | 2% |
| top 50% | 4% | 3% | 10% | 3% | 2% | 2% |
| Longer Crop Rotations | | | | | | |
| All | 10% | 22% | 10% | 3% | 6% | 3% |
| top 25% | 9% | 12% | 8% | 2% | 4% | 2% |
| top 50% | 10% | 19% | 10% | 2% | 5% | 2% |
| Cover Crops | | | | | | |
| All | 11% | <1% | 11% | 3% | 0% | 3% |
| top 25% | 9% | <1% | 9% | 2% | 0% | 2% |
| top 50% | 11% | <1% | 10% | 3% | 0% | 2% |
| No-Till | | | | | | |
| All | 7% | -2% | 7% | 2% | -1% | 2% |
| top 25% | 6% | -1% | 6% | 1% | <1% | 1% |
| top 50% | 7% | -2% | 7% | 2% | <1% | 1% |

**Scenario 1 (Grassed Waterways)**

In SWAT modeling, no run-off is infiltrated through grassed waterways. Instead, grassed waterways are designed to only reduce sediment flows. Therefore, we will see minimal nitrate reduction in this scenario. SWAT grassed waterways also will not account for real-world reduction of gullying from establishment of vegetation. Adjusting the model to account for gully reduction would be beneficial in future modeling efforts.

**Scenario 2 (Pond Dredging)**
Almost no sediment and nitrate reduction was produced with this scenario because the model could not adequately compare pond volume to drainage areas of the ponds. Therefore, the increasing of pond volume by removal of sediment through dredging did not impact sediment holding capacity. This may mean that the appropriate drainage area for a pond varies significantly throughout the subwatersheds, or that the methodology with which SWAT handles ponds in the Whitewater and Garvin Brooks/Rollingstone Watersheds is flawed. Pond parameterization should be improved in any future modeling, including more accurate sediment trapping characterization.

**Scenario 3 (Increased Ponds, Average Conditions)**
Table 1 shows modest reductions for sediment, nitrate and phosphorus for this scenario, with the greatest reduction possible for total phosphorus in the Whitewater. EOR staff considers that proposing averaging conditions plus an additional 25% increase in cropland draining to ponds would have resulted in greater sediment and nitrate reductions.

**Scenario 4 (Longer Crop Rotations)**
The addition of alfalfa proved to be very effective at reducing erosion and nitrate, because of residual roots and fertilization was no longer needed for the two year periods when alfalfa is growing. Greater reduction of nitrate and sediment loads in the Whitewater compared to the Garvin Brook/Rollingstone Watersheds is a function of greater cropland acres in the Whitewater.

**Scenario 5 (Fall Cover Crop)**
The simulated winter rye provided fall and winter cover and corresponding reductions in sediment (Table 1). However, the effect of nitrate reduction that is generally considered normal when cover crops are applied is not well observed with these scenario results. One reason for this lack of nitrate reduction is because after cover crop planting, fertilization rates were not reduced. Less nitrogen would be needed on croplands since cover crops will retain more nitrogen in the soils. Alternately, it is possible the model was not adequately parameterized for soil-water nutrient processes.

**Scenario 6 (No-Till)**
Unusually, this scenario, while producing reductions in phosphorus and sediment loading, saw moderate increases in nitrate for both Whitewater Watershed and when implemented on all croplands in the Garvin Brook Watershed. This increase is because of the presence of corn residue and its decomposition into the soil.

**Scenario Effects on Hydrology**
Increasing pond area in the model did not appear to have a significant impact on reducing flow. Less than a 1% decrease was observed for both watershed volume and peak flows. This occurred because the ratio of pond volume to total flow volume is extremely low (less than 1%). The increased pond volume in these scenarios is an insufficient increase in storage to affect flows.

**Combined Scenarios**
Table 2 provides sediment, nitrate, and phosphorus reductions when scenario BMPs are combined on a subwatershed-scale. Again, all scenarios were run for the entire landscape, and for the top 25% and top 50% most erodible subwatersheds based on sediment load that the model produced with existing conditions. Any redundancies of BMPs with similar functionality or reduction transport pathways are accounted for in these values.

**Table 11: Combined scenario load reductions at the watershed outlet; "Row-crop Conv. To Grasses" represents maximum reductions. "SED" =sediment; "NO3" =nitrate; "TP" =total phosphorus.**

| | | Whitewater | | | Garvin Brook | | |
|---|---|---|---|---|---|---|---|
| **Conservation Scenario** | | **SED** | **NO3** | **TP** | **SED** | **NO3** | **TP** |
| Row-crop Conv. to Grasses | | 37% | 78% | 35% | 38% | 65% | 36% |
| Grassed Waterways (SPI>=4)<br>Ponds (avg condition)<br>Longer Crop Rotations | | | | | | | |
| | All | 17% | 26% | 16% | 10% | 10% | 10% |
| | top 25% | 14% | 13% | 13% | 7% | 5% | 6% |
| | top 50% | 16% | 21% | 15% | 8% | 7% | 7% |
| Grassed Waterways (SPI>=4)<br>Ponds (avg condition)<br>Cover Crops | | | | | | | |
| | All | 17% | 6% | 16% | 11% | 4% | 10% |
| | top 25% | 14% | 2% | 13% | 7% | 1% | 7% |
| | top 50% | 17% | 3% | 16% | 8% | 2% | 8% |
| Grassed Waterways (SPI>=4)<br>Ponds (avg condition)<br>No-Till | | | | | | | |
| | All | 14% | 4% | 13% | 9% | 4% | 9% |
| | top 25% | 11% | 1% | 11% | 6% | 1% | 6% |
| | top 50% | 13% | 1% | 13% | 7% | 2% | 7% |
| All five scenarios | | | | | | | |
| | All | 27% | 20% | 26% | 12% | 8% | 11% |
| | top 25% | 22% | 10% | 21% | 8% | 5% | 7% |
| | top 50% | 27% | 16% | 25% | 10% | 7% | 9% |

## Appendix D. Key to Strategies Table.

| Key to Strategies Table: | |
|---|---|
| Rows = | Strategies for impaired waters requiring restoration. |
| Rows = | Strategies for unimpaired waters requiring protection. |
| **Strategy** | **Actions** |
| **1. Civic Engagement** | Bring people together for events such as a watershed citizen summit, facilitated discussions, neighborhood action groups, farmer-led councils, picnics, river paddling, pasture or stream walks. Engage citizens in learning, thinking and articulating the issue and in civic action. |
| | Provide targeted support, peer networks, and skill development to farmer-led councils, neighborhood groups, etc. |
| **2. Education & Awareness** | Educate home owners, businesses and elected officials about best practices for prioritized actions. These could include: fertilizer application training, lawn maintenance training, deicer application training, erosion control training, rain garden design and construction, landscaping for water retention and infiltration, farming and gardening practices, business property maintenance. |
| | Build, interpret, draw attention to demonstration projects. Engage citizens in building them. Use the process to educate through media. Include interpretive signage. |
| | Use digital and print communications tools to advantage, including websites, social media, newsletters, postcards, etc. Work with awareness of unique needs of target groups. |
| | Find and work with partners to achieve more. |
| | Education to elected officials (local, county and state) |
| **3. Lower Mississippi River Basin Fecal Coliform Implementation Plan, February 2007** | The implementation plan identifies strategies for non-point sources including grazing and pasture management, feedlot management, manure management, individual sewage treatment systems (ISTS) and conservation practices (tillage and buffers). See plan for specific strategies. |
| | The implementation plan identifies strategies for point sources including permitted wastewater treatment facilities, urban stormwater, livestock facilities requiring NPDES permits, and straight pipe systems. See plan for specific strategies. |
| | See 2007 Lower Mississippi River Basin Fecal Coliform Plan |
| **4. Nutrient Management BMPs** | Feedlot runoff control, ag waste management, nutrient/manure management, livestock exclusion, waste water treatment, onsite septic system upgrades, and sinkhole treatment. |
| **a) Nitrogen Reduction Strategies** | Manage marginal lands in perennials; optimize nutrient management planning, timing and implementation; expand use of cover crops; encourage managed grazing throughout the watershed |

| Key to Strategies Table: | |
|---|---|
| Rows = | Strategies for impaired waters requiring restoration. |
| Rows = | Strategies for unimpaired waters requiring protection. |
| **Strategy** | **Actions** |
| **b) Nutrient Reduction Strategy "Phase I Milestone" Nitrogen BMPs; (Chapter 5.3.3 Nitrogen Reduction Strategies)** | Reference NRCS Job Codes: Nutrient Management (590), Prescribed Grazing (528), Cover Crop (340), Filter Strip (393), Waste Storage Facility (313) |
| **c) Phosphorus Reduction Strategies** | Reduce sediment transport from row crop lands and promote sound residue management practices. Impoundments, contour farming, no-till farming, grassed buffer strips, etc. are all BMPs used to reduce soil erosion. |
| **d) Nutrient Reduction Strategy "Phase I Milestone" Phosphorus BMPs; (5.3.2 Phosphorus Reduction Strategies)** | Reference NRCS Job Codes: Cover Crop (340), Residue and Tillage Management (345 & 329), Filter Strip (393), Contour Farming (330), Contour Buffer Strips (332) |
| **5. Riparian Corridor Management** | Educate the public about shoreland regulations and enforce adherence to those rules. |
| | Increase land retirement and perennial vegetation. |
| | Develop managed grazing plans and livestock exclusion within the riparian corridor |
| **6. Soil Health BMPs** | Increase infiltration and decrease runoff/erosion/sediment transport with conservation cover, conservation tillage, contour & strip cropping, cover crop, crop rotations, field buffers & borders, filter strips, rotational grazing and increased perennial cover. These practices can be most effective on cropland with canning crops, corn for silage, soybeans and other low-residue annual row crops. |
| | Long-term conservation Reinvest in Minnesota (RIM) Reserve easements and Conservation Reserve Program (CRP). |
| | See page 60 in 2007 Lower Mississippi River Basin Fecal Coliform Plan |

| Key to Strategies Table: | |
|---|---|
| Rows = | Strategies for impaired waters requiring restoration. |
| Rows = | Strategies for unimpaired waters requiring protection. |

| Strategy | Actions |
|---|---|
| **7. Stormwater management** | Put strong local policy in place. Government units model best practices including: deicer storage; deicing application on roads and streets; street, parking lot, and infiltration infrastructure construction and management; mowing and fertilizer practices (no cuttings in street; landscaping, shoreland buffers; use of native plants). |
| | Sweep streets. |
| | Use best practices for erosion control on construction sites. Enforce erosion control regulations. |
| | Improve public infrastructure, particularly streets. Include storm water management improvements in every public project. Establish a storm water utility or other designated fund so money is available when opportunity arises. |
| | Capture water on site to infiltrate in basins and rain gardens. Install rain barrels and use the water on site. |
| | Label storm sewers as connectors to streams. Make bins available for pet waste. |
| | Nutrient management planning, education and implementation for lawns. |
| | Educate! Use partnerships, collaborations, media and clear messaging to achieve goals. |
| | All NPDES-permitted sources shall comply with conditions of their permits, which are written to be consistent with assigned wasteload allocations. |
| **8. Structural Impoundment BMPs** | Water impoundment structures reduce peak flows of rain events, stabilize gulley heads and capture sediment. These impoundments are located within row crop fields as well as edge of fields and in managed pastures. |
| | These practices include but are not limited to: Water and Sediment Control Basins (638), Grade Control Structures (410), Terraces (600) and Diversions (632) (as a component) |
| | The number of these structures in a row crop field could be as few as 1-2 per field or as many as 10+ in a field, depending on many variables, including size of field and landscape. |
| | At edge of field or managed pasture, structures are generally single or placed with 1-2 others around the perimeter |
| | Cleanout and rehab existing structures |
| **9. Stream Habitat Improvement** | Implement habitat improvement practices to reach a stream's full potential for sustaining game and non-game species. Incorporate natural design concepts in restoration project and work with stream evolution. |

**Key to Strategies Table:**

| | |
|---|---|
| **Rows =** | **Strategies for impaired waters requiring restoration.** |
| **Rows =** | **Strategies for unimpaired waters requiring protection.** |

| **Strategy** | **Actions** |
|---|---|
| | Practices: All practices listed in the Nongame Wildlife Habitat Guide (TU), Toewood design concept and cedar tree revetments. Also referenced NRCS Job Code; Stream Habitat Improvement and Management (395), |
| **10. Stream and Streambank Restoration** | Streambank stabilization is often required to 'patch' a section of a stream when failing conditions are present. The risk of losing infrastructure is typically the impetus behind implementing these practices. In actuality, these failing bank locations are major contributors to sediment loading in the stream system. Common practices include: sloping and shaping banks, natural riprap placement, weirs, stream barbs, log deflectors, cedar tree revetments and toewood design concept. |
| | Referenced NRCS Job Code: Streambank and Shoreline Protection (580), Critical Area Planting (342), Bank Vegetation (322) |
| **11. Protection** | Civic engagement, including: people together for events such as a watershed citizen summit, facilitated discussions, neighborhood action group, farmer-led council, picnics, river paddling and other outdoor activities, pasture or stream walks. Engage citizens in learning, thinking and articulating the issues, and in civic action. |
| | See Mississippi River-Winona Landscape Stewardship Plan, particularly education, civic engagement, and plan development sections. |
| | Use digital and print communications tools to advantage, including websites, social media, newsletters, postcards, etc. Work with awareness of unique needs of target groups. |
| | Cleanout and rehab existing structural impoundment BMPs. |
| | Increase Soil Health BMP knowledge and implementation |
| | Administration and enforcement of the County Planning and Zoning Ordinance is an effective protection strategy if implemented in MRLP. Activities such as land clearing, erosion control, new and expanding feedlot projects, wetland impacts, shoreland buffer requirements, bluffland protection and sand and gravel mining operations all are regulated in Olmsted, Wabasha and Winona Planning and Zoning Ordinance. Implementing the ordinance often requires assistance from various local/state agencies that are familiar with the above mentioned practices. |
| | Invasive species control |

**For additional information see: NRCS Design Guidance; Ag BMP Handbook**

**BMPs for Avoidance (Ag BMP Handbook):**

Conservation Cover, Conservation Crop Rotation, Contour Buffer Strips, Contour Farming, Cover Crops, Grade Stabilization Structure, Livestock Exclusion, Nutrient Management, Pest Management

| Key to Strategies Table: | |
|---|---|
| Rows = | Strategies for impaired waters requiring restoration. |
| Rows = | Strategies for unimpaired waters requiring protection. |
| Strategy | Actions |
| **BMPs for Control (Ag BMP Handbook):** | |
| | Clean Water Diversion, Conservation Tillage, Contour Strip Cropping, Feedlot Runoff Control, Feedlot/Wastewater Filter Strip, Grassed Waterways, Riparian and Channel Vegetation, Rotational Grazing, Streambank and Shoreline Protection, Terrace, Waste Storage Facility |
| **BMPs for Trapping (Ag BMP Handbook):** | |
| | Constructed Wetlands, Field Borders, Filter Strips, Grade Stabilization Structures, Sediment Basins, Water and Sediment Control Basin, Wetland Restoration, Woodchip Bioreactor |
| **Primary Responsibility:** | |
| **$** | Financial (Program funding & cost-share) |
| **T** | Technical & Implementation |
| **P** | Policy/Rule/Ordinance |
| **C** | Capacity Building/Civic Engagement/Education |
| **A** | All |
| **Key to Abbreviations in the "Primary Responsibility" section:** | |
| **SRMC WD** | Stockton-Rollingstone-Minnesota City Watershed District |
| **JPB** | Joint Powers Board |
| **SWCD** | Soil and Water Conservation District |
| **SEMNWRB** | South East Minnesota Water Resources Board |
| **SE Tech JPB** | South East Technical Joint Powers Board |
| **MDA** | Minnesota Department of Ag |
| **MPCA** | Minnesota Pollution Control Agency |
| **DNR** | Minnesota Department of Natural Resources |
| **BWSR** | Minnesota Board of Water and Soil Resources |
| **UM** | University of Minnesota |
| **NRCS** | (United States Department of Ag) Natural Resource Conservation Service |
| **FWS** | (United States) Fish and Wildlife Service |