Fredonia-Newburg Area Watershed-Based Plan

Including North Branch Milwaukee River, Town of Fredonia - Milwaukee River, & Village of Newburg - Milwaukee River watersheds

FINAL REPORT

October 2019

Applied Ecological Services, Inc.

Aqua Vitae

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

FREDONIA-NEWBURG AREA WATERSHED-BASED PLAN
Ozaukee, Sheboygan and Washington Counties, Wisconsin

A Strategy for Protecting and Restoring Watershed Health

FINAL REPORT

October 2019
(AES #18-0400)

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for

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT
Milwaukee Metropolitan Sewerage District
260 West Seeboth Street, Milwaukee, WI 53204
Contract No. M03059P11

Made possible through a Wisconsin Department of Natural Resources (WDNR) aid agreement with the District and funded by a Great Lakes Restoration Initiative (GLRI) Nearshore Nonpoint Source grant award.

WISCONSIN
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ACKNOWLEDGEMENTS

Milwaukee Metropolitan Sewerage District (MMSD) is a regional government agency that provides water reclamation and flood management services for more than one million people across the Greater Milwaukee region. MMSD is a leader in protecting public health and the drinking water through their wastewater treatment, flood management, and green infrastructure programs (MMSD 2019). Funding for this watershed planning process was made possible through a WDNR aid agreement with MMSD and is funded by a Great Lakes Restoration Initiative Nearshore Nonpoint Source grant. MMSD hired Applied Ecological Services, Inc. (AES) and AquaVitae (AV) in August 2018 to develop the plan. MMSD, AES, and AV used the funding to undergo a watershed planning effort and produce a "Watershed-Based Plan" for the Fredonia-Newburg Area watersheds that meets requirements as defined by the United States Environmental Protection Agency (USEPA).

Karen Nenahlo, Senior Project Planner, acted as Project Manager for MMSD. She worked closely with watershed stakeholders, AES, and AV to produce the watershed planning document. AES and AV conducted analysis, summarized results, and authored the Watershed-Based Plan. The stakeholder group representing the Fredonia-Newburg Area watersheds consisted of representatives from various municipal, governmental, private, and public organizations as well as local residents. These partners played an important role in providing input on watershed goals & objectives, various planning approaches, and input on the watershed plan content.

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Ozaukee County: Jeff Bell, Andy Holschbach, Andrew Struck, Beth Wentzel
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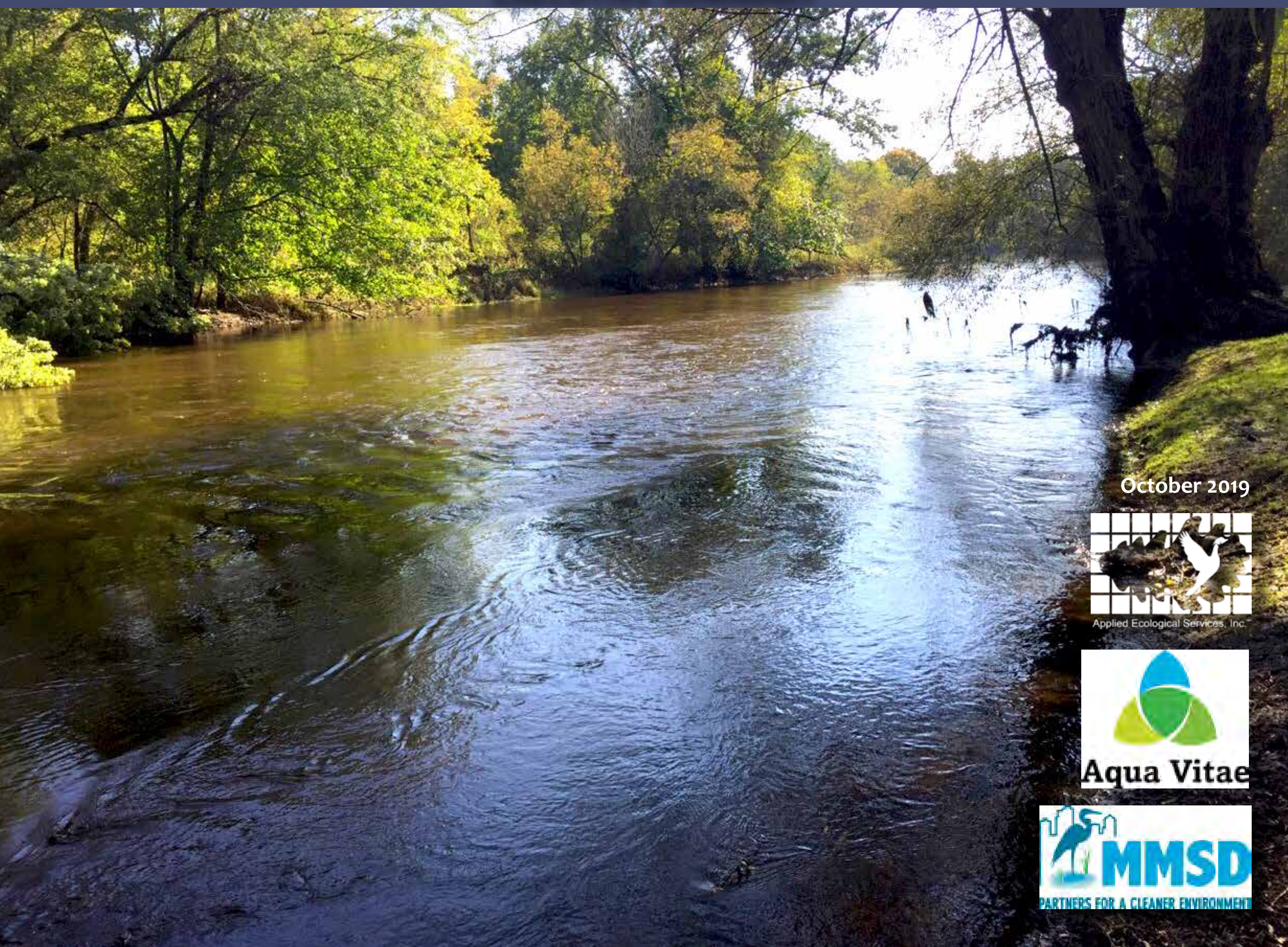
Fredonia-Newburg Area Watershed-Based Plan

Including North Branch Milwaukee River, Town of Fredonia - Milwaukee River, & Village of Newburg - Milwaukee River watersheds

EXECUTIVE SUMMARY



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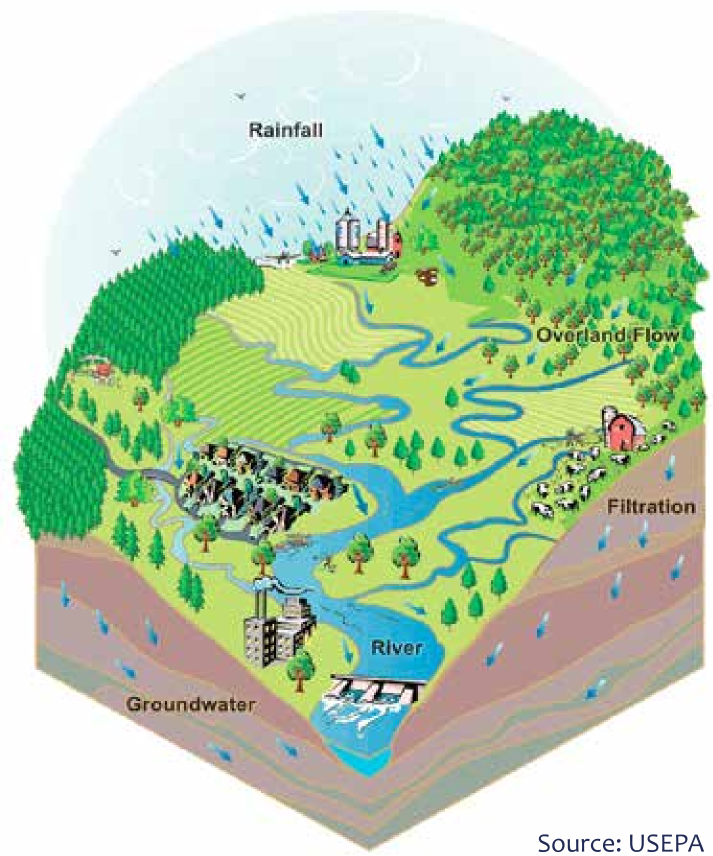
INTRODUCTION

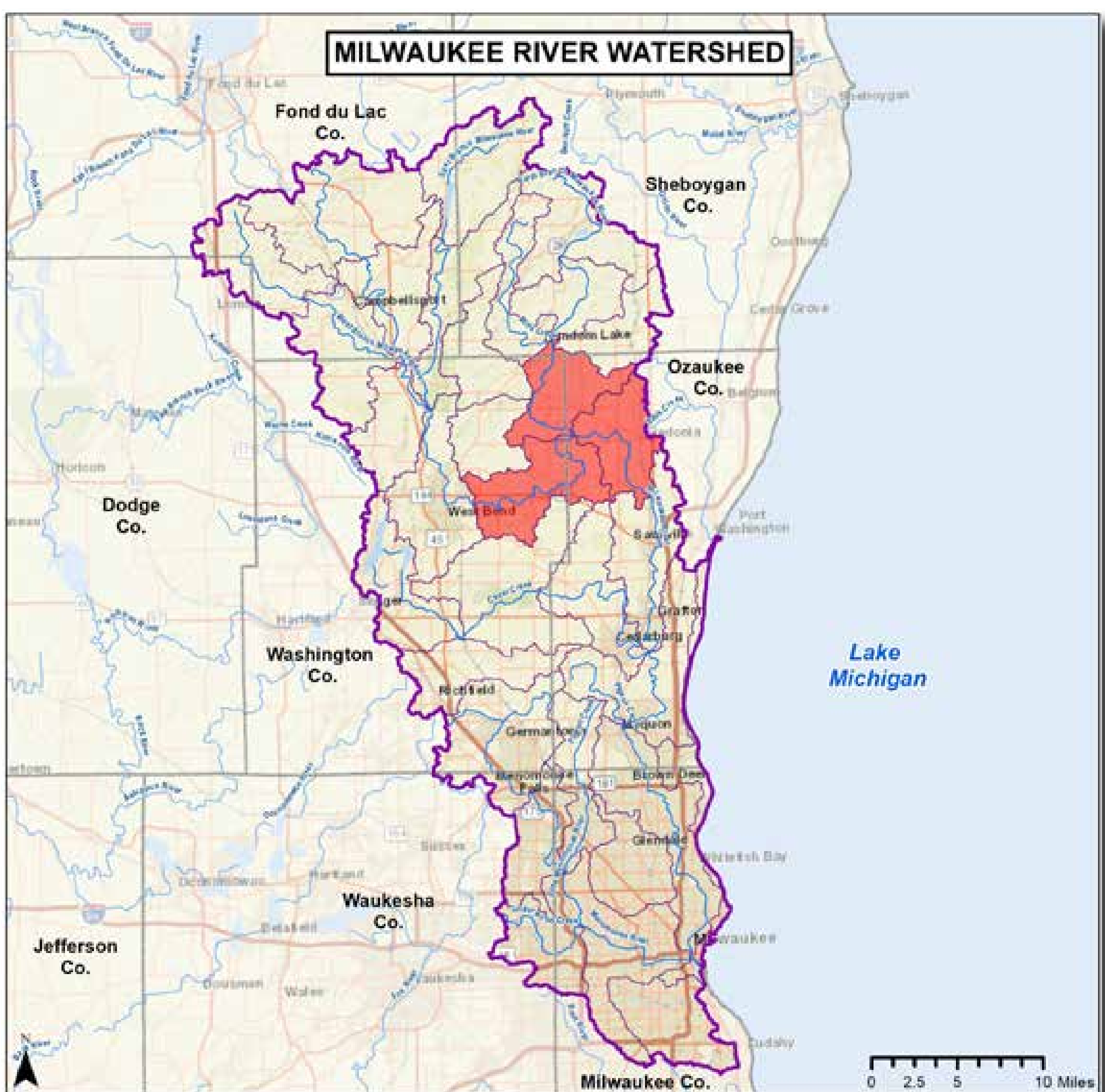
People live, work, and play in areas of land known as watersheds. A watershed is best described as an area of land where surface water drains to a common location such as a stream, river, or lake (see image, right). The source of groundwater recharge to aquifers, streams, and lakes is also considered part of a watershed. Watersheds are complex systems because there is interaction between natural elements such as climate, surface water, groundwater, and vegetation and human elements. Human influences can produce polluted stormwater runoff, increase impervious surfaces, alter stormwater flows, and degrade or fragment natural areas.



Source: USEPA

The Fredonia-Newburg Area watersheds planning area encompasses three HUC 12 watersheds: Town of Fredonia-Milwaukee River (HUC: 040400030602), Milwaukee River North Branch (HUC: 040400030107), and Village of Newburg-Milwaukee River (HUC: 040400030209). The planning area is located in southeast Wisconsin between Milwaukee and Sheboygan. Together, the three watersheds drain nearly 47,000 acres (73 square miles) of land surface.

Collectively, there are 378,341 linear feet or 71.6 miles stream miles and 8,441 acres of wetlands in the Fredonia-Newburg Area watersheds. Three counties and four municipalities comprise the watershed. The watershed is split almost evenly between Ozaukee and Washington Counties , with a small portion extending into Sheboygan County, and includes the Town of Fredonia, Village of Newburg, unincorporated Waubeka and the southeastern portion of West Bend.



WATERSHED PLANNING

Watershed planning is a collaborative approach to address natural resource issues and improve water quality protection. This approach allows stakeholders to share information, better target limited financial resources, and address common water-related challenges. These challenges can include improving water quality, preserving and protecting groundwater resources, managing stormwater, reducing flooding, conserving open space, protecting wildlife habitat, supporting opportunities for economic development, and other issues of concern.

Goals were drafted from the concerns expressed by watershed stakeholders during a May 7, 2019 workshop. Participants were given the opportunity to vote across eight goal topics as to which they felt were most important. Then, a facilitator led successive groups of stakeholders through questions and prompting around the mission statement and each goal, taking notes on stakeholder ideas and feedback. This information was then used to refine the mission, the goals, and the objectives of the plan.

MISSION

The communities of the Fredonia-Newburg Area watersheds are dedicated to the protection, preservation, and improvement of our area watersheds through planning, implementation, education and stewardship for shared health and area wellbeing.

GOALS

Goal 1: *Improve surface water quality to meet water quality standards.*

Goal 2: *Encourage agricultural techniques and soil conservation practices that will protect and conserve topsoil and bolster our water resources.*

Goal 3: *Increase stakeholder awareness of watershed issues through education and stewardship.*

Goal 4: *Protect groundwater quantity & quality.*

Goal 5: *Increase communication and coordination among stakeholders.*

Goal 6: *Manage and mitigate for existing and future structural flood problems.*

Goal 7: *Protect and manage natural and cultural components of the Green Infrastructure Network, including fish and wildlife habitat.*

Example of the pre-settlement landscape. Source: Riveredge.

THE WATERSHED OVER TIME

A diverse network of forests, prairies and wetlands remained intact in the Fredonia-Newburg Area watersheds until European settlers began to alter significant portions of the watershed's natural landscape, hydrology and wetland processes in the 1800s. Where it was feasible, trees were cleared, prairies were tilled under and wet prairie and marsh communities commonly found in floodplain areas were drained, streams channelized, and existing vegetation cleared to farm the rich soils. Today, the Fredonia-Newburg Area watersheds are collectively approximately 46% agricultural and 30% open space.

While these changes increased the agricultural productivity of the watershed, they created other problems resulting from the channelization of streams and removal of riparian buffers. Functional wetlands and riparian buffers do more for water quality improvement and flood reduction than any other natural resource. In addition, intact wetlands and riparian buffers typically provide habitat for a wide variety of plant and animal species. They also provide groundwater recharge, filter sediments and nutrients, and slowly discharge to streams thereby maintaining water levels in streams during drought periods.

Channelization is detrimental for the health of streams and rivers because it increases the speed and force of water through a channel, eliminates suitable in-stream habitat for fish and wildlife and limits the number of natural in-stream features such as pool-riffle sequences in the channel. In many locations, a berm comprised of historic side-cast dredge spoils cuts off the stream channels from the floodplain.

LAND USE

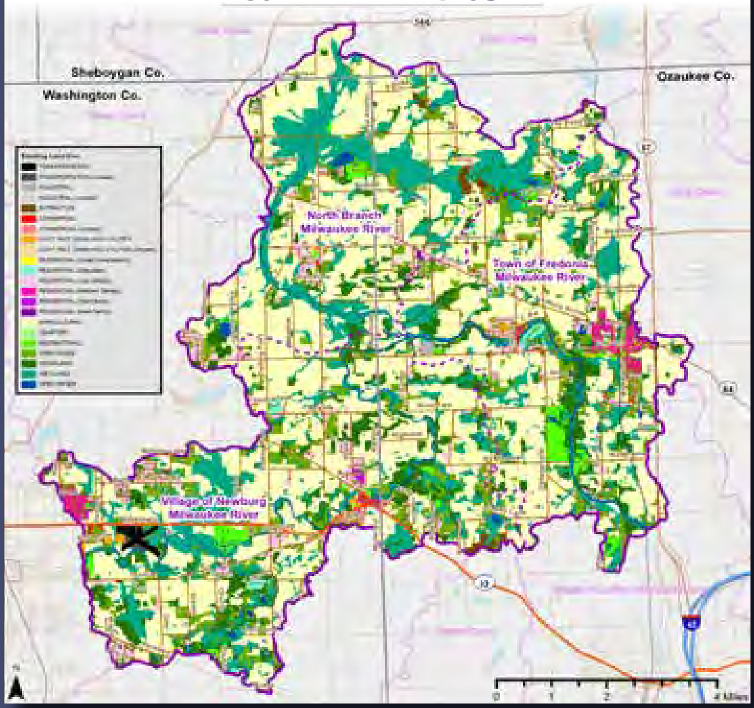
In all three watersheds agriculture is far and away the most prevalent land use. In the Village of Newburg, Town of Fredonia, and North Branch Milwaukee River watersheds this amounts to 8,390.6 acres (44.9%), 7,154.7 acres (50.7%), and 7,499.2 acres (53.1%) respectively. This includes row crop agriculture (largely corn and soybean) as well as livestock (largely dairy.)

Wetlands make up the next most abundant land use . The wetland areas are largely adjacent to the Milwaukee River and accompanying floodplain areas, as well as a large lowland area in the North Branch watershed. The Village of Newburg, Town of Fredonia, and North Branch Milwaukee River watersheds this amounts to 3,117.7 acres (16.7%), 1,929.9 acres (13.7%), and 3,392.9 acres (24.0%) respectively.

Within the Town of Fredonia and North Branch watersheds the third largest land use results from woodland areas. These account for 822.2 acres (5.8%) and 1,327.4 acres (9.4%) respectively. These woodland areas are also largely adjacent to the Milwaukee River. Woodlands are the fourth largest land use type within the Village of Newburg watershed spanning 1,877.2 acres (10.1%).

The third largest land use within the Village of Newburg is open land which makes up 1,980.9 acres (10.6%); this is generally defined as undeveloped land which has no discernable natural resource type. Open land is the fourth largest land use in both the Town of Fredonia and North Branch watersheds, covering 1,308.2 acres (9.3%) and 742.7 acres (5.3%) respectively.

CURRENT LAND USE



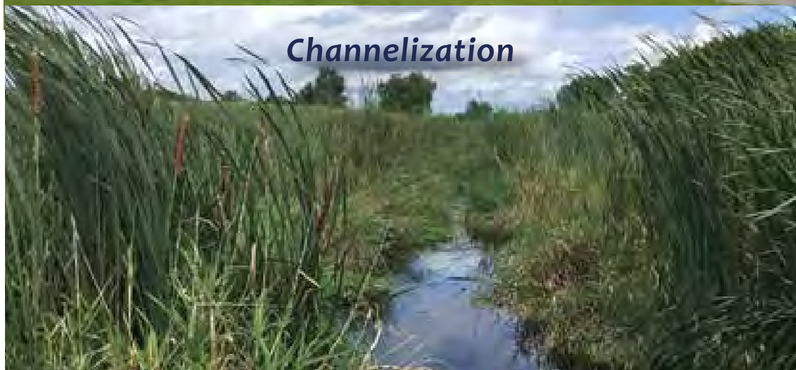
CHALLENGES & THREATS

During the planning process a number of challenges and threats to water quality were identified in the Fredonia-Newburg Area watersheds. These challenges and threats were identified while documenting existing conditions and assessment of the watershed and by stakeholders throughout the planning process. They include:

- Degraded or missing riparian areas and management
- Agricultural runoff
- Channelization of tributaries
- Funding challenges for large scale water quality, habitat, and flood prevention projects
- Funding challenges for implementation of additional agricultural management practices
- There is a gap in science and knowledge on how to cost effectively monitor water quality using *E. coli* as the indicator for bacteria-based surface water impairments.

Agricultural Runoff

Riparian Condition



Channelization

AGRICULTURAL LAND MANAGEMENT

While Wisconsin is known for its food production, how this land is managed can have a significant effect on water quality. According to the Environmental Protection Agency's National Water Quality Inventory, "agricultural nonpoint source (NPS) pollution was the leading source of water quality impacts on surveyed rivers and lakes… Agricultural activities that cause NPS pollution include poorly located or managed animal feeding operations; overgrazing; plowing too often or at the wrong time; and improper, excessive or poorly timed application of pesticides, irrigation water and fertilizer. "

Agricultural land can be a significant contributor of nutrients, sediment, and bacteria to local streams when practices such as filter strips, grass swales, no or reduced tillage, waste (manure) management, and fencing to restrict livestock access to streams are not in place. Some agricultural parcels within the watershed are already utilizing appropriate conservation practices, including no-till farming, vegetated swales, or cattle fencing in order to reduce nutrient and sediment loading to streams. Most farmers understand the inherent value in reducing soil and nutrient losses on their farms and consider it good business practice to do so. For those parcels where conservation practices appeared to be lacking, potential recommendations were noted during the watershed field inventory.

Since roughly half of the Fredonia-Newburg Area watersheds are used for agricultural purposes, the use of additional conservation practices on agricultural land is imperative to ensure the protection and improvement of water quality in the watershed. Selecting specific locations for agricultural BMPs is complicated and involves many considerations including owner willingness to participate, land configuration, and crop management practices already in place. Individual land owners are encouraged to work with NRCS and the Counties to appropriately manage nutrient and sediment loss on their lands.

The Watershed-Based Plan includes a list of general practices that should be implemented throughout the watershed where practicable.

Recommended agricultural BMPs include:

- Conservation crop rotation
- No-till or Conservation tillage
- Grass waterways
- Filter strips
- Fencing
- Injection
- Nutrient management plans
- Waste (manure) management

More information on all of these practices can be found in the full watershed plan document.

Images: Background - Conservation Tillage (no till) farming. Source: farmprogress.com.

Right, top to bottom - Stakeholders developing and prioritizing goals. Conservation crop rotation, and grass waterways.

Source: USDA NRCS

Source: USDA NRCS

GREEN INFRASTRUCTURE & YOUR BACKYARD

A Green Infrastructure Network is a connected system of natural areas and other open space that conserves natural ecosystem values and functions, sustains clean air and water, and provides a wide array of benefits to wildlife and people. The network is made up of hubs and linking corridors. Hubs generally consist of the largest and least fragmented areas such as Huiras Lake, Fellenz Woods, Kratzsch Conservancy, Mayhew Preserve, and Riveredge Nature Preserve. Corridors are generally formed by private agricultural or residential parcels along the Milwaukee River and its tributaries as well as along the primary SEWRPC Environmental Corridors. Corridors are extremely important because they provide habitat conduits between hubs. However, most parcels forming corridors are not ideal green infrastructure until landowners embrace the idea of managing stream corridors or creating backyard habitats.

Source: greeninfrastructure.net

Source: Appalachian Traveller.

Any property owner can improve green infrastructure. Create a safe place for wildlife by providing a few simple things such as food, water, cover, and a place for wildlife to raise their young. The National Wildlife Federation's Certified Wildlife Habitat® and the Conservation Foundation's Conservation@ Home programs can help you get started.

Creating a rain garden, or a small vegetated depression, to capture water is another way of promoting infiltration while beautifying your yard and providing additional habitat. Disconnecting your roof downspouts and capturing that runoff in rain barrels not only reduces the amount of runoff entering streams, but also serves as a great source of water for irrigating your yard.

Fellenz Woods (Source: OWLT)

RAIN BARREL

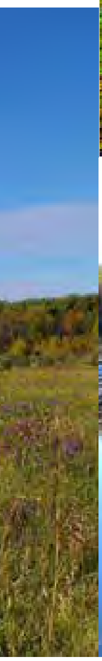
Source: Rainbarrelsource.com.

RAIN GARDEN

If a portion of a stream runs through your backyard, here are some tips to help properly manage your piece of the green infrastructure network:

1. **A NATURAL, MEANDERING STREAM IS A HAPPY STREAM**
   Work with experts to restore degraded streams.
2. **REMOVE NON-NATIVE SPECIES**
   Identify and remove plants that are out of place (see photo guide, right).
3. **PLANT NATIVE VEGETATION**
   Plants adapted to the Midwest climate can help control erosion by stabilizing banks.
4. **NO DUMPING**
   Avoid dumping yard waste and clear heavy debris jams.
5. **MANAGE CHEMICAL USE**
   Avoid over fertilizing or spilling/dumping chemicals near waterways.


RiverEdge Nature Center (Source: Riveredge)




Huiras Lake (Source: OWLT)


STREAM RESTORATION

REMOVE THESE NON-NATIVE AND INVASIVE SPECIES

COMMON REED

BUCKTHORN

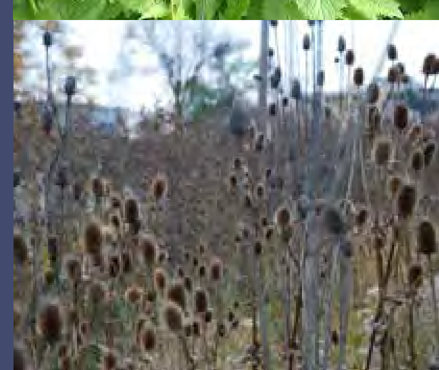

Source: Loras.edu.

REED CANARY GRASS

PURPLE LOOSESTRIFE

GARLIC MUSTARD

TEASEL



ACTION PLAN

The Fredonia-Newburg Area Watershed-Based Plan includes an Action Plan developed to provide stakeholders with recommendations to address plan goals. The Action Plan includes programmatic and site-specific recommendations. Programmatic recommendations are general watershed-wide remedial, preventatitve, and regulatory actions. Site-specific recommendations include actual locations where projects can be implemented to improve water quality, green infrastructure, and aquatic and terrestrial habitats.

Programmatic recommendations include...

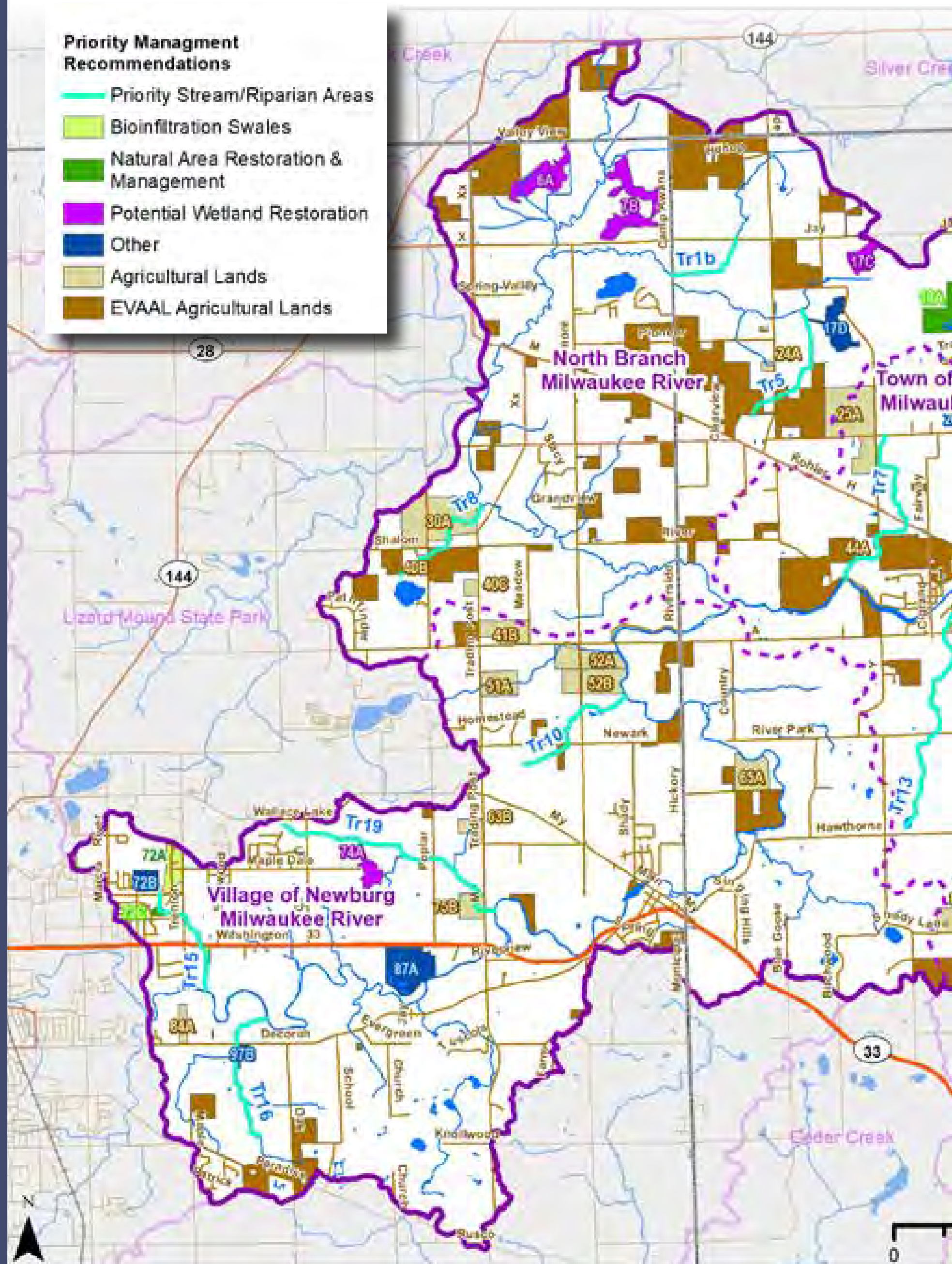
- Ordinance and Policy Recommendation
- Rainwater Harvesting & Re-use
- Native Landscaping
- Street Sweeping
- Septic System Maintenance
- Green Infrastructure Planning
- Conservation Design & Low Impact Development
- Water Quality Trading & Adaptive Management

Site-specific recommendations include...

- Stream & Riparian Area Restoration
- Agricultural Management Practices
- Other Management Measures:
    - Wetland Restoration
    - Natural Area Restoration
    - Bioinfiltration Swales
    - Golf Course Naturalization
    - Rain Gardens

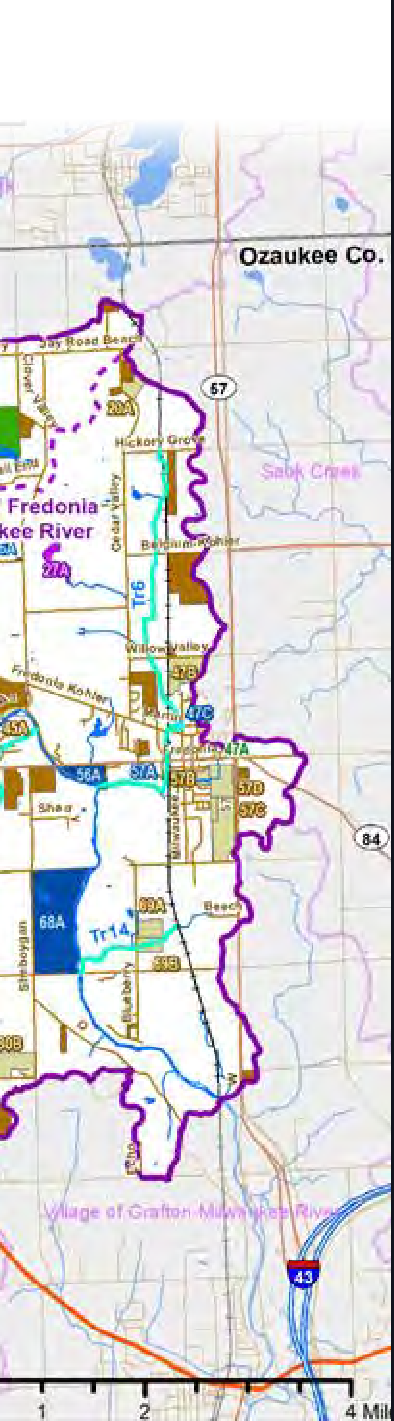
The recommended programmatic and site-specific management measures provide a solid foundation for protecting and improving watershed conditions over time but should be updated as projects are completed or other opportunities arise. Key implementation stakeholders are encouraged to organize partnerships and develop various funding arrangements to help delegate and implement the recommended actions. More details on the action plan and implementation can be found in the full waerhsed plan document.

PRIORITY AREAS




Stream & Riparian Area Restoration


Agricultural Manag



MILWAUKEE RIVER TOTAL MAXIMUM DAILY LOAD (TMDL) STUDY

For the Fredonia-Newburg Area watersheds, reduction targets for total phosphorus and total suspended solids were based on the Milwaukee River Total Maximum Daily Load (TMDL) pollutant load allocations for the corresponding watersheds within the Fredonia-Newburg watersheds, under the guidance of WDNR. In order to meet the Milwaukee River TMDL requirements, we need to reduce the total load of ...

Phosphorus by

- 45% for Newburg (MI-7)
- 33% for North Branch (MI-13)
- 51% for Fredonia (MI-15)

And total suspended solids by

- 68% for Newburg (MI-7)
- 66% for North Branch (MI-13)
- 57% for Fredonia (MI-15)

For fecal coliform, no percent reductions were developed under the TMDL, there was not enough existing water quality data to determine an annual load reduction target, and available models could not caluculate load reductions.

A water quality monitoring plan is an essential part of any watershed plan to evaluate plan implementation outcomes. Physical, chemical, and biological data will be collected over time to track progress towards acheiving the TMDL targets.

Water Quality Monitoring & Education


ement Practices


Natural Area Restoration


Wetland Restoration

WHERE DO WE GO FROM HERE?

Historical land uses have played a significant role in the degradation of water resources in the Fredonia-Newburg Area watersheds. Fortunately, there are actions outlined in the plan that can be taken to mitigate existing issues and prevent additional problems. The future health of the watershed is largely dependent on how the landscape and stormwater are managed. That includes implementing proven and environmentally-conscious landscape practices and approaches to stormwater management, such as those identified in this executive summary, to improve water quality and stream health in the watershed.

There is no single fix for the water quality and landscape challenges in the Fredonia-Newburg Area watersheds. These problems are the cumulative result of decisions made since people moved to the watershed in the 1800s. It will take all stakeholders and actions at every scale in order to positively impact watershed resources. This watershed-based plan is the first step in helping watershed residents and stakeholders understand what can be done to restore the valuable resources of the Fredonia-Newburg Area watersheds.

Milwaukee Metropolitan Sewerage District (MMSD) is a regional government agency that provides water reclamation and flood management services for more than one million people across the Greater Milwaukee region. MMSD is a leader in protecting public health and the drinking water through their wastewater treatment, flood management, and green infrastructure programs. Funding for this watershed planning process was made possible through a WDNR aid agreement with MMSD and is funded by a Great Lakes Restoration Initiative Nearshore Nonpoint Source grant. The findings and recommendations herein are not necessarily those of the funding agencies.

For more information on how you can help, contact the Counties:

Ozaukee County - Andy Holschbach
Land & Water Management Department
121 W. Main St, P.O. Boz 994, Port Washington, WI 53074
262-284-8271

Washington County - Paul Sebo
Land & Water Conservation Division
333 E. Washington St, Ste. 2300
P.O. Box 2003, West Bend WI 53095
262-335-4805

All photos by AES unless otherwise noted.

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1.0 INTRODUCTION

1.1 Fredonia-Newburg Area Watersheds Setting

People live, work, and recreate in areas of land known as "Watersheds". A watershed is best described as an area of land where surface water drains to a common location such as a stream, river, or lake (Figure 1). The source of groundwater recharge to streams, rivers, and lakes is also considered part of a watershed. Despite the simple definition for a watershed, they are complex systems with interaction between natural elements such as climate, surface water, groundwater, vegetation, and wildlife as well as human interactions. Urban development and agriculture can produce stormwater runoff, increase impervious surfaces thereby altering stormwater flows, and degrade or fragment natural areas. Other common names given to watersheds, depending on size, include basins, sub-basins, subwatersheds, and Subwatershed Management Units (SMUs).

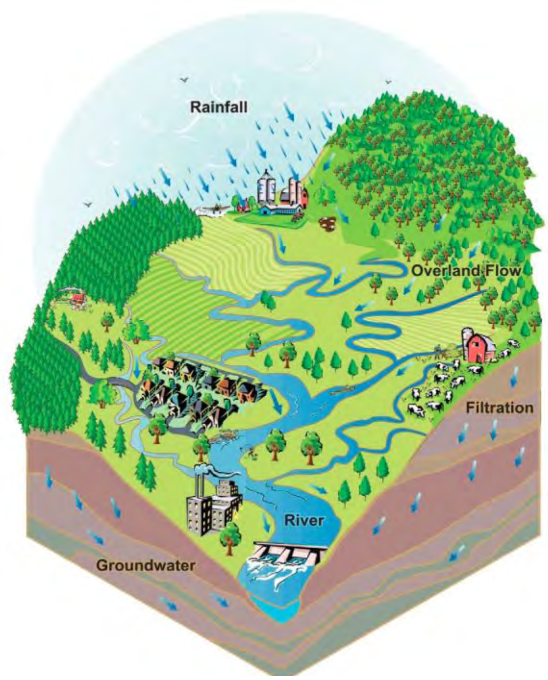


Figure 1. Hypothetical watershed setting (Source: USEPA)

The Fredonia-Newburg Area watersheds planning area encompasses three HUC 12 watersheds: Town of Fredonia- Milwaukee River (HUC: 040400030602), Milwaukee River North Branch (HUC: 040400030107), and Village of Newburg- Milwaukee River (HUC: 040400030209). The planning area is located in southeast Wisconsin in Washington, Ozaukee, and Sheboygan Counties (Figure 2). Together, the three watersheds drain nearly 47,000 acres (73 square miles) of land surface between Milwaukee and Sheboygan. Municipalities found in the watershed include Fredonia, Newburg, Waubeka, and West Bend. The watershed area lies across portions of Town of Fredonia, Town of Farmington, Town of Saukville, and Town of Trenton.

Prior to European settlement, the Fredonia-Newburg Area watersheds were ecologically intact, with clean water and a diversity of plant and wildlife populations. The area was a mosaic of southern mesic or dry-mesic forests and southern lowland forest or wetland communities and was shaped and maintained by frequent wildfires. During these times most of the water that fell as precipitation was absorbed in these forested and wetland areas. Southeast Wisconsin was inhabited by the Potawatomi Indian tribe until 1833 when the U.S. Government purchased 5 million acres of land and moved the Potawatomi to areas in the western United States.

Ecological conditions changed quickly and drastically following European settlement in the mid-1800s. Large scale fires no longer occurred, and bison and elk were extirpated. Significant portions of wooded communities and nearly all prairies were tilled, and tile systems were installed to drain wetland areas as farming became the primary land use by the early 1900s. Conversion from farmland to primarily residential and commercial uses followed, particularly over the past 30 years because of the close proximity to Milwaukee and Chicago, affordable land costs, and existing transportation.

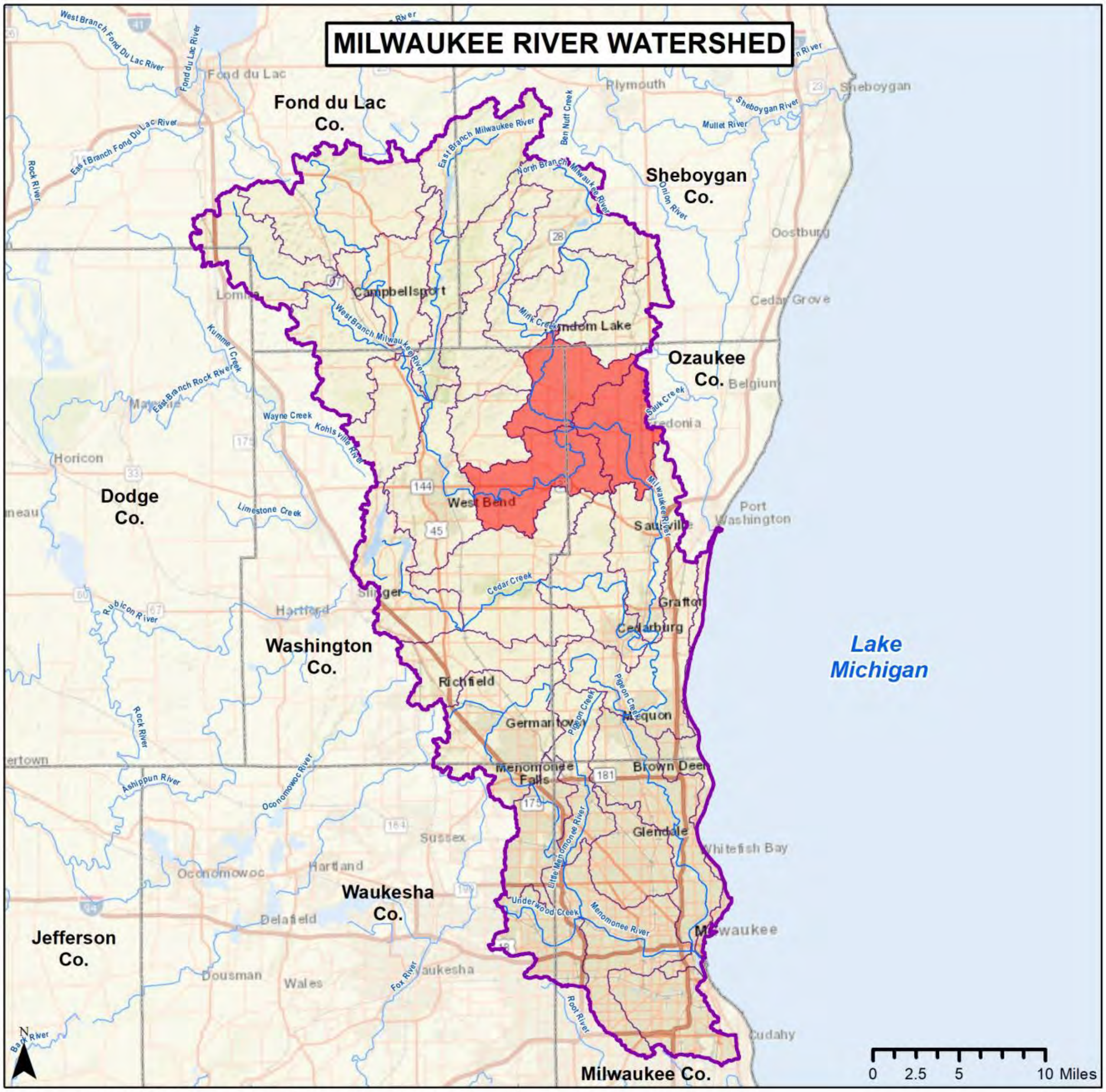
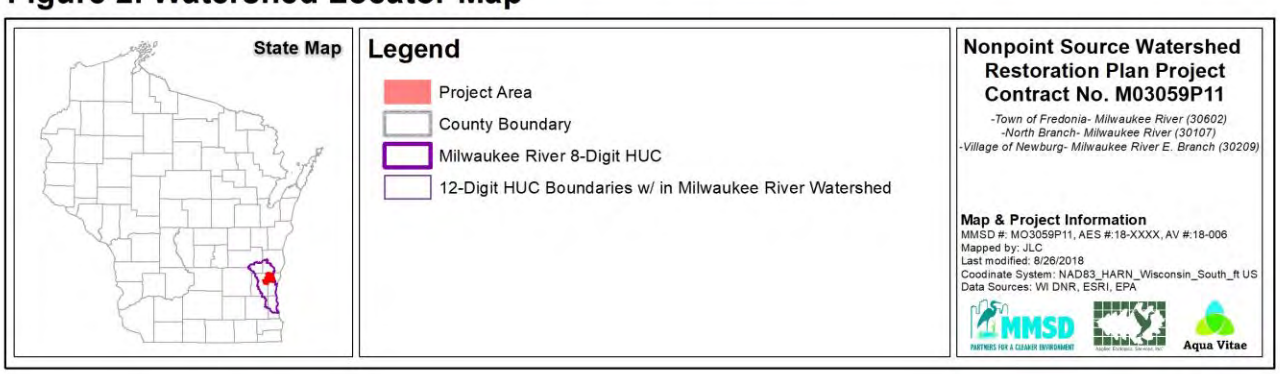


Figure 2. Watershed Locator Map



networks. The Fredonia-Newburg Area watershed is presently dominated by agricultural land, natural areas, and residential neighborhoods centered around few village centers.

While the Fredonia-Newburg Area watersheds have not experienced the levels of development seen in more urbanized areas, ongoing development and landscape change in the watershed has brought forth negative impacts to the environment. Increases in impervious surfaces greatly reduce the ability of precipitation to infiltrate into the ground. The channelization or straightening of streams has caused stormwater to run off of the land and in streams more quickly resulting in downcutting, widening, and moderate bank erosion, which in turn causes sediment and nutrient loading downstream. Meanwhile, invasive species established in adjacent floodplain wetlands are causing loss of wildlife habitat and reduced floodplain function. Discharged water from various sources that is not properly filtered is referred to as "non-point source pollution" and is the primary focus of this plan.

According to the Wisconsin Department of Natural Resources (WDNR) 2018 Water Quality Report and Section 303d List (WDNR 2018), the Milwaukee River, North Branch Milwaukee River, and Fredonia Creek within the Fredonia-Newburg Area watersheds are all listed as impaired. Under the Federal Clean Water Act, waterbodies that do not meet water quality standards are considered to be impaired. States are required to submit a list of impaired waterbodies to the U.S. Environmental Protection Agency every other year.

This section of the Milwaukee River is 303(d) listed because of an unknown pollutant and total phosphorus resulting in elevated water temperatures and an unknown impairment; this section was also 303(d) listed for PCBs at one time but was delisted in 2006. The North Branch Milwaukee River is 303(d) listed because of excessive amounts of phosphorus resulting in a degraded biological community. Finally, Fredonia Creek is 303(d) listed because of excessive amounts of phosphorus resulting in an unknown impairment.

Noteworthy- Watershed at a Glance

- Southern mesic, dry-mesic, lowland forests were common prior to European settlement in the 1830s.
- Tributaries in the watershed drain 73 square miles in Ozaukee, Washington, & Sheboygan Counties, WI.
- The dominant land uses in 2018 include agricultural land, open space, and residential areas.
- Municipalities include Fredonia, Newburg, and West Bend.
- The population of the watershed in 2010 was nearly 15,000 and is expected to increase to over 21,500 by 2050.
- Water quality is impacted by phosphorus and sediment.
- 56% of streams and tributaries are naturally meandering; 44% are moderately to highly channelized.
- 40% of streams exhibit no bank erosion; 60% are moderately eroded.
- 28% of the riparian areas are in "Good" ecological condition, 46% are "Average"; and 26% are "Poor".
- There were 18,171 acres of wetlands prior to European settlement; 8,441 acres or 46% remain in 2018.
- Open space parcels comprise approximately 44,656 acres or 78% of the watershed.
- 7 "Important Natural Areas" make up 600 acres and are home to number of important species.
- Shallow and deep groundwater aquifers provide the water supply for many private users and municipalities.
- Modeling indicates that agricultural land uses contribute the most to pollutant loading.
- Priority Area stream and riparian area restoration, agricultural management practice, and other management measures were identified for potential implementation across the watershed.

1.2 Project Scope & Purpose

Milwaukee Metropolitan Sewerage District (MMSD) is a regional government agency that provides water reclamation and flood management services for more than one million people across the Greater Milwaukee region. MMSD is a leader in protecting public health and the drinking water through their wastewater treatment, flood management, and green infrastructure programs (MMSD 2019). Funding for this watershed planning process was made possible through a WDNR aid agreement with MMSD and is provided via a Great Lakes Restoration Initiative Nearshore Nonpoint Source grant. MMSD hired Applied Ecological Services, Inc. (AES) and AquaVitae (AV) in August 2018 to develop the plan. MMSD, AES, and AV used the funding to conduct a watershed planning effort and produce a comprehensive "Watershed-Based Plan" for the Fredonia-Newburg Area watersheds that meets requirements as defined by the United States Environmental Protection Agency (USEPA). Ultimately, the intent is to develop and implement a Watershed-Based Plan designed to enable these waterbodies to achieve water quality standards/criteria.

The watershed planning process is a collaborative effort involving voluntary stakeholders who's primary intent is to restore impaired waters and protect unimpaired waters by developing an ecologically-based management plan. The Fredonia-Newburg Area watershed-based plan focuses on improving water quality by prioritizing cost effective projects in areas where progress in improving water quality can be achieved. Water quality improvement projects include protecting green infrastructure, creating protection policies, implementing ecological restoration, and educating the public. Another important outcome is to improve the quality of life for people in the watershed for current and future generations.

The primary purpose of this plan is to spark interest and give stakeholders a better understanding of the Fredonia-Newburg Area watersheds and to promote and initiate plan recommendations that will accomplish the goals and objectives of this plan. This plan was produced via a comprehensive watershed planning approach that involved input from stakeholders and analysis of complex watershed issues by watershed planners, ecologists, GIS specialists, water quality specialists, and environmental engineers. In addition, ideas and recommendations in this plan are designed to be updated through adaptive management that will strengthen the plan over time as additional information becomes available.

1.3 USEPA Watershed-Based Plan Requirements

In March 2008, the United States Environmental Protection Agency (USEPA) released watershed protection guidance entitled "Non-point Source Program and Grant Guidelines for States and Territories." The document was created to ensure that Section 319 funded projects make progress towards restoring waters impaired by non-point source pollution. Applied Ecological Services, Inc. consulted USEPA's "Handbook for Developing Watershed Plans to Restore and Protect Our Waters" (USEPA 2008) and subsequent guidance to create this watershed plan. Having a Watershed-Based Plan will allow Fredonia-Newburg Area watershed stakeholders to access 319 Grant funding and other funding for watershed improvement projects recommended in this plan. Under USEPA guidance, "Nine Elements" are required in order for a plan to be considered a Watershed-Based Plan.

Noteworthy- USEPA Nine Elements

Element A: Identification of the causes and sources or groups of similar sources of pollution that will need to be controlled to achieve the pollutant load reductions estimated in the watershed-based plan;

Element B: Estimate of the pollutant load reductions expected following implementation of the management measures described under Element C below;

Element C: Description of the BMPs (non-point source management measures) that are expected to be implemented to achieve the load reductions estimated under Element B above and an identification of the critical areas in which those measures will be needed to implement;

Element D: Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement the plan;

Element E: Public information/education component that will be implemented to enhance public understanding of the project and encourage early and continued participation in selecting, designing, and implementing/maintaining non-point source management measures that will be implemented;

Element F: Schedule for implementing the activities and non-point source management measures recommended in the plan; identified in this plan that is reasonably expeditious;

Element G: Description of interim, measurable milestones for determining whether non-point source management measures or other control actions are being implemented;

Element H: Set of environmental or administrative criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards;

Element I: Monitoring component to evaluate the effectiveness of the implementation efforts over time.

1.4 Planning Process

The planning process for the Fredonia-Newburg Area watersheds was designed to be stakeholder-driven with assistance from MMSD and AES and other partner agencies. MMSD and AES facilitated meetings between October 2018 and November 2019. Feedback gathered at these meetings, best professional judgement, and the requirements outlined in USEPA's *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* directed the development of the watershed-based plan. AES provided technical assistance for the watershed-based plan and drafted the report and AV provided technical assistance for the report, developed the GIS data/maps, and conducted the modeling for the plan.

MMSD, SEWRPC, Ozaukee and Washington Counties, WDNR, municipal representatives, and other active stakeholders played an important role in the early identification of watershed issues, stakeholder goals, and an overall vision for watershed improvements. Meetings were initiated by the Watershed Coordinator, Karen Nenahlo, and covered a wide range of topics specific to the Fredonia-Newburg Area watersheds. Meeting schedules and topics of those meetings are included in Table 1. Attendance lists and stakeholder meeting flyers are included in Appendix A.

Table 1. Meeting dates, agendas and summaries.

Meeting Date	Agenda	Summary
October 9, 2018	• Background context to the plan effort • Introduction to Watershed Planning Process • Overview of Field Inventory	MMSD presented the context for putting together a watershed plan for the Fredonia-Newburg Area and Applied Ecological Services detailed the planning process and what to expect. AES then detailed the results of the watershed field inventory.
November 13, 2018	• Watershed Characteristics Assessment, Part 1	AES detailed the geology, topology, soils, and subwatersheds as well as summarized the jurisdictions and demographics, existing and future land use, and impervious cover in the watershed. AES then gave an overview of the Code and Ordinance review process and its importance in the planning process.
January 15, 2019	• Watershed Characteristics Assessment, Part 2	AES detailed the watershed drainage network, highly productive agricultural lands, important natural areas and summarized groundwater conditions. Then AES walked stakeholders through the process and results of the open space inventory, prioritization and green infrastructure network.
March 12, 2019	• Water Quality Data Summary • Initial Pollutant Loading Model Results	Applied Ecological Services presented plan Section 4.0 (Water Quality & Pollutant Modeling Assessment). It was explained to the group that phosphorus and total suspended solids are the primary water quality threats in the watershed.
April 30, 0219	• Watershed Overview • Goal Building	MMSD and UW Extension Cooperative provided overview of plan, plan purpose and requested input from area farmers on their priorities for water quality
May 7, 2019	• Watershed Overview Presentation • Watershed Goal Prioritization • World Café Exercise - Goal Building	Applied Ecological Services first gave summary of the Fredonia-Newburg Area watershed conditions to prepare stakeholders for a visioning session. The mission and goal-setting session followed a World Café Exercise format whereby stakeholders provided valuable information about the group's goals for the watershed.
July 9, 2019	• Priority Areas • Programmatic Action Plan • Site Specific Action Plan	Applied Ecological Services presented plan Section 5.0 (Causes & Sources of Impairment & Reduction Targets) and 6.0 (Management Measures Action Plan). This also included a discussion of the Priority Areas within the watershed and potential project types.
August 1-20, 2019	• Plan Overview Presentations	MMSD presented an overview of the plan purpose and content at local board and plan commission meetings
September 10, 2019	• Executive Summary • Information & Education Plan • Future Water Quality Monitoring	Applied Ecological Services presented the Executive Summary. This was followed by an in-depth presentation of plan Section 7.0 (Information & Education Plan) by various partners. AES presented the Future Water Quality Monitoring Plan from plan Section 8.0.
November 12, 2019	• Present Final Watershed Plan • Discuss Implementation Phase	MMSD presented the Final Watershed Plan and discussed next steps with the stakeholder group.

1.5 Using the Watershed-Based Plan

The information provided in this Watershed-Based Plan is prepared so that it can be easily used as a tool by any stakeholder including elected officials, federal/state/county/municipal staff, and the general public to identify and take action related to watershed issues and opportunities. The pages below summarize what the user can expect to find in each major "Section" of the plan.

Section 2.0: Mission, Goals, and Objectives
Section 2.0 of the plan contains the Fredonia-Newburg Area watershed goals and objectives. Goal topics include Surface Water Quality, Agriculture, Education & Stewardship, Groundwater, Communication & Coordination, Flooding, and Species and Habitat, and the Green Infrastructure Network. In addition, "Measurable Objectives" were developed where possible for each goal so that the progress toward meeting each goal can be measured in the future by evaluating information included in Section 9.0 (Measuring Plan Progress & Success).

Section 3.0: Watershed Resource Inventory
An inventory of the characteristics, problems, and opportunities in the Fredonia-Newburg Area watersheds is examined in Section 3.0. Resulting analysis of the inventory data led to recommended watershed actions that are included in Section 6.0 (Management Measures Action Plan). Inventory results also helped identify causes and sources of watershed impairment as required under USEPA's *Element A*.

Section 3.0 includes summaries and analysis of the following inventory topics:

Watershed Resource Inventory Topics *Included* in the Plan	
- 3.1 Geology & Climate	- 3.10 Impervious Cover Impacts
- 3.2 Pre-European Settlement Landscape & Present Landscape	- 3.11 Open Space & Green Infrastructure
- 3.3 Topography, Watershed Boundary, Subwatersheds	- 3.12 Highly Productive Agricultural Land
- 3.4 Soils	- 3.13 Important Natural Areas
- 3.5 Jurisdictions, Roles & Protections	- 3.14 Watershed Drainage System
- 3.6 Existing Policies & Ordinance Review	- Streams
- 3.7 Demographics	- Wetlands
- 3.8 Transportation Network	- Floodplain
- 3.9 Existing & Future Land Use/Land Cover	- 3.15 Groundwater

Section 4.0: Water Quality & Pollutant Modeling Assessment
A summary and analysis of available water quality data for the watershed and pollutant modeling assessment is included in its own section because of its importance in the watershed planning process. This section includes a detailed summary of physical, chemical, and biological data available for the Fredonia-Newburg Area watersheds. Water quality data combined with pollutant loading data provides information needed for developing pollutant reduction targets and identifying Priority Areas, as outlined in Section 5.0 (Causes & Sources of Impairment & Reduction Targets).

Section 5.0: Causes & Sources of Impairment & Reduction Targets
This section of the plan includes a list of causes and sources of watershed impairment as identified in Section 3.0 (Watershed Resource Inventory) and by watershed stakeholders that affect Wisconsin DNR "Designated Uses" for water quality and other watershed features. As required by USEPA,

Section 4.0 also addresses all or portions of *Elements A, B, & C* including an identification of the Priority Areas, pollutant load reduction targets, and estimate of pollutant load reductions following implementation of recommended Priority Area Management Measures identified in Section 6.0.

Section 6.0: Management Measures Action Plan

A "Management Measures Action Plan" is included in Section 6.0. The Action Plan is divided into a Programmatic Action Plan and a Site-Specific Action Plan. Programmatic recommendations are described in paragraph format; site specific recommendations are presented in paragraph, figure, and table formats with references to entities that would provide consulting, permitting, or other technical services needed to implement specific measures. The site-specific tables also outline project priority, pollutant reduction efficiency, implementation schedule, sources of technical and financial assistance, and cost estimates. This section also contains a watershed-wide summary table of specific information for all recommended site-specific management measures combined including "Units," "Cost," and "Estimated Pollutant Load Reduction". This section addresses all or a portion of USEPA *Elements C & D.*

Section 7.0: Information & Education Plan

This section is designed to address USEPA *Element E* by providing an Information/Education component to enhance public understanding and to encourage early and continued participation in selecting, designing, and implementing recommendations provided in the Watershed-Based Plan. This is accomplished by providing a matrix that outlines each recommended education action, target audience, package or vehicle for implementing the action, who will lead the effort, what the expected outcomes or behavior change will be, and estimated costs to implement.

Sections 8.0 & 9.0: Plan Implementation & Measuring Plan Progress & Success

A list of key stakeholders and discussion about forming a Watershed Implementation Committee that forms partnerships to implement watershed improvement projects is in included in Section 8.0. Section 9.0 includes two monitoring components; 1) a "Water Quality Monitoring Plan" that includes specific locations and methods where future sampling should occur and a set of water quality "Criteria" that can be used to determine whether pollutant load reduction targets are being achieved over time and 2) "Report Cards" for each plan goal used to measure milestones and to determine if Management Measures are being implemented on schedule, how effective they are at achieving plan goals, and need for adaptive management if milestones are not being met. Sections 8.0 and 9.0 address USEPA *Elements F, G, H, and I.*

Sections 10.0 & 11.0: Literature Cited and Glossary of Terms

Section 10.0 includes a list of literature that is cited throughout the report. The Glossary of Terms (Section 11.0) includes definitions or descriptions for many of the technical words or agencies that the user may find useful when reading or using the document.

Appendix

The Appendix to this report is included on the attached CD located on the back cover (hard copies only). It contains watershed stakeholder attendance lists and stakeholder meeting flyers (Appendix A), Center for Watershed Protection local ordinance review results (Appendix B), map results of the watershed resource field inventory (Appendix C), a list of the public wells in the Fredonia-Newburg Area watersheds (Appendix D), the STEPL modelling results and assumptions used to develop pollutant loading estimates and reductions (Appendix E), County maps of potentially failing private onsite wastewater treatment systems (POWTS) (Appendix F), and a list of potential funding programs and opportunities (Appendix G).

1.6 Prior and Concurrent Studies and Projects

Various studies and other planning processes have been completed or are in progress describing and analyzing conditions within the Fredonia-Newburg Area watersheds. This Watershed-Based Plan uses existing data to analyze and summarize work that has been completed by others and integrates new data and information and has been developed concurrent to several other planning projects. A list of known studies and projects is summarized below.

1. Southeastern Wisconsin Regional Planning Commission (SEWRPC) developed a number of stormwater or drainage management plans, environmental reports, or watershed planning documents for various municipalities and contextual settings within the Fredonia-Newburg Area watershed beginning in the 1960s and continues to develop and updates these plans.
2. In 1970, SEWRPC created a comprehensive plan for the Milwaukee River watershed (Planning Report No.13). This report provides an overview of land and water resource quality and identifies challenges within this basin.
3. Between 1989 and 1991, the WDNR in partnership with the Wisconsin Department of Agriculture, Trade & Consumer Protection and county land conservation departments developed three priority watershed plans that each cover portions of the Fredonia-Newburg Area HUC-12s. These projects were designed to address nonpoint source pollution. The three plans were: Nonpoint Source Control Plan for the East and West Branches of the Milwaukee River Priority Watershed Project (1989), Nonpoint Source Control Plan for the North Branch Milwaukee River Priority Watershed Project (1989), Nonpoint Source Control Plan for the Milwaukee River South Priority Watershed Project (1991).
4. In 1999, SEWRPC developed a comprehensive land use plan for the Town of Fredonia. This was updated to a comprehensive plan through 2035 in March of 2009.
5. In 2002, SEWRPC completed a study of groundwater entitled Groundwater Resources of Southeastern Wisconsin (Technical Report No. 37). This report provides an overview of the current extent and conditions of both deep and shallow aquifers in Southeastern Wisconsin.
6. In 2007, SEWRPC issued an update to the regional water quality management plan for the greater Milwaukee watershed, including the Milwaukee River watershed. This plan was accompanied by a technical report on water quality and sources of water pollution for the watersheds addressed. SEWRPC set forth limited revisions to this plan update in a 2013 plan amendment."
7. In 2008, SEWRPC and the Ozaukee County Planning and Parks Department developed a county comprehensive plan called *A Multi-Jurisdictional Comprehensive Plan for Ozaukee County: 2035*. This plan followed a "Smart Growth" framework and guidelines and was amended in 2009 and 2013.
8. In 2008, SEWRPC and the Washington County Planning and Parks Department Planning Division developed a county comprehensive plan called *A Multi-Jurisdictional Comprehensive Plan for Washington County: 2035*. This plan followed a "Smart Growth" framework and guidelines and was adopted that same year. This plan is being updated to 2050 and a preliminary draft was released in January 2019.
9. In 2009, SEWRPC and the Washington County Planning and Parks Department developed A Park and Open Space Plan for Washington County. An update for this plan is in progress.

10. In 2011, SEWRPC and the Ozaukee County Planning and Parks Department developed A Park and Open Space Plan for Ozaukee County. An update for this plan is in progress.
11. In 2012, SEWRPC developed a comprehensive land use plan for the City of West Bend.
12. The Milwaukee Metropolitan Sewerage District created a plan in 2013 to implement widespread green infrastructure throughout their planning region.
13. In 2013, SEWRPC and Ozaukee County developed A Farmland Preservation Plan for Ozaukee County that extends to 2035. This plan is designed to preserve economically viable agriculture and the rural character of the County.
14. In 2015, Ozaukee County developed a Land and Water Resource Management Plan (2011-2015). The mission of this plan is "to protect, preserve and enhance natural resources, local ecology and the quality of life in Ozaukee County." An update for this plan is in progress.
15. In 2015, Ozaukee County developed a GIS-based Fish and Wildlife Decision Support Tool that addresses the role of wetland protection and restoration within the larger context of landscape-based fish and wildlife habitat conservation.
16. Wisconsin has also utilized Section 208, or the Priority Watershed Program, to develop a nonpoint pollutant source program, the most recent of which was approved by EPA in 2015. WDNR identified watersheds and lakes in most need of nonpoint pollution abatement and encouraged the use of nonpoint source controls to improve water quality.
17. In 2016, SEWRPC completed its Vision 2050: A Regional Land Use and Transportation System Plan for Southeastern Wisconsin which forecasts various demographic, land use, and transportation data for the planning area through 2050.
18. In 2016, Ozaukee County completed the Ozaukee County Coastal Resources Ecological Prioritization Master Plan. The Plan is a parcel-level prioritization and planning effort for preservation and restoration of critical land and water resources in the County.
19. The Community Rivers Program works to with communities in the Upper Milwaukee River Watershed to create healthier ecosystems. In 2017, they completed a Report Card for the Milwaukee River Basin that summarizes the water quality conditions within the planning area.
20. As a stipulation of MMSD's new WPDES permit, a Water Quality Improvement Plan (WQIP) is due to WDNR by March 1, 2020. The WQIP is intended to be a holistic plan to address water quality issues and stream impairments, to build the framework behind an Intergovernmental Cooperation Agreement to prioritize and implement cost-effective water quality improvement measures, collaboratively between and across watershed stakeholders. The WQIP will recommend a monitoring system that will measure and document water quality, and when streams can be removed from the WDNR Section 303(d) list of impaired waterbodies ("delisting streams").
21. Approved by the USEPA in March 2018, the Milwaukee River Basin Total Maximum Daily Load (MRB TMDL) Report provides documentation of the sources, loads, and required reductions for three pollutants (total phosphorus, total suspended solids, and fecal coliform) in the Milwaukee, Menomonee, and Kinnickinnic River Watersheds, as well as in the Milwaukee Harbor Estuary. The MRB TMDL was a third-party TMDL (not created by WDNR) commissioned by MMSD and produced by a consultant team led by CDM Smith, with input from WDNR and SEWRPC.

2.0 MISSION, GOALS, AND OBJECTIVES

2.1 Fredonia-Newburg Area Watershed-Based Plan Mission

The Watershed Coordinator and stakeholders of the Fredonia-Newburg Area watersheds developed a mission statement to guide the watershed plan. That mission is as follows:

"The communities of the Fredonia-Newburg Area watersheds are dedicated to the protection, preservation, and improvement of our area watersheds through planning, implementation, education, and stewardship for shared health and area wellbeing."

Scenic view of the Fredonia-Newburg Area landscape

2.2 Places-of-the-Heart

During a May 7, 2019 meeting devoted to gathering feedback from the community on the development of the plan and goals, stakeholders were given the opportunity to participate in an exercise called Places-of-the-Heart. Participants were asked to place heart-shaped stickers on a map of the watershed to indicate places they felt a connection to and to explain to the group why they placed their stickers where they did. Figure 3 depicts where participants placed their hearts and Table 2 summarizes what participants shared with the group (note: not all participants shared a description of why they placed a heart where they did).

Table 2. Location and description of Places-of-the-Heart group exercise.

Heart #	Description
7	"I see lots of wild life there and hope to keep their wild land home into the future (birds, deer, turtles, turkeys, ducks, etc.)"
8	"I've seen many snapping turtles killed on County Road W crossing the road"
9	"Riveredge – 379 acres of restored farmland and Hardwood forest – beautiful"
16	"Agricultural land and management. The Ag Component is a strong vibrant part of the watershed, maintain the ag component, improve the vibrancy and management of the land"
17	"I see this is a problem flooding area where I live"
18	"My home"
19	"Home, Waubeka runoff erosion brown water vs clean water/ *opened up a 10 acre wetland north of our farm -> not closed back to past level (destroyed owl habitat in Hames Woods) *Woodbank was compromised in 1970s/ Floodwater force through woods and our land."
20	"This is where I cross the River when the cops are after me"
21	"Pioneer Rd South, South parcel – neighboring farmer dug ditch (a new ditch) right on our property line in January within less than 1,000 feet of our pond. DNR first objected to his clearing his own ditch but later said his ditching was for ag reasons (the new ditch was never there before)"
22	"North Branch – our original family homestead pre-Civil War has had other owners since. Neighbor to west built a pond right on the north branch within "feet" of the north branch.
24	"A small wetland I own into which people throw tires and other junk to get rid of it."
25	"The area where I am responsible for the quality of effluent that enters the river."
26	"River is great for canoeing and kayak trips"
27	"Beautiful natural areas and a great park for community"

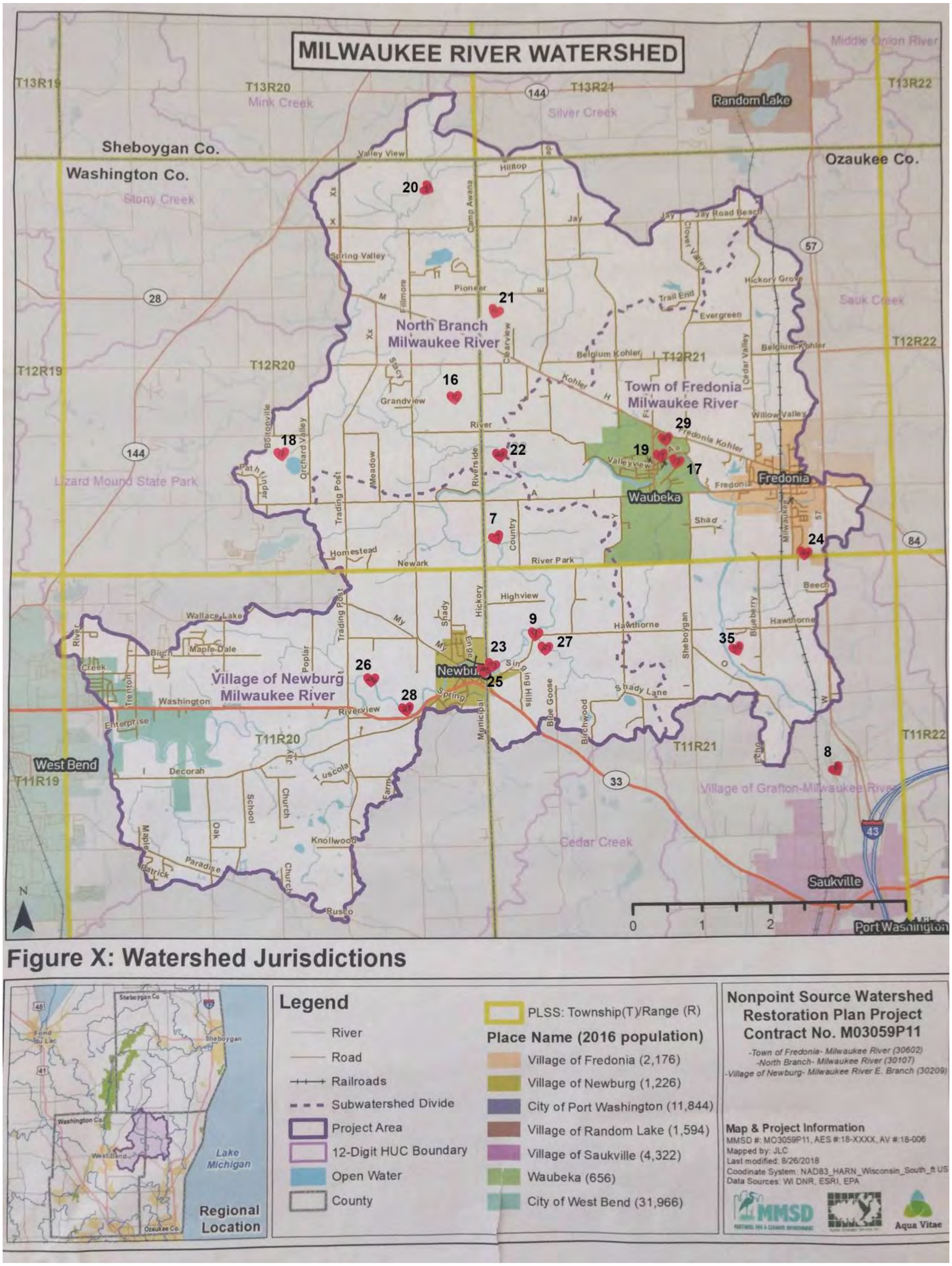


Figure 3. Places-of-the-Heart mapping exercise results.

2.3 Goals & Objectives

Watershed stakeholders were first presented with information about the character, existing conditions, and quality of watershed resources over the course of several meetings prior to developing goals. Eight general goal topics that address issues that were brought up during those meeting as important in the Fredonia-Newburg watershed were selected. Stakeholders were then given the opportunity to vote on goals they felt were most important as a way of prioritizing those goals.

The voting process occurred during the Goals meeting held on May 7, 2019. Each stakeholder was given five votes. Each person was allowed to use up to two votes on a single goal if he or she felt strongly about it. The voting process helped focus on goals that need to be adequately addressed in the planning process and within this watershed plan report. Tallied votes by goal topic were as follows:

1) Surface Water Quality – *21 votes*
2) Agriculture – *20 votes*
3) Education & Stewardship – *15 votes*
4) Groundwater – *13 votes*
5) Communication & Coordination – *9 votes*
6) Flooding – *8 votes*
7) Species & Habitat – *5 votes*
8) Green Infrastructure Network – *4 votes*

Finally, stakeholders that attended the Goals meeting participated in a World café exercise dedicated to a facilitated brainstorming session around the watershed plan mission statement and goals. Facilitators led successive groups of stakeholders through questions and prompting around each goal and the mission statement, taking notes on stakeholder ideas and feedback. This information was then used to refine the mission, the goals, and the objectives of the plan, as well as incorporated into the plan document where appropriate.

Objectives for each goal were further refined to be specific where appropriate and designed to be measurable so that future progress toward meeting goals can be assessed. Goals and objectives ultimately lead to the development of action items and project recommendations. The Management Measures Action Plan section of this report is geared toward addressing watershed goals by recommending programmatic and site-specific Management Measure actions to address each goal. The goals and objectives are examined in more detail in the discussion of the measurement of plan progress and success via milestones and “Report Cards” given in Section 9.2.

Goal 1: ***Improve surface water quality to meet water quality standards.***

Objectives:

1) Restore 152,621 linear feet of riparian areas buffers and spot stream stabilization along High Priority and Medium Priority stream reaches.
2) Implement 1,589 acres of other management measures recommended in this plan.
3) Implement agricultural best management practices on 5,052 acres of agricultural land identified in the plan.
4) Continue existing water quality monitoring programs and implement the Water Quality Monitoring Plan targeting assessment of Total Phosphorus, Total Nitrogen, Total Suspended

Solids, and *E. coli* at identified locations. Other parameters are identified for additional monitoring within the water quality monitoring plan.

5) Track changes in water quality over time as related to the Milwaukee River TMDL and make adaptive management changes to the plan as necessary to ensure water quality improvements toward meeting the TMDL reductions.

Goal 2: *Encourage agricultural techniques and soil conservation practices that will protect and conserve topsoil and bolster our water resources.*

Objectives:

1) Encourage landowner to utilize existing programs and agencies such as the Natural Resource Conservation Service (NRCS), the University of Wisconsin-Division of Extension, and the land conservation departments of Ozaukee, Sheboygan, and Washington Counties to install conservation practices that protect soil loss and water quality.
2) Educate and inform landowners about federal and state cost-share programs, which provide incentives for landowners to enroll in conservation programs and implement conservation practices.
3) Increase support for and develop additional financial assistance programs targeted at increasing the installation of conservation practices.
4) Encourage landowners and farmers to leave adequate buffers between agricultural land and waterways.
5) Implement agricultural best management practices on 5,052 acres of agricultural land identified in the plan.

Goal 3: *Increase stakeholder awareness of watershed issues through education and stewardship.*

Objectives:

1) Increase environmental stewardship opportunities and encourage stakeholders to participate in watershed plan implementation and restoration campaigns to increase activism in the watershed.
2) Implement the Fredonia-Newburg Watershed-Based Plan Information & Education Campaign.
3) Inform public officials of the benefits of conservation and low impact development and the importance of ordinance language changes that promote these developments.
4) Create targeted educational information for riparian land owners.
5) Install watershed interpretation signage at public access points and major roads.
6) Develop recommendations and alternatives for the use of fertilizer and road salt and the disposal of pet waste.

Goal 4: *Protect groundwater quantity and quality.*

Objectives:

1) Encourage county health departments or other appropriate entities to monitor the extent and current condition of septic tanks in the watershed and to educate septic tank owners on how to properly maintain their systems.
2) Educate stakeholders about potential groundwater contamination issues and encourage private well testing.
3) Implement model groundwater recharge policies for development in all "High" and "Very High" groundwater recharge potential areas.
4) Encourage landowners to install downspout disconnection practices such as rain gardens and rain barrels and utilize pavement alternatives.

5) Encourage use of Stormwater Treatment Train, Conservation Developments, or Low Impact Designs within new and redevelopment.
6) Encourage additional studies and stakeholder education on connections between well-abandonment and groundwater quality.

Goal 5: ***Increase communication and coordination among stakeholders.***
Objectives:
1) Inform public officials on the benefits of conservation, low impact development, and the importance of ordinance language changes.
2) Encourage adoption of the Fredonia-Newburg Area Watershed-Based Plan by local municipalities in the watershed.
3) Leverage existing outreach programs and develop additional programs and vehicles dedicated to conducting water quality outreach and grass roots communication within the Fredonia-Newburg Area watersheds.
4) Increase awareness of surface water quality issues among the general public and agricultural community.
5) Encourage amendments to municipal comprehensive plans, codes, and ordinances to include watershed plan goals and objectives where necessary.

Goal 6: ***Manage and mitigate for existing and future structural flood problems.***
Objectives:
1) Implement impervious reduction measures into development that is predicted to occur within Subwatershed Management Units 3, 8, 11, 12, 25, 33, 34, and 35, which are "Highly Vulnerable" to future development changes and associated impervious cover.
2) Mitigate for identified flood problem areas on a case by case basis where feasible.
3) Limit development in the identified FEMA 100-year floodplain.
4) Restore 489 acres of potential wetland restoration sites and maintain existing wetland connectivity to streams.

Goal 7: ***Protect and manage natural and cultural components of the Green Infrastructure Network, including fish and wildlife habitat.***
Objectives:
1) Include the identified Green Infrastructure Network in all county and municipal comprehensive plans and development review maps.
2) Encourage private land owners with parcels within the Green Infrastructure Network to manage their land for ecological and water quality benefits.
3) Increase the width of and restore riparian buffers along 11 stream reaches identified as critical stream reaches and reconnect the stream to the floodplain where possible.
4) Improve habitat in degraded stream reaches using natural design approaches.
5) Develop and implement restoration and management plans for all Natural Area Restoration sites.
6) Implement conservation or low impact design standards where new or redevelopment occurs.
7) Incorporate natural landscaping into golf courses.

3.0 WATERSHED RESOURCE INVENTORY

3.1 Geologic History & Climate

Geologic History

The terrain of the Midwestern United States is shaped by several significant features and processes including The Niagara Escarpment and the Late Wisconsin Glaciation. The Niagara Escarpment is a 650-mile (1,050 km) long discontinuous bedrock ridge that runs from western New York near Niagara Falls, through southern Ontario and the Upper Peninsula of Michigan into eastern Wisconsin (Luczaj 2013). The ancient Niagara Escarpment has had a lot to do with creating the familiar landscape of eastern Wisconsin. During the last ice age, this erosion-resistant rock ridge caused the vast glacier to split into two lobes, which carved out Green Bay, Lake Winnebago and Lake Michigan. It continues to lend a special sense of place to the region, as it snakes through the countryside, affording a dramatic backdrop here or a spectacular view there (Kluessendorf 2010).

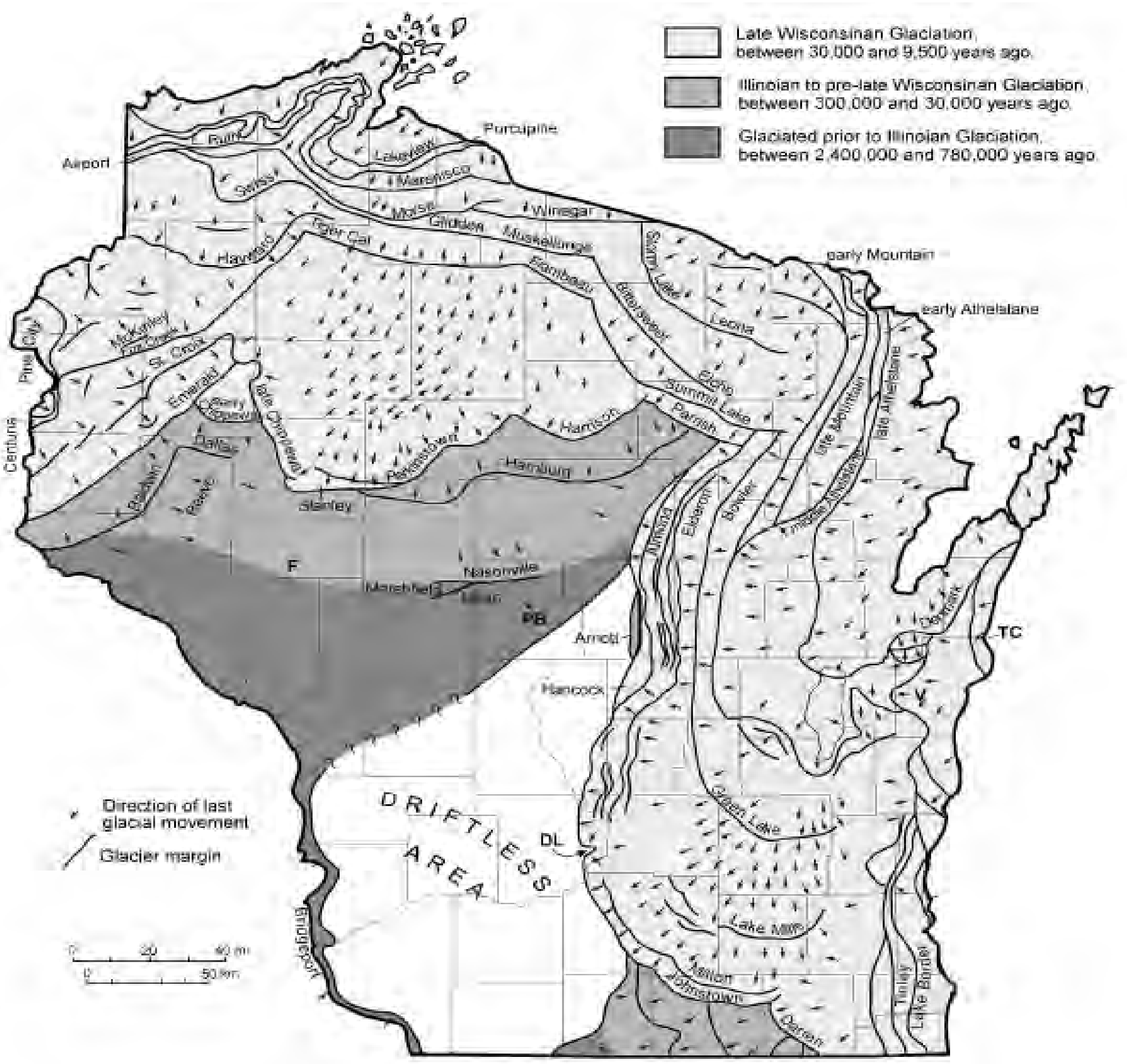


Figure 4. Phases of glaciations in Wisconsin. Source: Syverson & Colgan.

After the 400-million-year-old Niagara Escarpment established the foundation, the subsequent process of shaping the terrain we see now took thousands of years as glaciers advanced and retreated during the Pleistocene Era or "Ice Age". Some of these glaciers were a mile thick or more. The area of east central Wisconsin where the Fredonia-Newburg Area watersheds now lie was covered by the most recent glacial event known as the Late Wisconsin Glaciation that began approximately 30,000 years ago and ended around 9,500 years ago (Figure 4). During this period the earth's temperature warmed and the ice slowly retreated leaving behind moraines and glacial ridges where it stood for long periods of time (Hansel 2005). As the glaciers from this period receded, they scoured out what have become the Great Lakes and left behind a nearby terminal moraine known as the Kettle Moraine. The Kettle Moraine geology defines the character of these watersheds and the communities within them. Massive amounts of meltwater from the melting and receding glacier also carved out many of the ravines found along the coastline.

The composition of the soil in the watershed area is also a remnant of the ancient ice movement. Above the bedrock lies a layer of deposits left behind from the glaciers, consisting of clay, silt, sand, and limestone cobble. A somewhat tundra-like environment covered by spruce forest was the first ecological community to colonize after the glaciers retreated. As temperatures continued to rise, cool moist deciduous forests dominated by maple, basswood, and beech trees developed along Lake Michigan coastal areas and oak-hickory forests, oak savannas, marshes, and prairies developed more inland. Black ash, relict cedar, and tamarack swamps were also part of the landscape.

Climate

The southeast Wisconsin climate can be described as temperate with cold winters and warm summers where great variation in temperature, precipitation, and wind can occur on a daily basis. Surges of polar air moving southward or tropical air moving northward cause daily and seasonal temperature fluctuations. The action between these two air masses fosters the development of low-pressure centers that generally move eastward and frequently pass over the study area, resulting in abundant rainfall. Prevailing winds are generally from the west but are more persistent and blow from a northerly direction during winter. Lake Michigan significantly influences the study area as it reduces the heat of summer and buffers (warms) the cold of winter by several degrees on average.

The Weather Channel website (www.weather.com) provides an excellent summary of climate statistics including monthly averages and records for most locations in Southeast Wisconsin. Data for West Bend, WI was selected to represent the climate and weather patterns experienced across the three watersheds (Figure 5). The average temperature in West Bend ranges from a high of 81 °F (July) to a low average temperature of 11 °F (January). Record high and low temperatures are 107 °F and -30 °F, respectively. The average annual rainfall is 33.2 inches. The average annual snow measures 44.7 inches. (Sperling's, 2018).

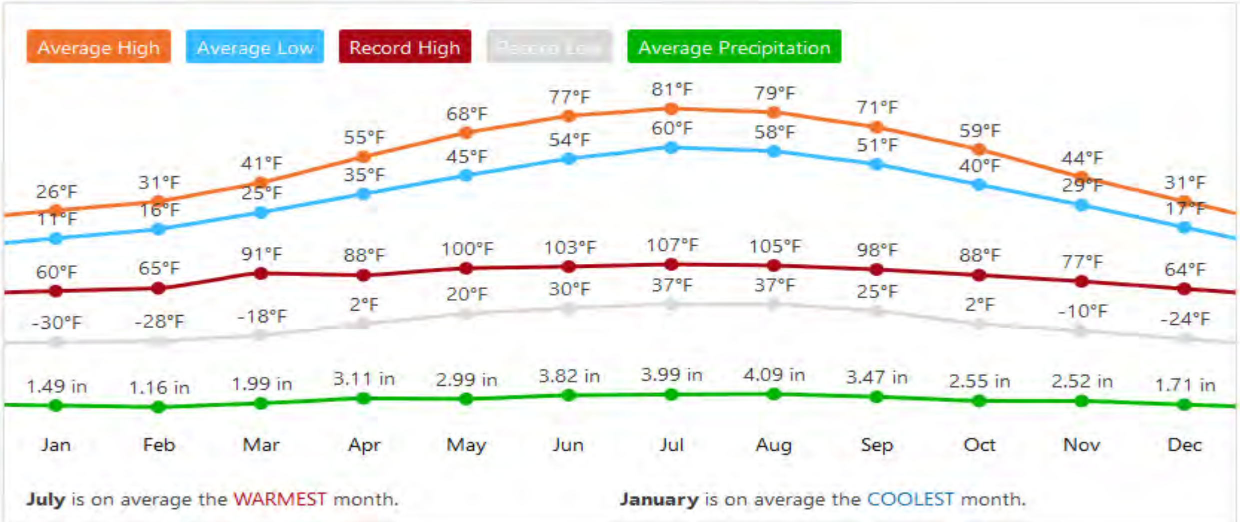


Figure 5. Monthly averages, highs and lows for temperature and precipitation in West Bend, WI (Source: the Weather Channel).

According to Wisconsin Initiative on Climate Change Impacts (WICCI) Wisconsin's climate is changing. On average, Wisconsin has become warmer and wetter over the past 60 years. Future projections for Wisconsin created by University of Wisconsin-Madison suggest Wisconsin's warming trend will continue and increase considerably. By the middle of the century, statewide annual average temperatures are likely to warm by 6-7 ° F.

3.2 Pre-European Settlement Landscape Compared to Present Landscape

The last Native American Indian tribe to call the area home was the Potawatomie. Per old historical accounts: "The Milwaukee River was the boundary line between the Chippewas and the Pottawatomies, the former holding all lands south of the entire length of the Milwaukee River, while the latter occupied everything north of that stream" (Cigrand 1916). These people lived in relative harmony with the environment until they signed a land cession treaty with the United States in 1816 at Prairie du Chien, Wisconsin. By the early 1830's, Wisconsin and Illinois lands were rapidly dwindling and pressure on natural resources by incoming white settlers on adjacent lands severely affected supplies and game (Cigrand 1916). A subsequent treaty in 1833 resulted in their removal from the land by the U.S. Government.

This treaty further paved the way for European settlement in the area that began with surveys of the land. The original public land surveyors that worked for the office of U.S. Surveyor General in the early and mid-1800s mapped and described natural and man-made features and vegetation communities while creating the township, range, and section ("Rectangular Survey System") for mapping and sale of western public lands of the United States (Daly & Lutes et. al., 2011). Ecologists know by interpreting survey notes and hand drawn Federal Township Plats of Wisconsin (1833-1866) and from documents written by the earliest settlers in the area that a complex interaction existed between several ecological communities including creeks, rivers, oak savannas, forests, and wetland prior to European settlement in the 1830s (Figures 6 - 8).

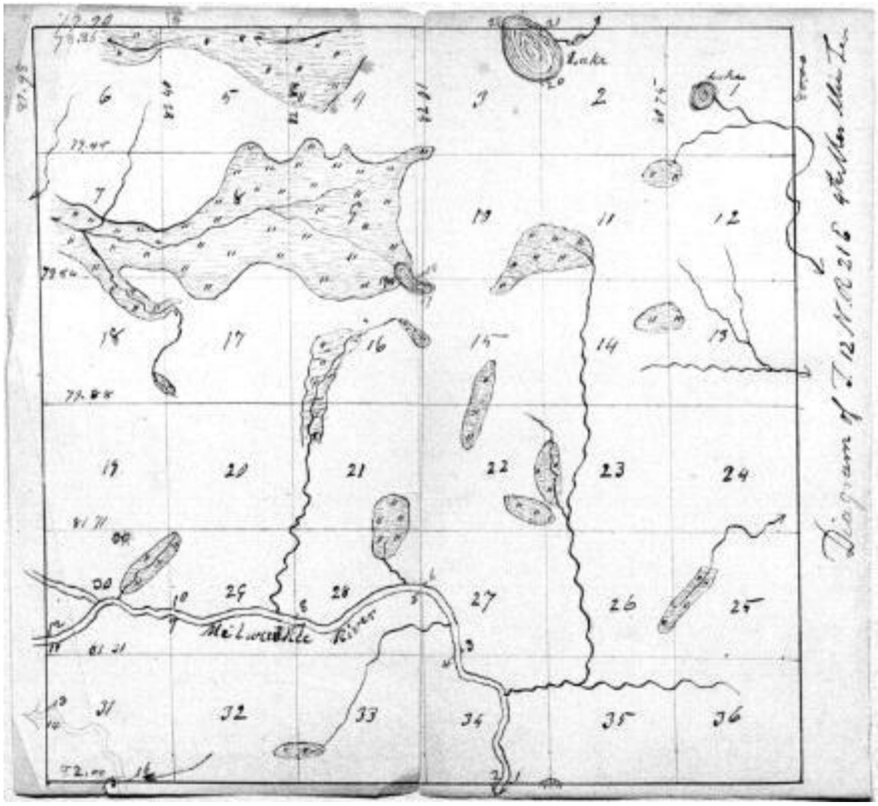


Figure 6. Sketch map for T12N R21E, Fredonia, WI and area to NW (Source: Wisconsin Board of Commissioners of Public Lands).

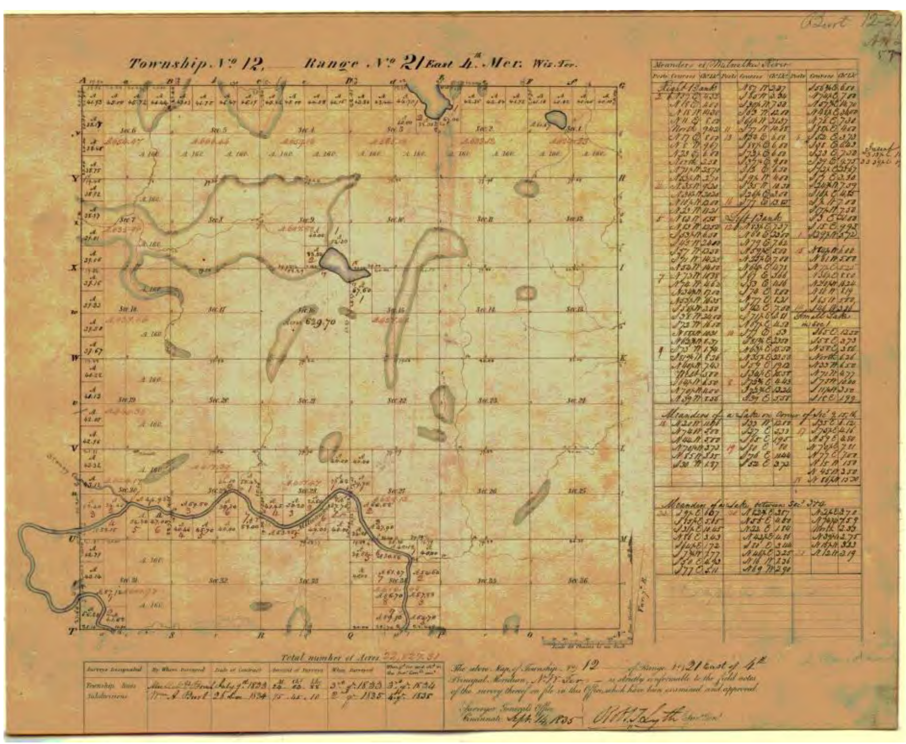
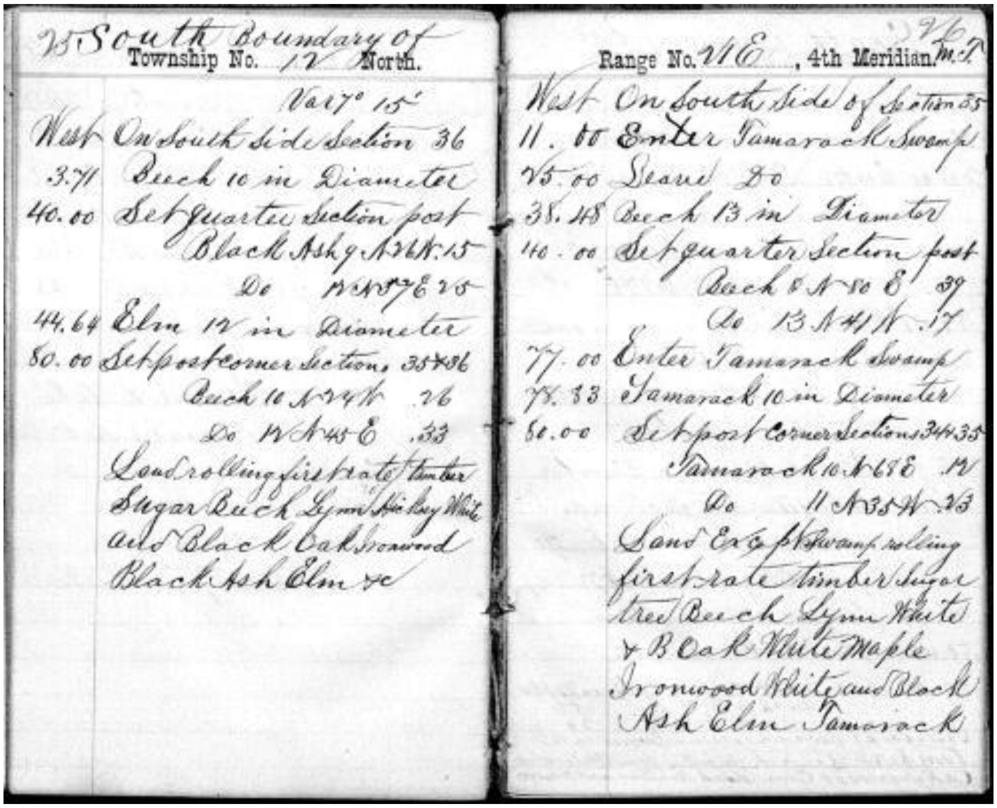


Figure 7. 1835 plat map of land features along the Upper Milwaukee River T12N R21E (Source: Wisconsin Board of Commissioners of Public Lands).



South Boundary of Township No. 12 North.

Var 7° 15'

West On South Side Section 36

3.71 Beech 10 in Diameter

40.00 Set Quarter Section post

Black Ash 9 N 26 W 15

Do N 57 E 25

44.64 Elm 12 in Diameter

80.00 Set post corner Sections 35 & 36

Beech 10 N 24 W 26

Do 12 N 45 E 33

Land rolling first rate timber

Sugar Beech Lynn Hickory White

and Black Oak Ironwood

Black Ash Elm &c

Range No. 21 E, 4th Meridian M.T.

West On South Side of Section 35

11.00 Enter Tamarack Swamp

25.00 Leave Do

38.48 Beech 13 in Diameter

40.00 Set Quarter Section post

Beech 8 N 80 E 39

Do 13 N 41 W 17

77.00 Enter Tamarack Swamp

78.33 Tamarack 10 in Diameter

80.00 Set post Corner Sections 34 & 35

Tamarack 10 N 68 E 12

Do 11 N 35 W 23

Land Ex of Swamp rolling

first rate timber Sugar

tree Beech Lynn White

& B Oak White Maple

Ironwood White and Black

Ash Elm Tamarack

Figure 8. 1835 surveyor's notes for plat map T12N R21E Sec. 36 (Source: Wisconsin Board of Commissioners of Public Lands).

The surveyors described the large majority of the area of the Fredonia -Newburg Area watersheds as forested with a variety of tree species (Figure 9). Forested areas were comprised of three primary sub-communities as described by Curtis (1959). Southern mesic forest dominated by maple, basswood, and beech trees was likely the most common in the watershed. Southern dry-mesic forest, dominated by a variety of oak and hickory species, was also common, particularly on the slopes that are well-drained and derived from glacial till. Southern lowland forest was also probably common in the area and these wet areas contained black ash and alder.

European settlement beginning in the 1830s resulted in drastic changes to the fragile ecological communities as most of the old growth forests were cleared by settlers who used the wood for fuel, to build their homes, sold it to sawmills, and farmed the cleared land. This area's relatively proximity to the explosive growth occurring just south in Chicago, put tremendous strain on resources. Wetland complexes in the valleys and hillslopes of tributaries and the riparian area of the Fredonia-Newburg Area watersheds were also cleared and drained for farmland. The majority of streams were channelized and ditched to further drain water off the land. The earliest aerial photographs taken in 1937 (Figure 10) depict Fredonia-Newburg Area watersheds when row crop farming was the primary land use but before much of the residential, commercial, and industrial development seen today. By 1937, very few forested areas that once dominated the watershed remained.

Figure 11 shows a 2015 aerial photograph of the Fredonia -Newburg Area watersheds. One can see that large portions of agricultural land are replaced by residential, commercial, and industrial development, specifically near the cities, towns, and villages within the watershed. Newer residential development is common in the western portion of the Village of Newburg-Milwaukee River watershed near the city of West Bend. Industrial land uses are more common along the transportation corridors of State Highway 33 and WI Highway 57 near the city of West Bend and Town of Fredonia. There is also an airport in the city of West Bend just south of State Highway 33. Most of the watershed is still used for agricultural purposes, with natural areas interspersed throughout owned by local conservation groups.

Depiction of what the pre-settlement landscape might have looked like (Source: Riveredge)

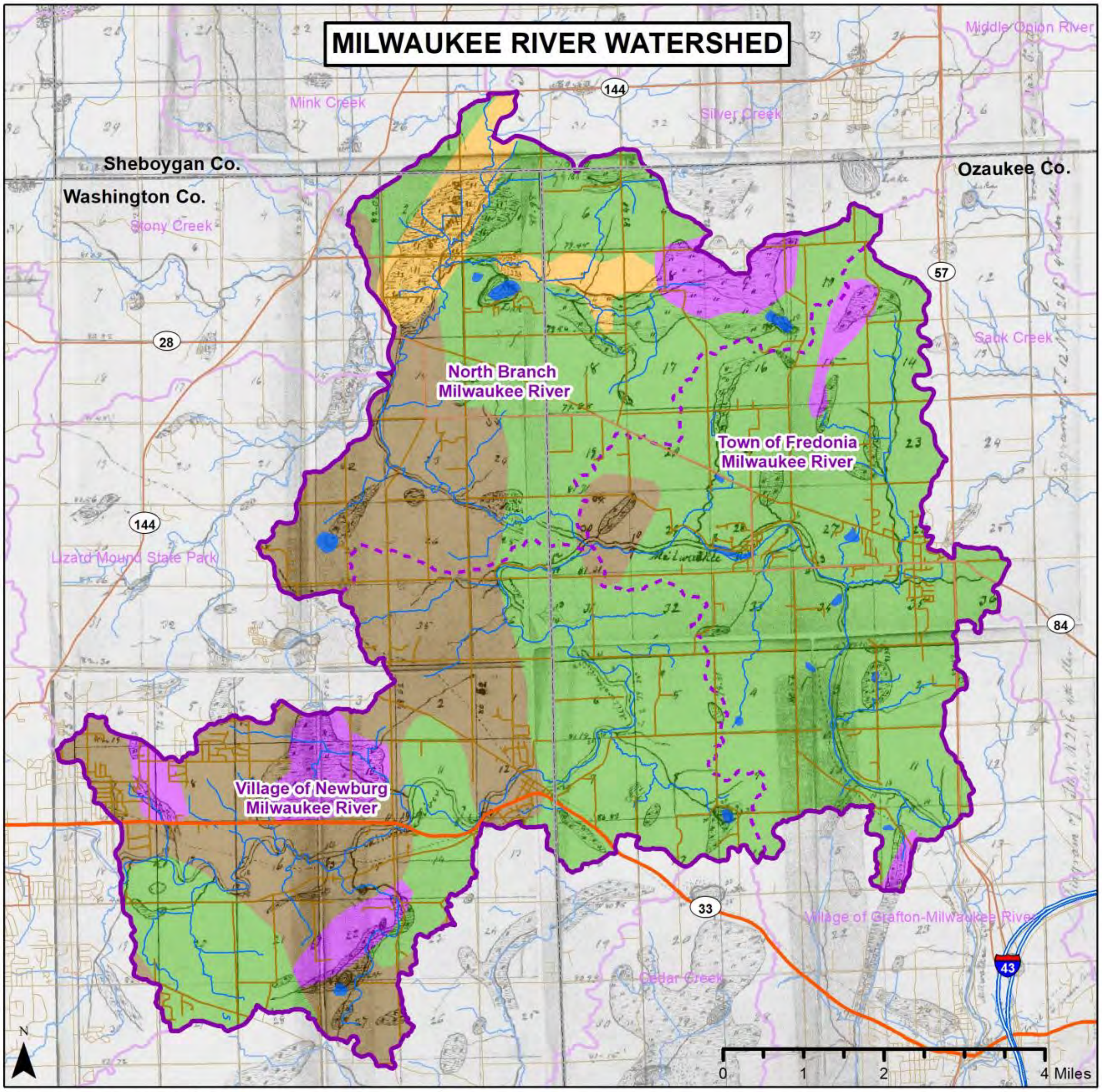
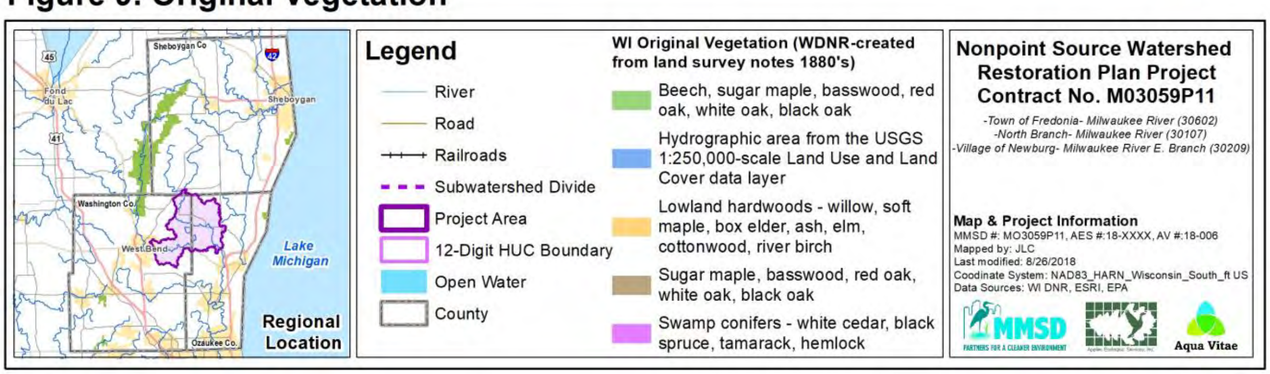


Figure 9. Original Vegetation



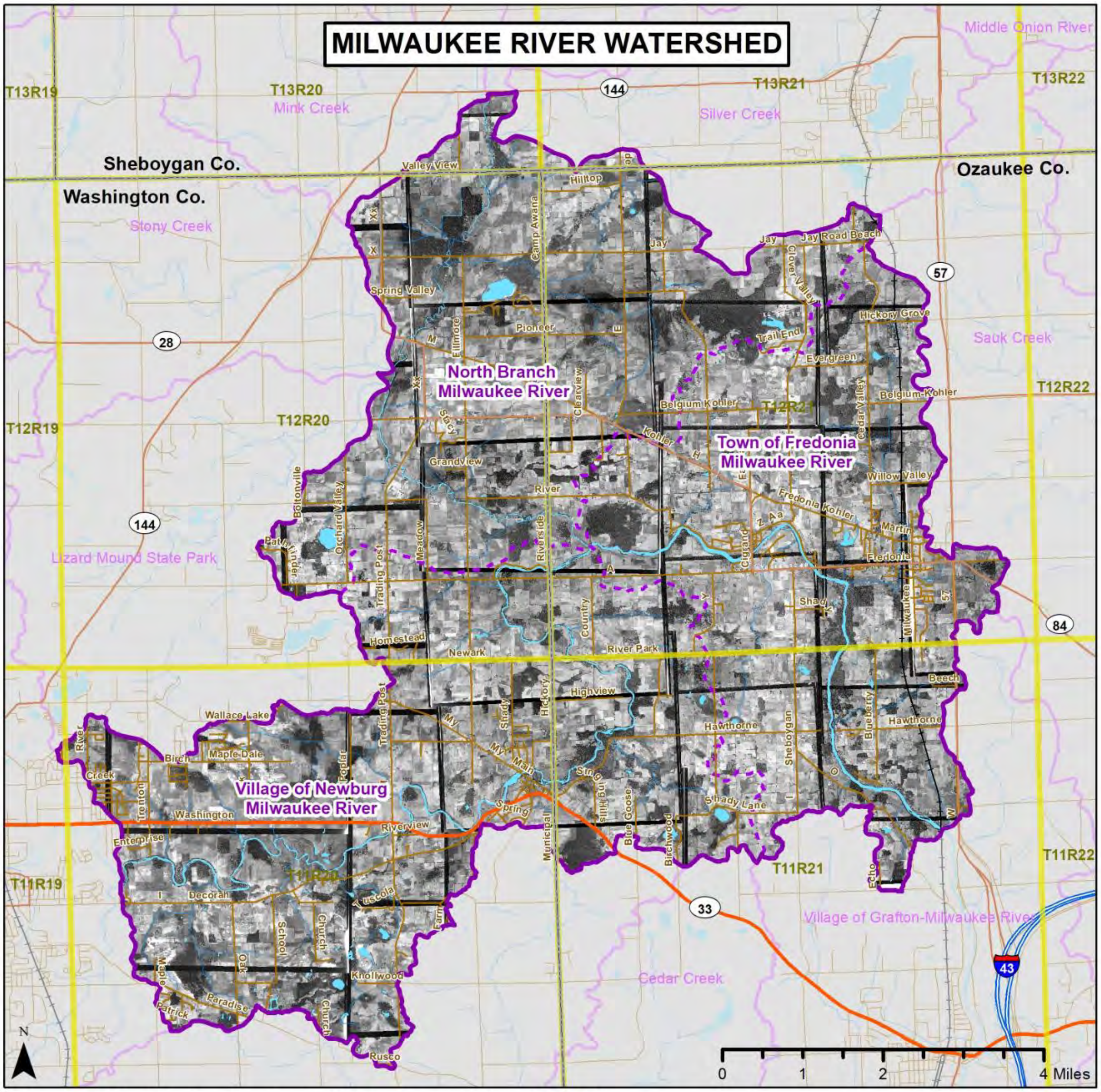
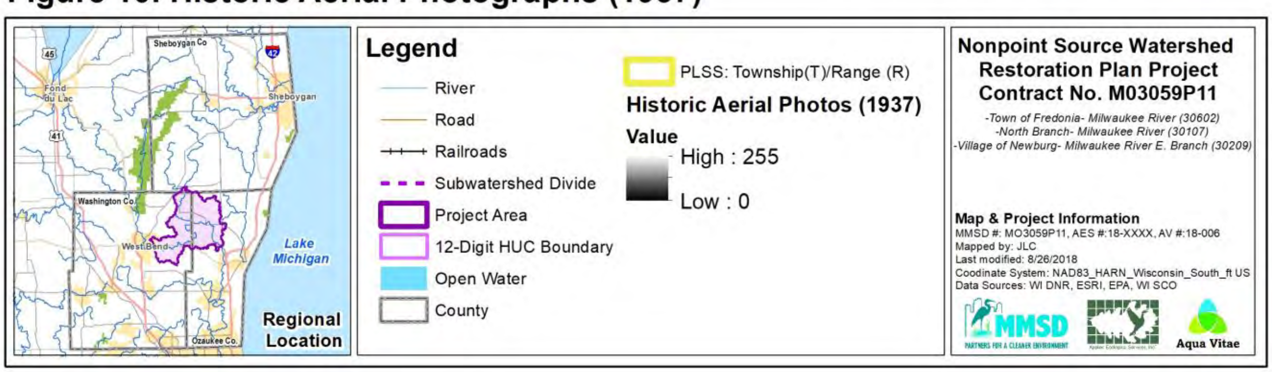


Figure 10. Historic Aerial Photographs (1937)



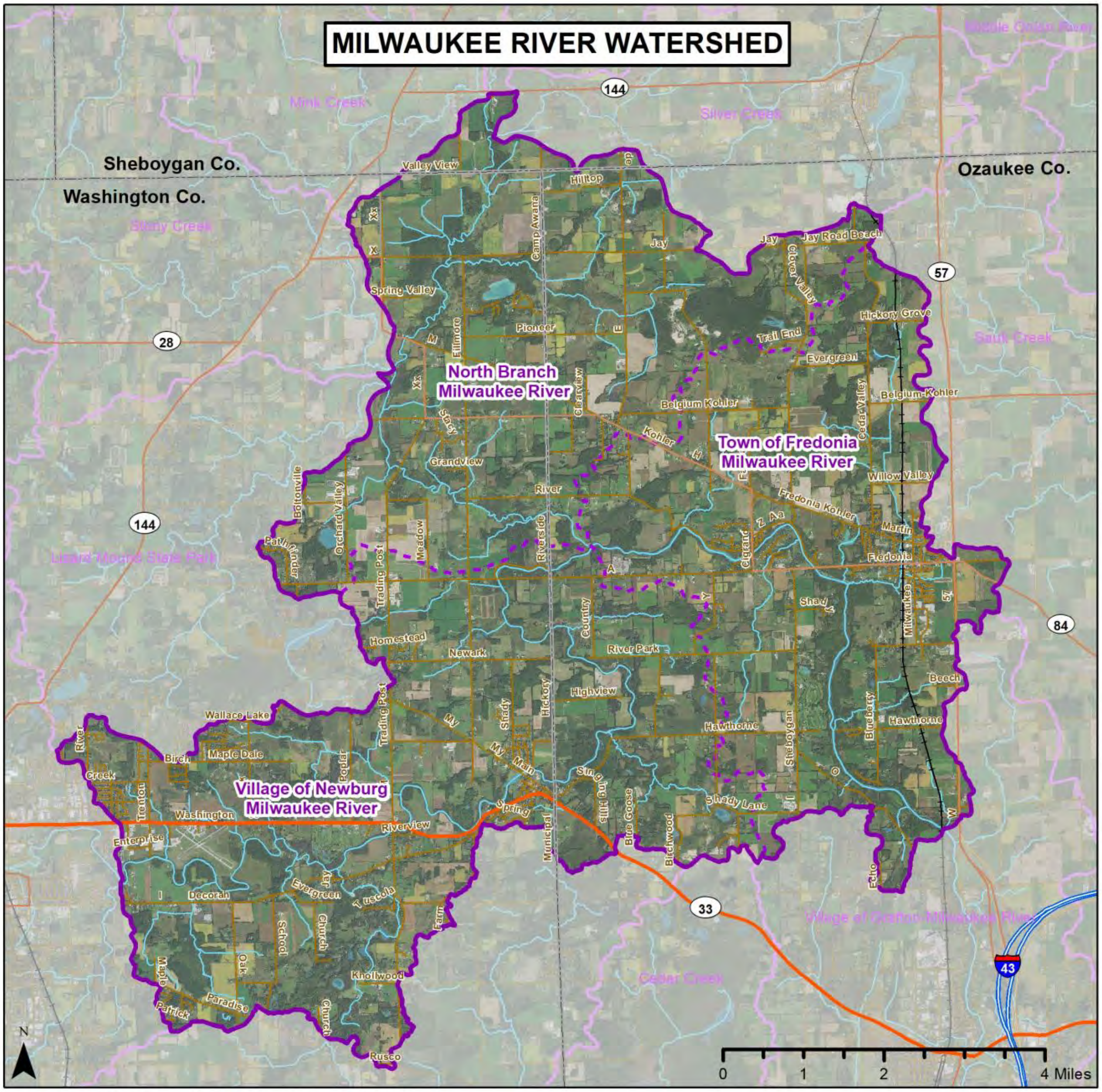
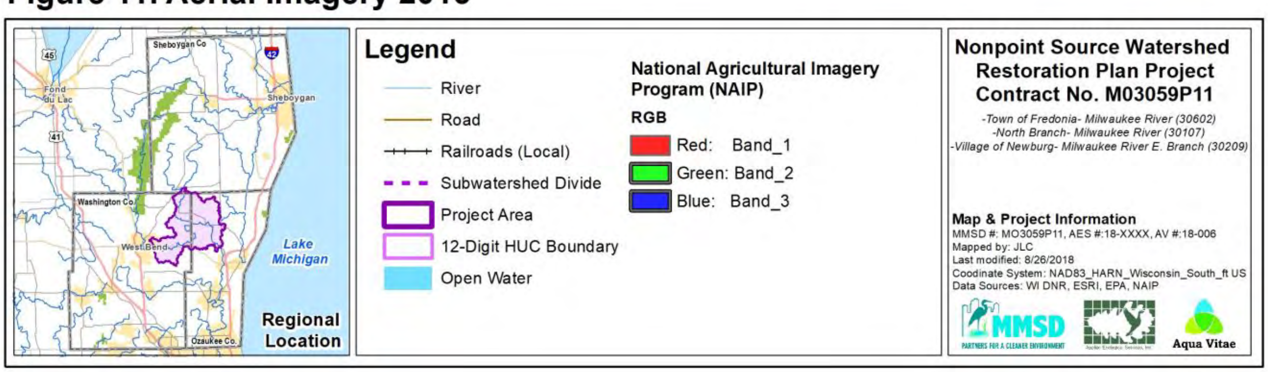


Figure 11. Aerial Imagery 2015



With degraded ecological conditions comes the opportunity to implement ecological restoration to improve the condition of these three watersheds. Present day knowledge of how pre-European settlement ecological communities formed and evolved provides a general template for developing present day natural area restoration and management plans and projects. One of the primary goals of this watershed plan is to identify, protect, restore, and manage remaining natural areas.

Noteworthy- Old Stone Foundations

Old stone foundations and stone fences are common sights around many of the old farmsteads within all three watersheds. Before tilling the land, farmers had to remove and pile the rocks or repurpose them. This reflects the rocky geology of glacial till in this area of Kettles and Moraines. Removing rocks and plowing the land was backbreaking labor done by horses and by hand (Note: old relict steel Horse Drawn Walking Plow sits in foreground).

3.3 Topography, Watershed Boundary, & Subwatershed Management Units

Topography & Watershed Boundary

The Wisconsin glacier that retreated about 10,000 years ago following formation of the Niagara Escarpment (described previously in this document) formed much of the topography and defined the watershed catchment boundaries of today. Topography refers to elevations of a landscape that describe the configuration of its surface and ultimately defines watershed boundaries. And, the specifics of watershed planning cannot begin until a watershed boundary is clearly defined.

Intertwined land uses of agriculture and wildlife/natural areas characterize the Fredonia-Newburg watersheds.

The watershed boundaries used in this study are a combination of boundaries provided by both Wisconsin Department of Natural Resources (WDNR) and Southeastern Wisconsin Regional Planning Commission (SEWRPC). Small discrepancies noted during field inventories were also used to alter the boundary where appropriate. Topographic data was derived from a DEM (Digital Elevation Model) dataset at 2' resolution. This detailed LiDAR (Light Detection and Ranging) data was provided by SEWRPC for Ozaukee and Washington Counties. Sheboygan County contour data were converted into a DEM and mosaiced to create a seamless high-resolution DEM for the entire watershed. ArcSWAT was then used to generate SMUs (Sub Management Units) based on the DEM (Figure 12).

Collectively, the Village of Newburg, Town of Fredonia, and North Branch- Milwaukee River Watersheds span 46,923 acres, or about 73.3 square miles. The entire watershed drains from north and west to south and eventually to Lake Michigan at Milwaukee, WI. Elevation within the watersheds range from a high of 1048 feet above mean sea level (AMSL) to a low of 754 feet AMSL on the Milwaukee River just upstream of Grafton, WI for a total relief of 294 feet (Figure 12). The highest point is found just east of West Bend along a ridge south of Decorah Road.

Natural areas such as this oak savanna restoration at Riveredge Nature Center (left) illustrate potential opportunities to restore parcels for water quality, wildlife habitat and useable open space.

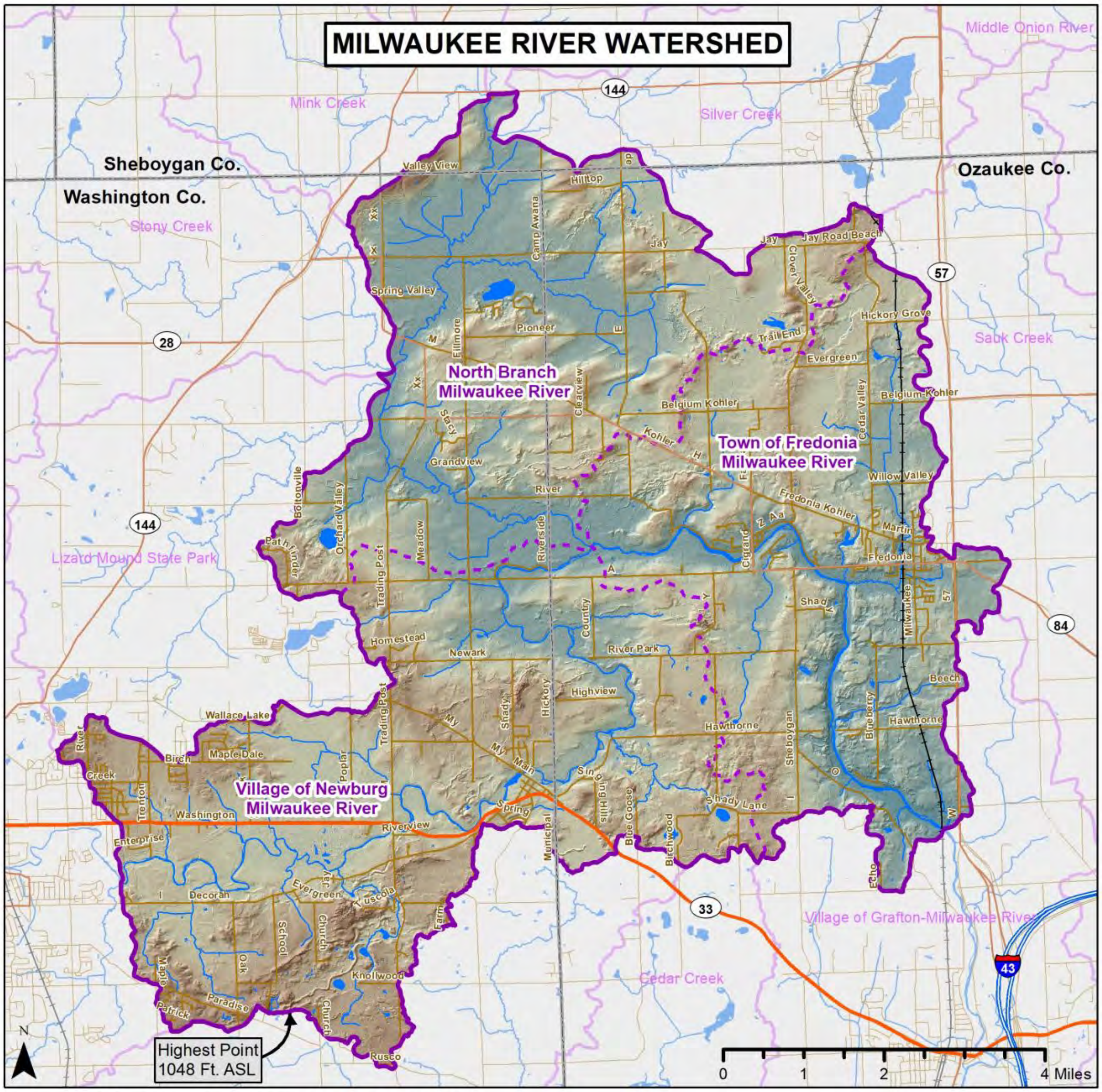
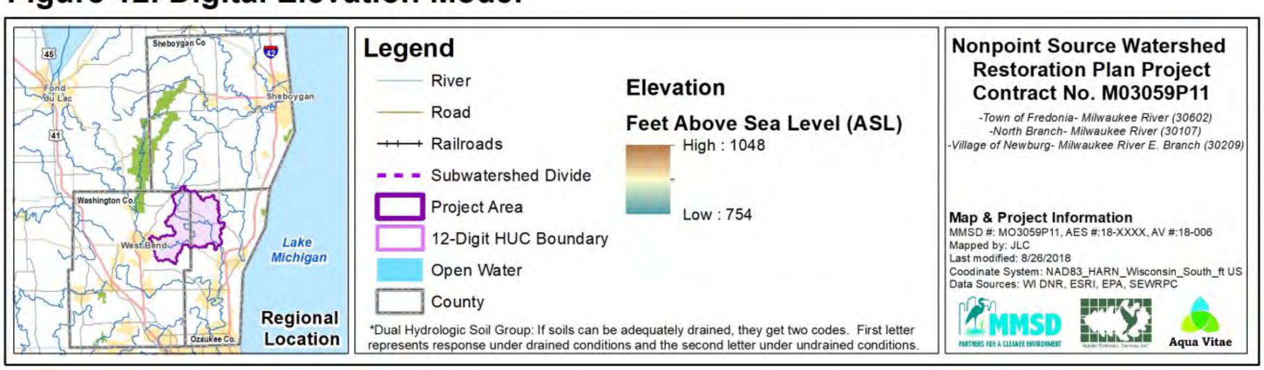


Figure 12. Digital Elevation Model



Rolling hills of the Fredonia-Newburg area watersheds

Subwatershed Management Units (SMUs)

The Center for Watershed Protection (CWP) is a leading watershed planning agency and has defined watershed and subwatershed sizes appropriate to meet watershed planning goals. In 1998, the CWP released the "Rapid Watershed Planning Handbook" (CWP 1998) as a guide to be used by watershed planners when addressing issues within urbanizing watersheds. The CWP defines a watershed as an area of land that drains anywhere from 10 to 100 square miles. Broad assessments of conditions such as soils, wetlands, and water quality are generally evaluated at the watershed level and provide some information about overall conditions. As mentioned, the combined watershed area is about 73.3 square miles and therefore this plan allows for a detailed look at watershed characteristics, problem areas, and management opportunities. However, an even more detailed look at smaller drainage areas must be completed to find site specific problem areas or Priority Areas that require immediate attention.

A watershed can be divided into subwatersheds called Subwatershed Management Units (SMUs) to address issues at a smaller scale. The North Branch, Town of Fredonia, and Village of Newburg-Milwaukee River watersheds were delineated into 10, 12, and 13 SMUs respectively using the Digital Elevation Model (DEM) information (Table 3; Figure 13). All SMUs contribute directly to the Milwaukee River, or to a tributary within the SMU. All SMUs have a single outlet point where the tributary or river flow from one SMU into the next downstream. Information obtained at the SMU scale allows for detailed analysis and better recommendations for site specific "Management Measures" otherwise known as Best Management Practices (BMPs). Delineation into SMUs also allows for better identification of areas contributing to water quality problems as summarized in Section 4.0. No internally drained areas were found within the subwatershed management units.

Table 3. Subwatershed management units, acreages and square miles.

Watershed/SMU	Acres	Sq. Miles
Town of Fredonia-Milwaukee River		
SMU 1	1,643	2.6
SMU 2	536	0.8
SMU 3	775	1.2
SMU 4	1,157	1.8
SMU 5	1,349	2.1
SMU 6	985	1.5
SMU 7	486	0.8
SMU 8	1,041	1.6
SMU 9	1,098	1.7
SMU 10	1,668	2.6
SMU 11	475	0.7
SMU 12	2,909	4.5
Total	**14,122**	**22.1**
North Branch Milwaukee River		
SMU 13	678	1.1
SMU 14	1,476	2.3
SMU 15	1,070	1.7
SMU 16	1,542	2.4
SMU 17	2,144	3.4
SMU 18	1,041	1.6
SMU 19	624	1.0
SMU 20	1,088	1.7
SMU 21	2,646	4.1
SMU 22	1,821	2.9
Total	**14,131**	**22.1**
Village of Newberg-Milwaukee River		
SMU 23	1,301	2.0
SMU 24	901	1.4
SMU 25	986	1.5
SMU 26	607	1.0
SMU 27	1,442	2.3
SMU 28	2,788	4.4
SMU 29	1,571	2.5
SMU 30	545	0.9
SMU 31	1,521	2.4
SMU 32	1,870	2.9
SMU 33	2,237	3.5
SMU 34	1,407	2.2
SMU 35	1,492	2.3
Total	**18,669**	**29.2**
Total all 3 Watersheds	**46,922**	**73.3**

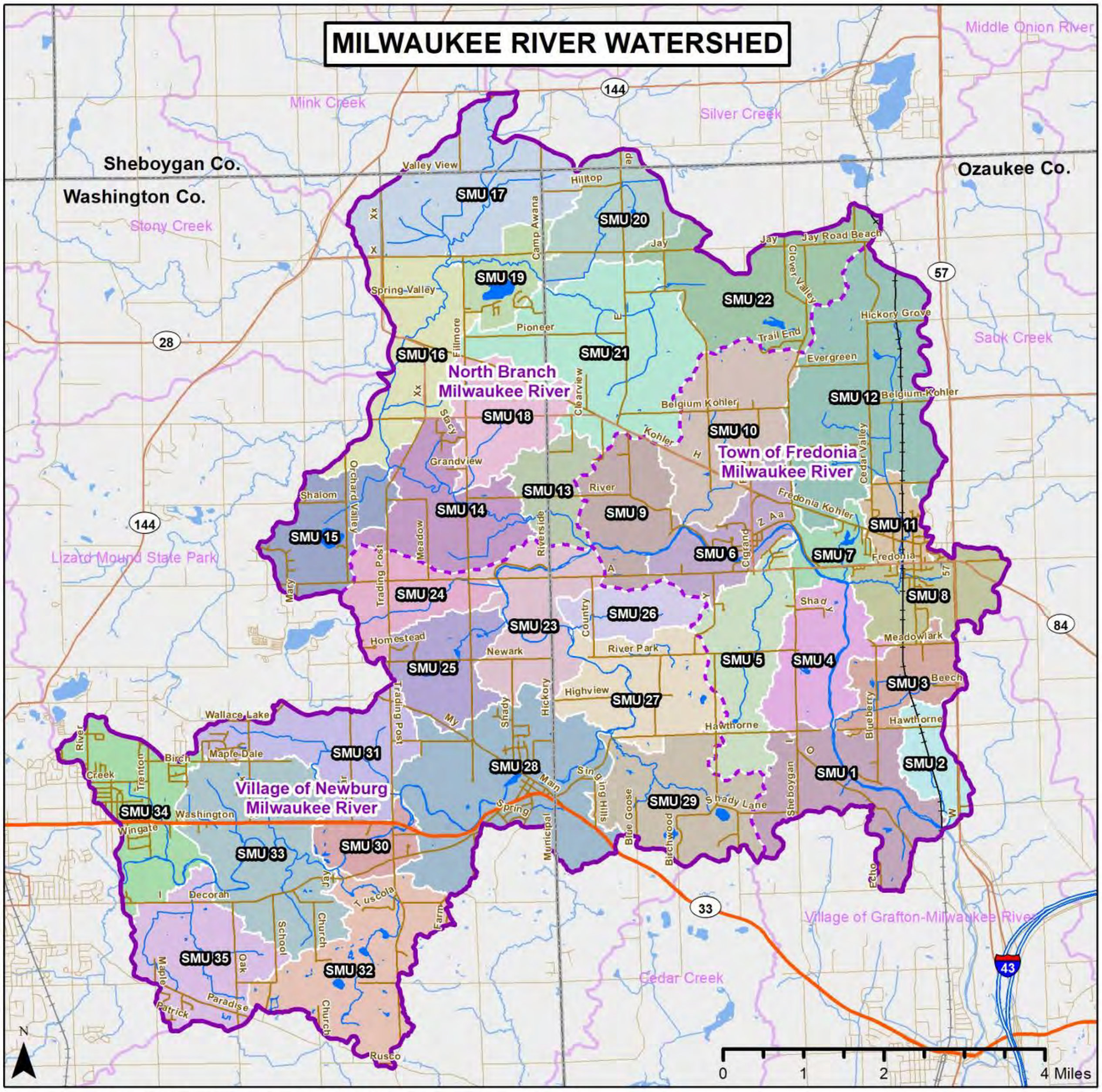
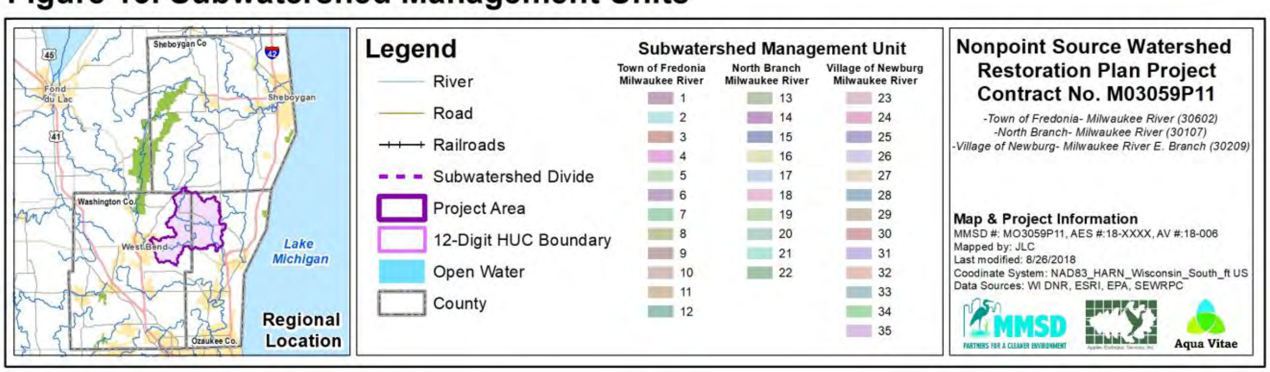


Figure 13. Subwatershed Management Units



3.4 Hydric Soils, Soil Erodibility, & Hydrologic Soil Groups

Soils

Deposits left by the Wisconsin glaciation 10,000 years ago are the raw materials of present soil types in the watershed. These raw materials include till (debris) and outwash. A combination of physical, biological, and chemical variables such as topography, drainage patterns, climate, and vegetation, have interacted over centuries to form the complex variety of soils found in the watershed. Most soils formed under wetland, woodland, and prairie vegetation. The most up to date soils mapping provided by the Wisconsin DNR (WDNR), United States Environmental Protection Agency (EPA), and United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) for Washington, Ozaukee, and Sheboygan Counties was used to summarize the extent of hydric soils, soil susceptibility to erosion, and infiltration capacity of soils in the North Branch, Town of Fredonia, and Village of Newburg Milwaukee River HUC 12 watersheds (Tables 4-7; Figures 14-16).

Hydric Soils

Wetland or "Hydric Soils" generally form over poorly drained clay material associated with wet prairies, marshes, and other wetlands and from accumulated organic matter from decomposing surface vegetation. Hydric soils are important because they indicate the presence of existing wetlands or drained wetlands where restoration may be possible. Most of the wetlands in the North Branch, Town of Fredonia, and Village of Newburg Milwaukee River HUC 12 watersheds were intact until settlers began to alter significant portions of the watershed's natural hydrology and wetland processes. Where it was feasible wet areas were cleared of vegetation and drained to farm the rich soils. The location of hydric, partially hydric, and upland soils in the watershed is summarized and depicted on Table 4 and Figure 14, respectively.

Within the North Branch- Milwaukee River watershed, hydric soils comprise 3,964 acres or 28% of the watershed, in the Town of Fredonia- Milwaukee River watershed, hydric soils comprise 1,883 acres or 13% of the watershed, and in the Village of Newburg- Milwaukee River watershed, hydric soils comprise 3,261 acres or 17% of the watershed. Most of these soils are located in the Milwaukee River floodplain areas of the North Branch of the Milwaukee River watershed and the floodplain areas directly east of West Bend in the Village of Newburg-Milwaukee River watershed. Vegetation mapping developed by the WDNR from 1880's land survey notes suggests the areas surrounding the hydric soils in the North Branch watershed were dominated mostly by lowland hardwoods and swamp conifers; while those in the Village of Newburg watershed are largely split between swamp conifers as well as sugar maple, basswood, and red, white and black oak.

Within the North Branch, Town of Fredonia, and Village of Newburg Milwaukee River watersheds, partially hydric soils occur over 1,931 (14%) acres, 3,642 (26%) acres, and 3,491 (19%) acres respectively. Partially hydric soils exhibit some, but not all, of the characteristics of hydric soils. These soils are scattered throughout the watershed, typically found adjacent to hydric soils in floodplains, but there is also a concentration of partially hydric soils on the eastern boundary of the Town of Fredonia watershed. These soils likely did not support true wetland communities.

Additionally, the North Branch, Town of Fredonia, and Village of Newburg Milwaukee River watersheds, contain non-hydric soils spanning 8,236 (58%) acres, 8,598 (61%) acres, and 11,972 (64%) acres respectively.

Table 4. Percent coverage of hydric soil classes within the watersheds.

HUC 12 Name/Erosion Rating	Acres	PCT of HUC 12
North Branch Milwaukee River	**14,130.6**	**100%**
Not Hydric	8,235.9	**58%**
Partially Hydric	1,930.8	**14%**
Hydric	3,964.0	**28%**
Town of Fredonia-Milwaukee River	**14,123.1**	**100%**
Not Hydric	8,598.2	**61%**
Partially Hydric	3,641.9	**26%**
Hydric	1,883.0	**13%**
Village of Newburg-Milwaukee River	**18,669.1**	**100%**
Not Hydric	11,917.8	**64%**
Partially Hydric	3,490.7	**19%**
Hydric	3,260.6	**17%**

Soil Erodibility

Soil erosion is the process whereby soil is removed from its original location by flowing water, wave action, wind, and other factors. Sedimentation is the process that deposits eroded soils on other ground surfaces or in bodies of water such as streams and lakes. Soil erosion and sedimentation reduces water quality by increasing total suspended solids (TSS) in the water column and by carrying attached pollutants such as phosphorus, nitrogen, and hydrocarbons. When soils settle in streams and lakes they often blanket rock, cobble, and sandy substrates needed by fish and aquatic macroinvertebrates for habitat, food, and reproduction.

A highly erodible soils map was created based on soil information provided by the WDNR, EPA, and USDA NRCS (Figure 15). Highly erodible soils have attributes that when located on slopes are susceptible to erosion. It is important to know the location of highly erodible soils because these areas have the highest potential to degrade water quality during farm tillage, development, or other factors such as bluff failures.

Based on mapping, soils with the North Branch-Milwaukee River watershed classify as "severely erodible" across 2,949 (21%) acres, "moderately erodible" 4,413 (31%) acres, "slightly erodible" 6,489 (46%) acres, and "not rated" 279 (2%) acres.

Within the Town of Fredonia-Milwaukee River watershed, soils classify as "severely erodible" across 3,905.70 (28%) acres, "moderately erodible" 5,502 (39%) acres, "slightly erodible" 4,459 (32%) acres, and "not rated" 256 (2%) acres.

The Village of Newburg-Milwaukee River watershed soils consist of "severely erodible" across 3,812 (20%) acres, "moderately erodible" 6,255 (34%) acres, "slightly erodible" 8,251 (44%) acres, and "not rated" 351 (2%) acres (Table 5).

Table 5. Percent coverage of soil erodibility ratings in the watersheds.

HUC 12 Name/Erodibility Rating	Acres	PCT of HUC 12
North Branch Milwaukee River	**14,130.6**	**100%**
Slight	6,489.2	46%
Moderate	4,413.4	31%
Severe	2,948.9	21%
Not rated	279.2	2%
Town of Fredonia-Milwaukee River	**14,123.1**	**100%**
Slight	4,459.1	32%
Moderate	5,502.0	39%
Severe	3,905.7	28%
Not rated	256.3	2%
Village of Newburg-Milwaukee River	**18,669.1**	**100%**
Slight	8,251.4	44%
Moderate	6,255.2	34%
Severe	3,811.9	20%
Not rated	350.6	2%

Fortunately, much of the highly erodible areas are currently stabilized by existing land uses/cover. However, others are located adjacent to areas of urban expansion near Newburg, Fredonia, and West Bend; or near farming in the form of dairy pastureland, and row crop farmland where erosion following annual tilling is a possibility.

One option for farmers is to convert highly erodible areas to vegetative cover under the USDA NRCS's Conservation Reserve Program (CRP). Under this program farmers receive an annual rental payment for the term of the multi-year contract.

To combat erosion due to the expansion of urban areas and the subsequent increase in impermeable surfaces, municipalities can explore options which limit the peak flow from areas of impermeability into areas of severe erodibility, such as stormwater pond retrofits, bioinfiltration basins, and permeable pavement.

Hydrologic Soil Groups

Soils also exhibit different infiltration capabilities and have been classified to fit what are known as "Hydrologic Soil Groups" (HSGs). HSGs are based on a soil's infiltration and transmission (permeability) rates and are used by engineers and planners to estimate stormwater runoff potential. Knowing how a soil will hold water ultimately affects the type and location of recommended infiltration Management Measures such as wetland restorations and detention basins. More importantly however is the link between hydrologic soil groups and groundwater recharge areas. Groundwater recharge is discussed in detail in Section 3.15.

HSG's are classified into four primary categories; A, B, C, and D, and three dual classes, A/D, B/D, and C/D. Dual classes represent soils which can be adequately drained, with the first letter representing the soil under drained conditions, and the second letter representing the soil under undrained conditions. Figure 16 depicts the location of each HSG in the watershed. The HSG categories and their corresponding soil texture, drainage description, runoff potential, infiltration rate, and transmission rate are shown in Table 6 while Table 7 summarizes the acreage and percent of each HSG.

Within the North Branch Milwaukee River watershed, Group B soils are most prevalent throughout the watershed at about 27% or 3,878 acres and are found in most upland areas. Group B/D soils make up 1,731 acres or 12% of the watershed and are generally found within floodplain areas. Group C soils make up 3,167 acres (22%) and C/D soils 106 acres (1%). Group A soils account for 82 acres (1%) and A/D 2,010 (14%) acres within the watershed. Group D soils comprise 2,960 acres or another 21% of the watershed; group D soils are located centrally within the watershed and are associated with areas most susceptible to erosion. Group A/D and B/D soils generally line up with areas dominated by hydric soils within areas adjacent to the Milwaukee River and tributaries.

In the Town of Fredonia-Milwaukee River watershed the soil groups are dominated by group B which accounts for 52% or 7,375 acres of the watershed area. This largely corresponds with non-hydric, moderately-erodible upland. Soil group C accounts for 2,952 acres (21%) of the watershed; soil group D makes up 1,748 (12%) acres. Though largely spread out through the watershed, soil groups C and D are concentrated along the eastern border of the watershed and near Fredonia. This area is of interest as the land use is dominated by row crops, and Fredonia is one of the areas in the region with projected population growth and expansion over the next 30 years.

The Village of Newburg-Milwaukee River watershed is very similar in make-up to that of the Town of Fredonia-Milwaukee river watershed. The landscape is predominantly soil group B with 10,701 acres (57%). The next largest group is C with 3,231 acres (17%) which combines with soil group A/D 1,633 (9%) and B/D 1,540 (8%) to span most of the hydric and partially hydric land directly east of West Bend. Highly erodible group D soils cover 1,203 acres (6%) of the watershed and are clustered in the upland areas northeast of Newburg which are largely used for agriculture.

Table 6. Hydrologic Soil Groups and their corresponding attributes.

HSG	Soil Texture	Drainage Description	Runoff Potential	Infiltration Rate	Transmission Rate
A	Sand, Loamy Sand, or Sandy Loam	Well to Excessively Drained	Low	High	High
B	Silt Loam or Loam	Moderately Well to Well Drained	Moderate	Moderate	Moderate
C	Sandy Clay Loam	Somewhat Poorly Drained	High	Low	Low
D	Clay Loam, Silty Clay Loam, Sandy Clay Loam, Silty Clay, or Clay	Poorly Drained	High	Very Low	Very Low

Table 7. Hydrologic Soil Groups including acreage and percent of watershed.

HUC 12 Name/Hydrologic Soil Group	Acres	PCT of HUC 12
North Branch Milwaukee River	**14,130.6**	100%
A	81.7	1%
A/D	2,010.0	14%
B	3,877.7	27%
B/D	1,730.5	12%
C	3,167.2	22%
C/D	105.6	1%
D	2,960.4	21%
Not Classed	197.5	1%
Town of Fredonia-Milwaukee River	**14,123.1**	100%
A	33.7	0%
A/D	1,038.8	7%
B	7,374.5	52%
B/D	691.6	5%
C	2,952.2	21%
C/D	54.0	0%
D	1,748.4	12%
Not Classed	230.0	2%
Village of Newburg-Milwaukee River	**18,669.1**	100%
A	17.2	0%
A/D	1,632.8	9%
B	10,701.1	57%
B/D	1,540.1	8%
C	3,231.2	17%
C/D	10.5	0%
D	1,202.9	6%
Not Classed	333.4	2%

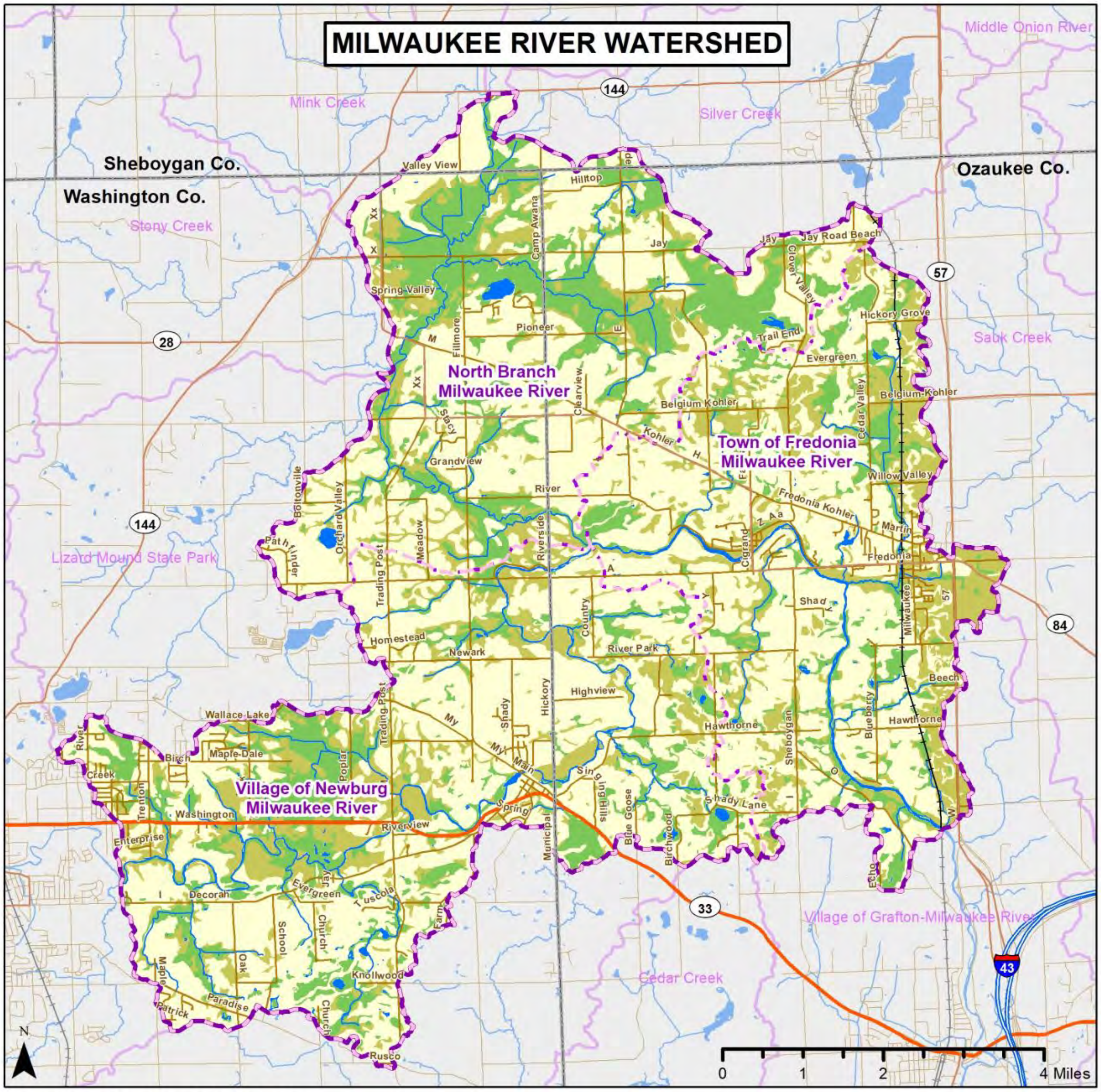
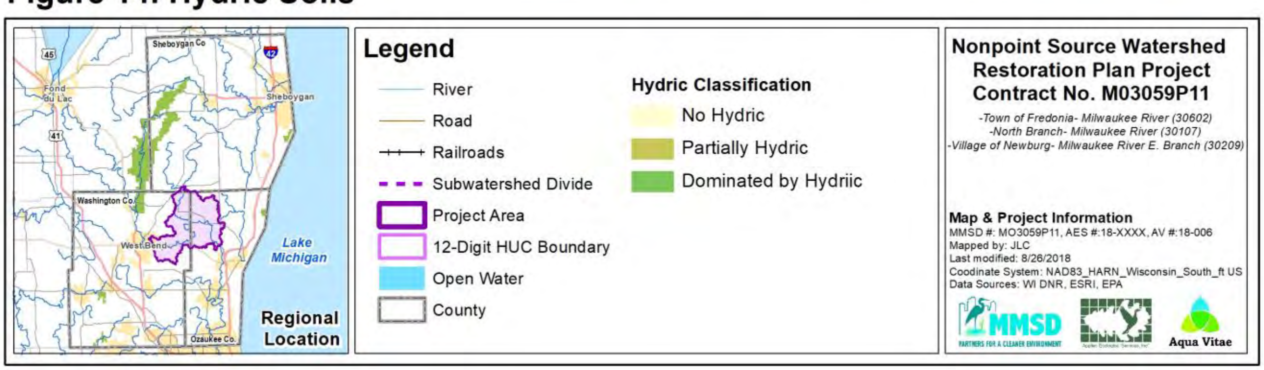


Figure 14. Hydric Soils



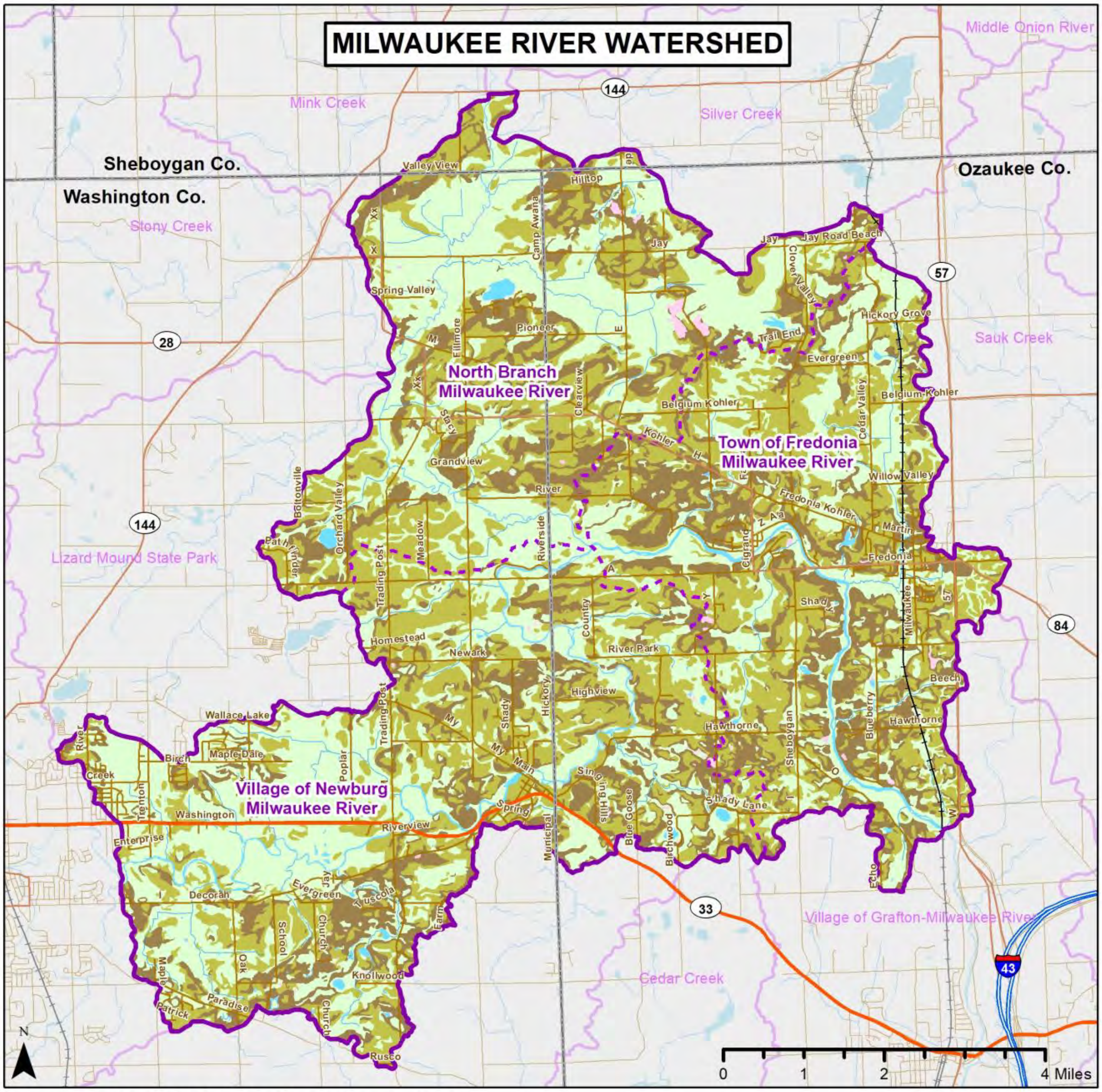
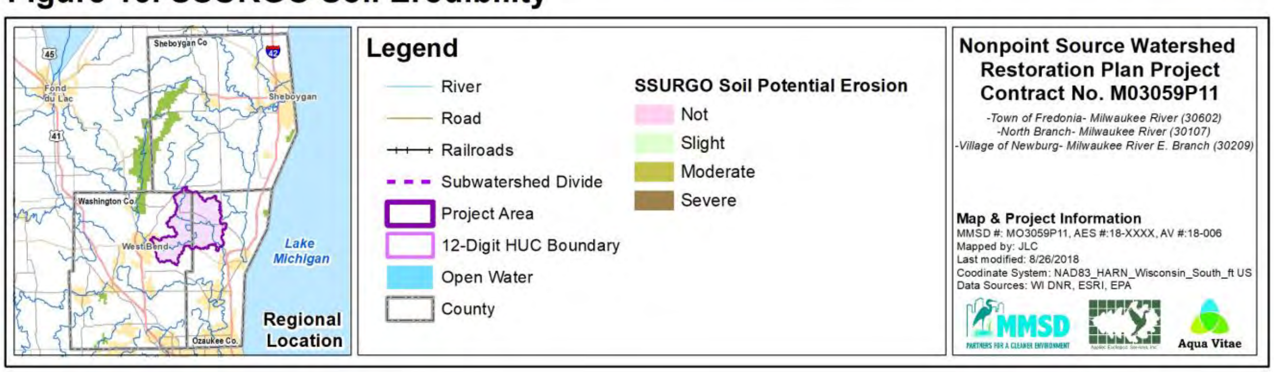


Figure 15. SSURGO Soil Erodibility



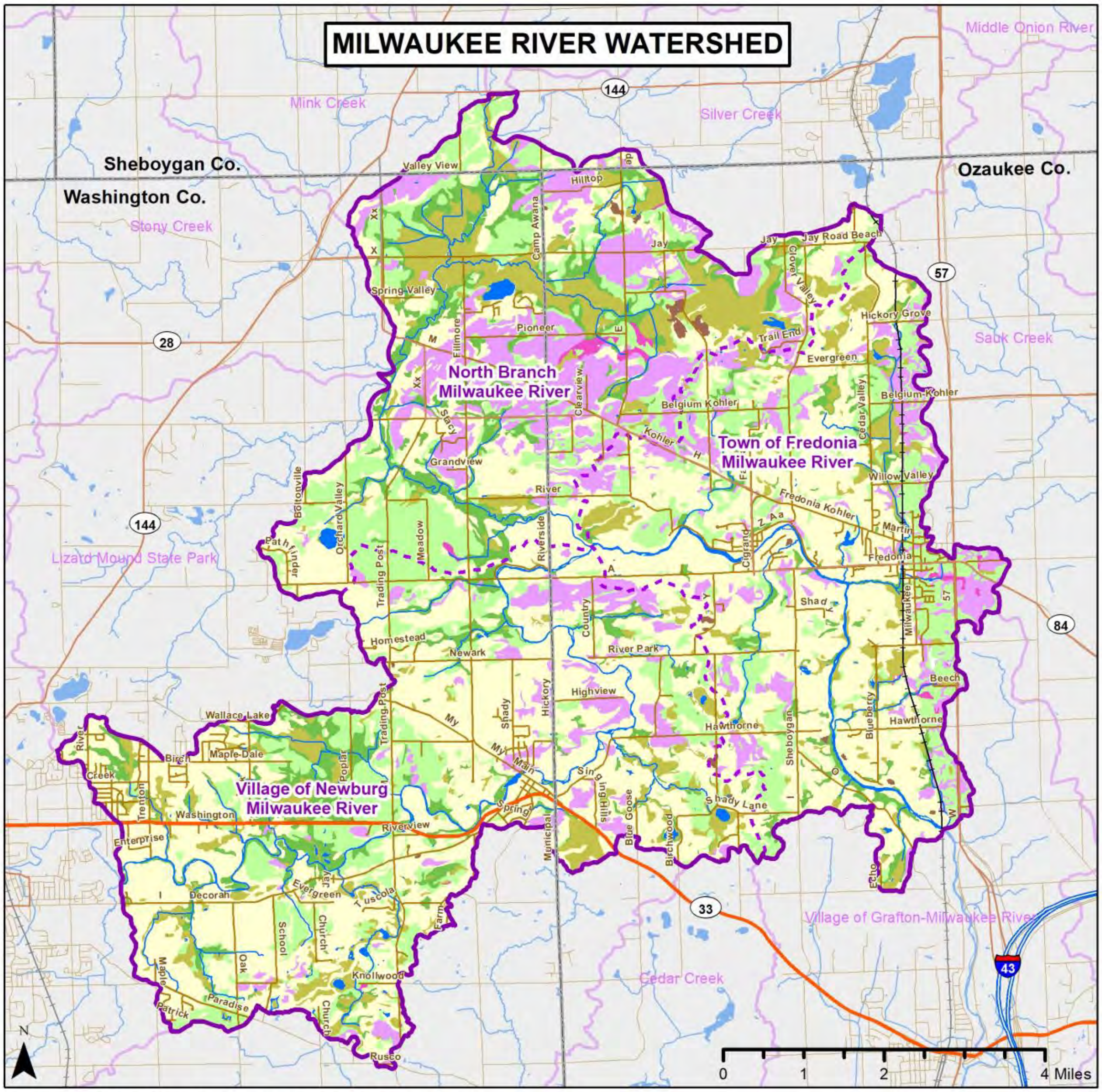
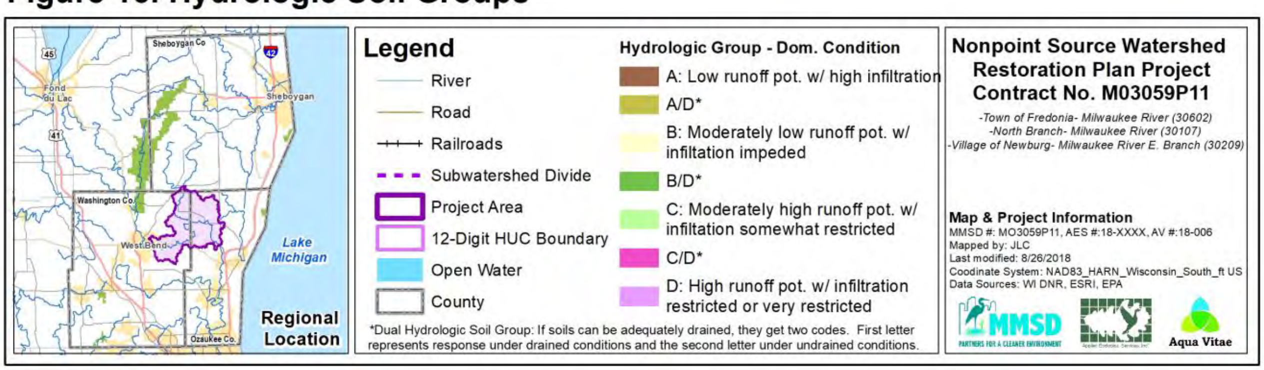


Figure 16. Hydrologic Soil Groups



3.5 Jurisdictions, Roles & Protections

The HUC-12 watersheds of the North Branch of the Milwaukee River, Town of Fredonia-Milwaukee River, and Village of Newburg-Milwaukee River are subwatersheds within the much larger, HUC-8 Milwaukee River watershed. Individually, the North Branch of the Milwaukee River watershed spans three counties, 14,130.6 acres, and no municipalities, the Town of Fredonia-Milwaukee River watershed covers one county, 14,123.1 acres, and one municipality, and the Village of Newburg-Milwaukee River watershed spans two counties, 18,669.1 acres, and two municipalities (Table 8, Figure 17).

The northernmost tip of the North Branch Milwaukee River watershed (698.4 acres, 5%) is in Sheboygan County, though the majority is split down the middle with Washington County (7,655.7 acres, 54%) in the west, and Ozaukee County (5776.5 acres, 41%) in the east. There are no municipalities located within the boundaries of the North Branch Milwaukee River watershed. The Town of Fredonia-Milwaukee River watershed is entirely within Ozaukee County, and 7% of the land cover is municipal, with the Village of Fredonia covering 975.9 acres. The Village of Newburg-Milwaukee River watershed is split with 13,927.6 acres (75%) lying in Washington County, and 4,741.5 acres (25%) lying in Ozaukee County; and of this area, 8% is covered by a municipality. The easternmost borders of West Bend extend in the west lobe of the watershed covering 1,012.6 acres (5%) with its population making it the largest and most rapidly growing municipality in the watershed. Newburg is the next largest municipality at 562.4 acres (3.0%).

There are also several unincorporated towns that have all assumed Village powers for the purposes of general zoning. These include the Towns of Fredonia, Saukville and Waubeka in Ozaukee County, Scott and Sherman in Sheboygan County, and Farmington and Trenton in Washington County.

Note: For clarity throughout the remainder of this report, when referring to "Fredonia", in every case this refers to *the Village* of Fredonia, not *the Town* of Fredonia.

Table 8. County and municipal jurisdictions.

HUC 12 Name/Place Name	Acres	PCT of HUC 12
North Branch Milwaukee River	**14,130.6**	**100%**
Ozaukee County	5,776.5	41%
Sheboygan County	698.4	5%
Washington County	7,655.7	54%
Town of Fredonia-Milwaukee River	**14,123.1**	**100%**
Ozaukee County	14,123.1	100%
Village of Newburg-Milwaukee River	**18,669.1**	**100%**
Ozaukee County	4,741.5	25%
Washington County	13,927.6	75%
Town of Fredonia-Milwaukee River	**975.9**	**7%**
Fredonia	975.9	7%
Village of Newburg-Milwaukee River	**1,575.0**	**8%**
Newburg	562.4	3%
West Bend	1,012.6	5%

Source: Washington County, Ozaukee County, SEWRPC

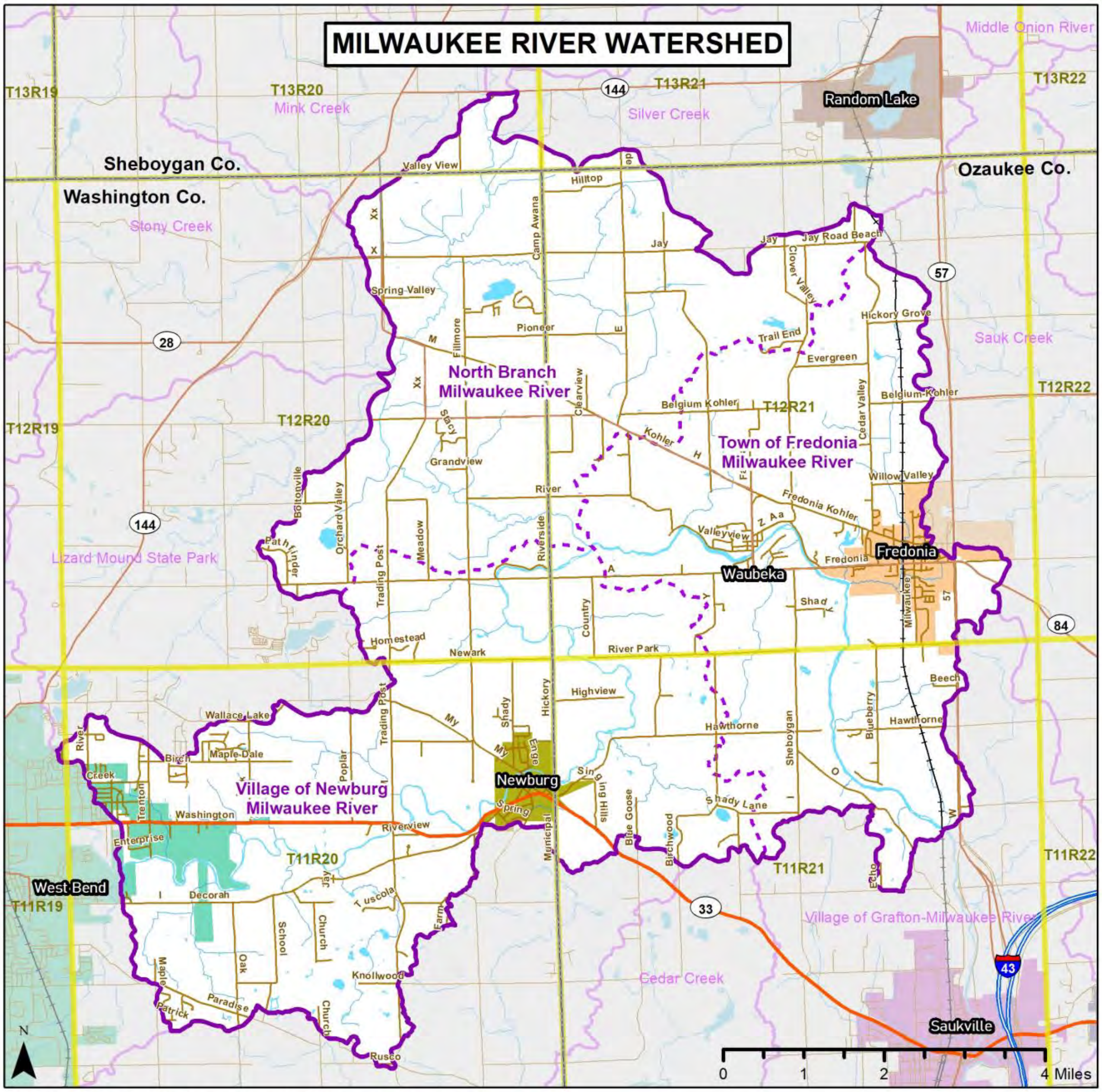
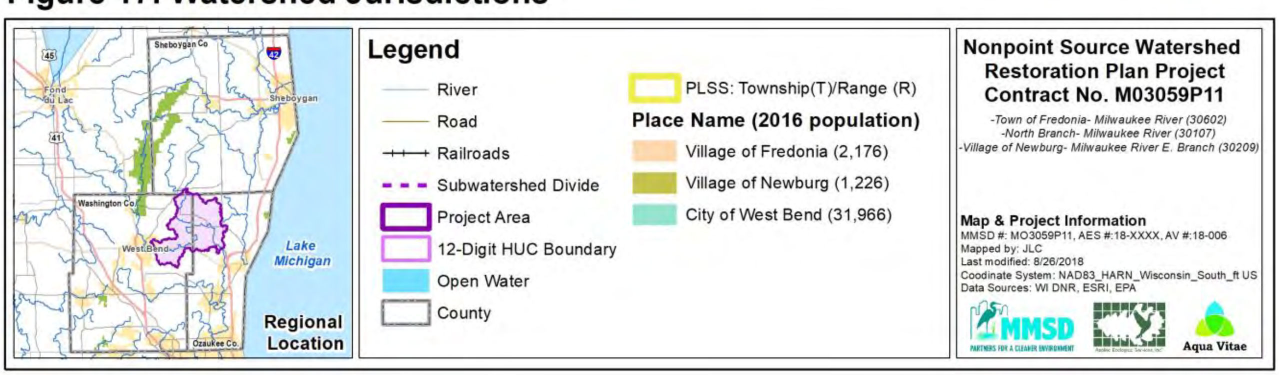


Figure 17. Watershed Jurisdictions



Jurisdictional Roles and Protections

Water quality and land protection throughout the United States are protected to some degree under federal, state, and/or local law.

Water Quality Protection

At the federal level, the Clean Water Act (CWA) is the strongest tool in protecting water resources. Within the state of Wisconsin, the authority to administer the provisions of the CWA has been delegated to the Wisconsin Department of Natural Resources (WDNR). Section 402 of the CWA establishes the National Pollution Discharge Elimination System (NPDES), while Section 319 Nonpoint Source Management Program was created in order to further support state and local nonpoint pollutant source efforts not addressed by NPDES permits. Section 319 permits states to receive grant money towards activities such as technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of nonpoint pollutant source implementation projects. Section 303 of the CWA requires states to catalogue impaired waters, prioritize them, and calculate Total Maximum Daily Loads (TMDLs) of pollutants a waterbody can receive and still safely meet the water quality standards. Wisconsin has also utilized Section 208, or the Priority Watershed Program, to develop a nonpoint pollutant source program. WDNR identified watersheds and lakes in most need of nonpoint pollution abatement and encouraged the use of nonpoint source controls to improve water quality (Kent, 2001).

Lake Twelve, one of 28 preserves owned and managed by the Ozaukee-Washington Land Trust (OWLT)

The Safe Drinking Water Act also plays a role in protecting surface and groundwater resources. In Wisconsin, the Wellhead Protection Program includes both mandatory and voluntary initiatives aimed at protecting groundwater resources.

Additionally, Wisconsin is part of three interstate compact agreements that also have jurisdiction over Lake Michigan. The first is the Great Lakes Basin Compact which established the Great Lakes Commission and gave it the authority to research and make recommendations regarding water use and development in the Great Lakes. The Council of Great Lakes Governors established the Great Lake Protection Fund to finance projects used to protect and restore the Great Lakes. Finally, the Great Lakes Charter, signed by the Council of Great Lakes Governors, regulates water transfers out of the Great Lakes Drainage basin in excess of 100,000 gallons per day.

The Wisconsin Coastal Management Program, established under the Federal Coastal Zone Management Act, also serves to protect the Lake Michigan coast and manage this valuable resource.

Land Protection

The U.S. Fish and Wildlife Service (USFWS) and WDNR protect various dedicated natural areas and threatened and endangered species. Local government agencies such as the Washington County Land and Water Conservation Division and local conservation groups such as the Ozaukee Washington Land Trust and Riveredge Nature Center also serve in a similar capacity by working to protect and restore natural areas.

The U.S. Army Corps of Engineers (USACE), with approval of WDNR, regulates wetlands through Sections 401 and 404 of the Clean Water Act (CWA). Land development affecting water resources (rivers, streams, lakes, wetlands, and floodplains) is regulated by the USACE when "Waters of the U.S." are involved. These types of waters include any wetland or stream/river that is hydrologically connected to navigable waters. The USACE primarily regulates filling activities and requires buffers or wetland mitigation for developments that impact jurisdictional wetlands. Village of Newburg, Town of Fredonia, and North Branch Milwaukee River watersheds fall within USACE's Detroit District of the Great Lakes & Ohio River Division.

Land development in the watershed is regulated by county and municipal ordinances. Washington Ozaukee, and Sheboygan Counties each have a Subdivision Ordinance and Zoning Ordinance as well as dedicated regulating ordinances for both stormwater and erosion control.

Beyond county-level regulations, each municipality has its own applicable regulations. Municipalities in the watershed may or may not provide additional watershed protection above and beyond existing local municipal codes. Most municipal codes provide ordinances covering businesses regulations, building regulations, zoning regulations, new subdivision regulations, stormwater management, streets, utilities, landscaping/restoration, tree removal, etc. None of the unincorporated towns within the watersheds have additional codes and ordinances.

Municipal codes and ordinances include:

- *Village of Fredonia*: Land development is regulated under both subdivision and zoning codes. Dedicated ordinances include Subdivision Controls, Shoreland Zoning, Erosion Control and Stormwater Management, Floodplain Zoning.

- *Village of Newburg*: Land development is regulated under both subdivision and zoning codes. Dedicated ordinances include Subdivision Controls, Shoreland-Wetland Zoning, Erosion Control and Stormwater Management, Floodplain Zoning.

- *Village of Waubeka*: As a census designated place within the Town of Fredonia, Waubeka is subject to the zoning regulations defined by the Town of Fredonia.

- *City of West Bend*: Municipal codes in West Bend include chapters on: Zoning, Subdivision, Erosion Control, and Stormwater Management.

Other governments and private entities with watershed jurisdictional or technical advisory roles include the Federal Emergency Management Agency (FEMA), the USDA's Natural Resources Conservation Service (NRCS), and Southeastern Wisconsin Regional Planning Commission

(SEWRPC). County Boards are also important because they oversee decisions made by respective county governments and therefore have the power to override or alter policies and regulations.

Noteworthy- NPDES/WPDES Program

The Wisconsin Department of Natural Resources (WDNR) has delegated authority to administer the National Pollutant Discharge Elimination System (NPDES) program, as the Wisconsin Pollutant Discharge Elimination System (WPDES). The NPDES program was initiated under the federal Clean Water Act to reduce pollutants to the nation's waters. This program requires permits for discharge of: 1) treated municipal effluent; 2) treated industrial effluent; and 3) stormwater from municipal separate stormsewer systems (MS4's) and construction sites.

The NPDES Phase I Stormwater Program began in 1990 and applies only to large and medium-sized municipal separate stormsewer systems (MS4's), several industrial categories, and construction sites hydrologically disturbing 5 acres of land or more.

The NPDES Phase II program began in 2003 and differs from Phase I by including additional MS4 categories, additional industrial coverage, and construction sites hydrologically disturbing greater than 1 acre of land. Under NPDES Phase II, all municipalities with small, medium, and large MS4's are required to complete a series of Best Management Practices (BMPs) and measure goals for six minimum control measures:

1) Public education and outreach
2) Public participation and involvement
3) Illicit discharge detention and elimination
4) Construction site runoff control
5) Post-construction runoff control
6) Pollution prevention and good housekeeping

The Phase II Program also covers all construction sites over 1 acre in size. For these sites the developer or owner must comply with all requirements such as completing and submitting a Notice of Intent (NOI) before construction occurs, developing a Stormwater Pollution Prevention Plan (SWPPP) that shows how the site will be protected to control erosion and sedimentation, completing final stabilization of the site, and filing a Notice of Termination (NOT) after the construction site is stabilized.

There are two municipal permits located in the Fredonia-Newburg watersheds for their respective wastewater treatment plants- the Fredonia Municipal Sewer and Water Utility in Fredonia and Newburg Village in Newburg.

Planning, Policy and Regulation

Planning, policy, and regulation are the foundation of watershed protection as the process sets the minimum standards for development that occurs or is proposed to occur in the vicinity of water resources. It is hoped that recommendations from this watershed plan would be referenced in future comprehensive plans and implemented in ordinances. In many cases, municipal codes also lay the foundation for the types of trees that can be removed from sites as well as what types of plant communities and species that can be replanted. County stormwater ordinances are the primary preventative measure that can be used to standardize for the respective county the requirements that proposed developments must meet. Monitoring and enforcement of implemented municipal codes and county regulations falls in the hands of local municipalities or County agencies. It is up to these enforcing bodies to communicate effectively and discuss often the problems with how ordinance language is interpreted and amendments that may help clarify certain regulations.

Planning/zoning guidance provides another level of watershed and natural resource protection. Most planning and zoning guidance is in the form of local floodplain or zoning ordinances that regulate onsite land use practices to ensure adequate floodplain, wetland, stream, lake, pond, conservancy soil, and other natural resource protection. Zoning ordinances and overlay districts in particular define what type of development is allowed and where it can be located relative to natural resources. For example, the Village of Newburg's Shoreland-Wetland zoning ordinance defines acceptable and prohibited uses and other regulations that apply within the designated "Shoreland-Wetland" zoning area. Other examples of how planning and zoning can provide resource protection include making recommendations or instituting requirements to establish and maintain riparian and wetland buffers, reduce impervious area, dedicate land to open space and greenways, establish conservation easements, and implement conservation and/or low-density development.

To improve the impact of planning/zoning guidance on water resource protection, there needs to be improved coordination and communication between county and local government. Watershed development regulations should be made very clear to local enforcement officers; local planners and zoning boards should consider revisions to local ordinances that address watershed, subwatershed, and/or site-specific natural resource issues. For example, communities with less impervious development now should revise their zoning ordinances sooner rather than later in order to adequately prevent the types of development that contribute to flooding, degrade wildlife habitat, and reduce water quality.

3.6 Existing Policies and Ordinance Review

Protection of natural resources and green infrastructure during future urban growth will be important for the future health of these Milwaukee River watersheds. To assess how future growth might further impact the watershed, an assessment of local municipal ordinances was performed to determine how development is regulated in each municipality. In this way, potential improvements to local ordinances can be identified. As part of the assessment, municipal governments were asked to compare their local ordinances against model policies outlined by the Center for Watershed Protection (CWP) in a publication entitled "*Better Site Design: A Handbook for Changing Development Rules in Your Community*" (CWP 1998).

CWP's recommended ordinance review process involves assessments of three general categories including "Residential Streets & Parking Lots", "Lot Development" and "Conservation of Natural Areas". Various questions with point totals are examined under each category. The maximum score is 100. CWP also provides general rules based on scores. Scores between 60 and 80 suggest that it may be advisable to reform local development ordinances. Scores less than 60 generally mean that local ordinances are not environmentally friendly and serious reform may be needed. Of the municipalities queried for ordinance review (Ozaukee County, Washington County, the Village of Fredonia, Newburg, Waubeka, and West Bend) two responded: Washington County and the Village of Fredonia (Figure 18). Their scores were 32% and 16% respectively. Although these scores are low, it should be noted that this assessment is meant to be a tool to local communities to help guide development of future ordinances. Various policy recommendations are included in the Action Plan section of the report to address general ordinance deficiencies. Completed ordinance review worksheets can be found in Appendix B.

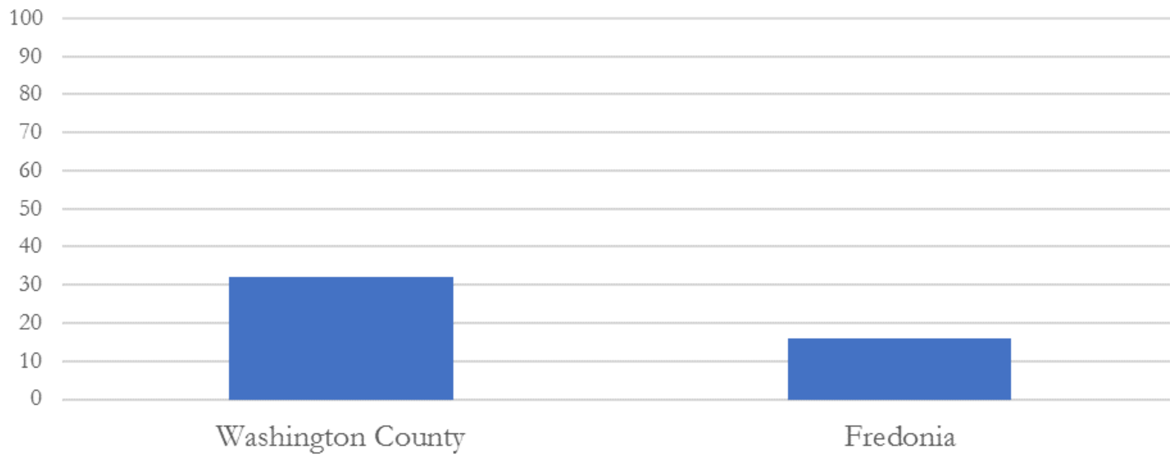


Figure 18. Center for Watershed Protection ordinance review results for local municipalities.

3.7 Demographics

The Southeastern Wisconsin Regional Planning Commission (SEWRPC) developed multi-jurisdictional comprehensive plans for both Ozaukee and Washington Counties which project regional changes out to 2050 at the county level and provide reliable growth forecasts. These were produced as part of the "Smart Growth Initiative" in 2009 which also led to the development of comprehensive plans for the municipalities in the watershed. SEWRPC also predicts demographics data extending to 2050 and converted the data to quarter-section data in 2015. The County data is published in SEWRPC Technical Reports No. 10 and 11 (fifth edition), available on SEWRPC's website.

SEWRPC's 2010 to 2050 forecasts of population, households, and employment were used to project how these attributes will impact the North Branch Milwaukee River, Town of Newburg, and Village of Fredonia watersheds. These forecasts were created under the guidance of SEWRPC's Advisory Committee on Regional Population and Economic Forecasts (SEWRPC 2013). The Committee utilized the cohort-component method to develop their population projections; used the projection of the population in households, the projection of average household size, and the application of the projected household size to the projected household population to achieve household projections; and used a disaggregate approach to the preparation of employment projects that took into account the explicit consideration of employment in selected industry groups and the preparation of projections for those groups.

Table 9 showss SEWRPC's forecasts of changes in population, households, and employment forecast changes between 2000 and 2050 for the combined area of the Fredonia-Newburg Area watersheds. The data is generated by Township, Range, and quarter Section and is depicted on Figures 19-21. Note: AquaVitae and AES used GIS to overlay the combined watershed boundaries onto SEWRPC's quarter Section data. If any part of a quarter Section fell inside the watershed boundary, the statistics for the entire quarter Section were included in the analysis.

The combined population of the watershed is expected to increase from 14,980 in 2010 to 21,522 by 2050, a 44% increase. The highest population increase is expected in the western portion of the watershed within the City of West Bend. Much of this area is currently agricultural land and multiple residential developments are currently in progress.

Some high to moderate population growth is expected in the eastern portion of the watershed within the Town of Fredonia. Some of this growth is already occurring or is anticipated in areas that are currently farmed or vacant. Similarly, projected household change generally follows change in population. The combined number of households in the watershed is expected to increase from 5,608 in 2010 to 8,572 by 2050, a 53% increase.

Employment is expected to increase greatly from 4,374 jobs in 2010 to 6,915 jobs by 2050, a 58% decrease. Employment growth is projected to be highest in the west area of the watershed nearest to West Bend and the eastern area of the watershed near the Town of Fredonia. Despite the large projection of regional growth in employment, much of the areas within the watershed are projected to see decreased employment opportunities or very slight growth.

Table 9. SEWRPC 2010 data and 2050 forecast data.

Data Category	2010	2050	Change (2010-2050)
Population	14,980	21,522	6,542
Household	5,608	8,572	2,964
Employment	4,374	6,915	2,541

Source: Southeastern Wisconsin Regional Planning Commission 2050 Forecasts

Socioeconomic Status

The communities within the watershed can best be described as middle class. Active growth slowed beginning in 2007 due to an economic downturn. However, the region did experience a mixture of residential, industrial, and commercial growth over the past 20 years and offers amenities such as parks, shopping, conservation areas, schools and libraries, and is in somewhat close proximity to interstate highway access.

Within the watershed, the 2010 U.S. Census Bureau only has data for the City of West Bend, and Washington and Ozaukee Counties. Economic countywide data is not representative of the communities within the watershed area, it is greatly skewed by exurban communities in the southern portion of the counties. So, census data from the City of West Bend is used as a basis for profiling the socioeconomic status of the three watersheds. To summarize, the area is comprised of a mostly white population (~95%). The median household income is about $56,000 with around 8% of the population in West Bend below poverty level. In addition, approximately 64% of housing units are owner occupied; the remainder are rented. Owner occupied units are valued at about $164,000 on average in West Bend.

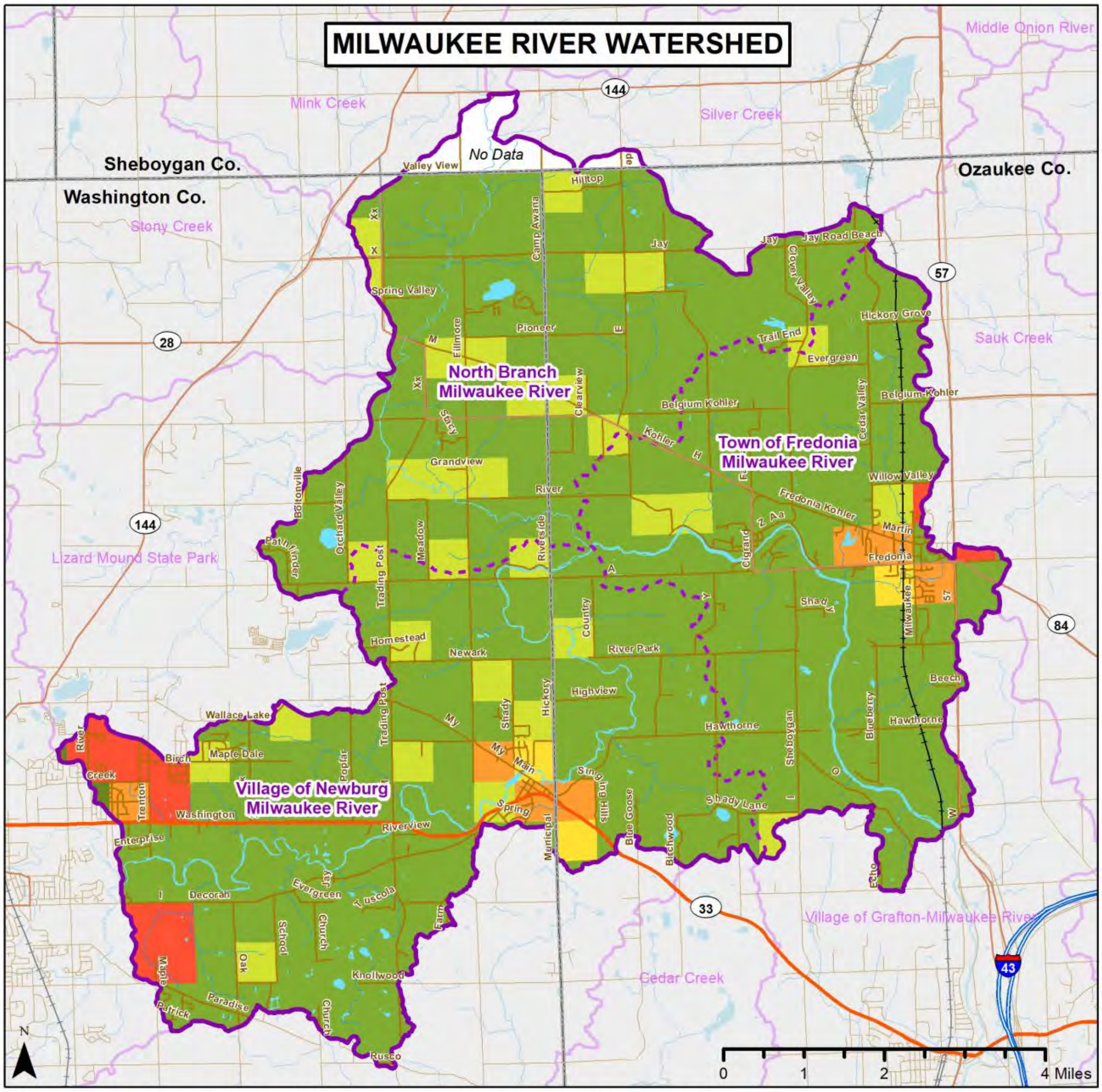
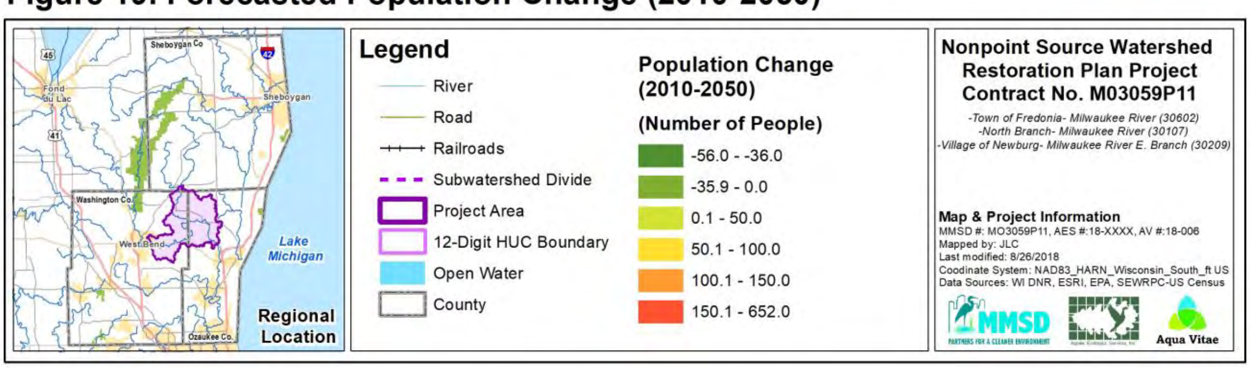


Figure 19. Forecasted Population Change (2010-2050)



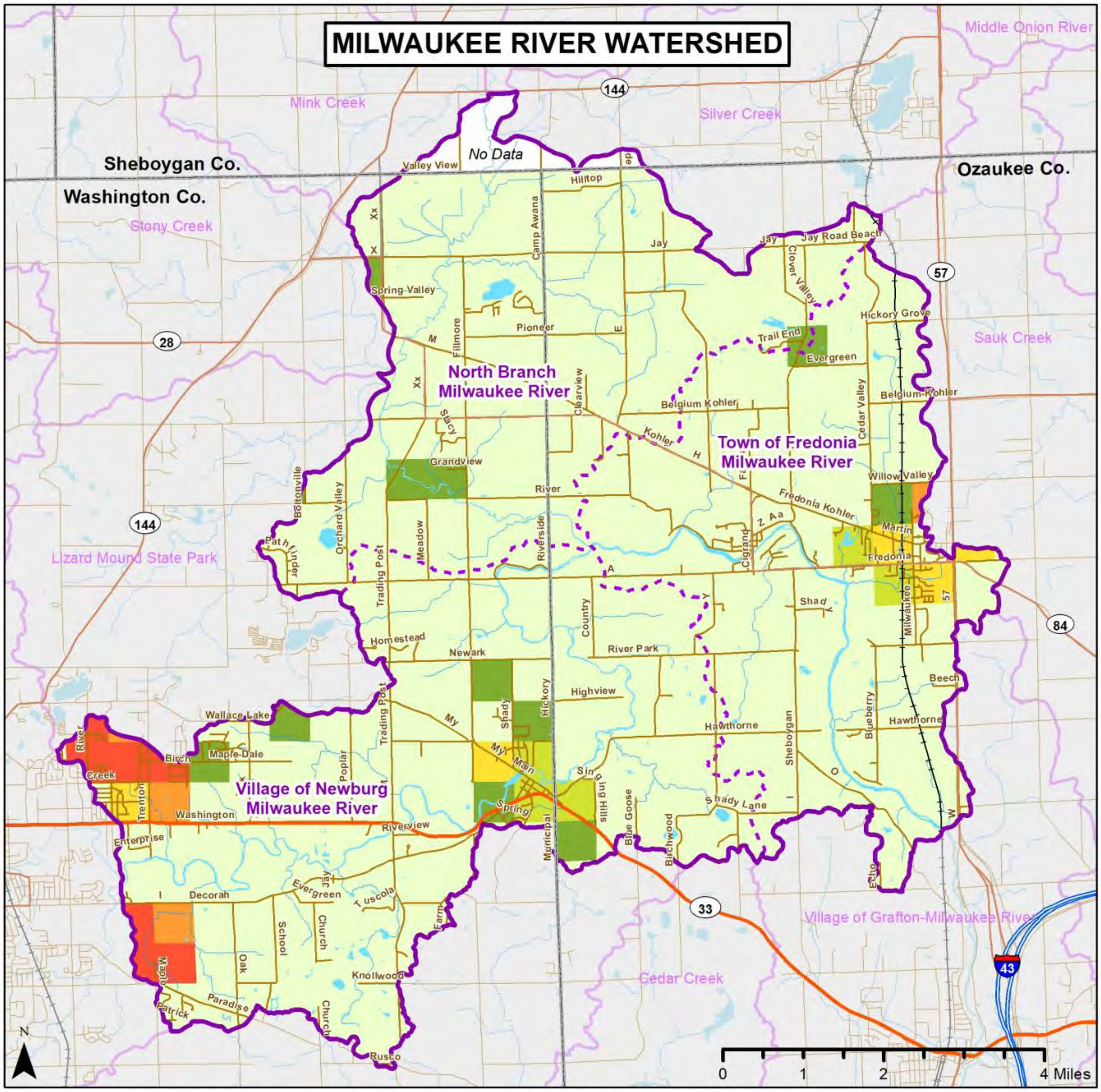
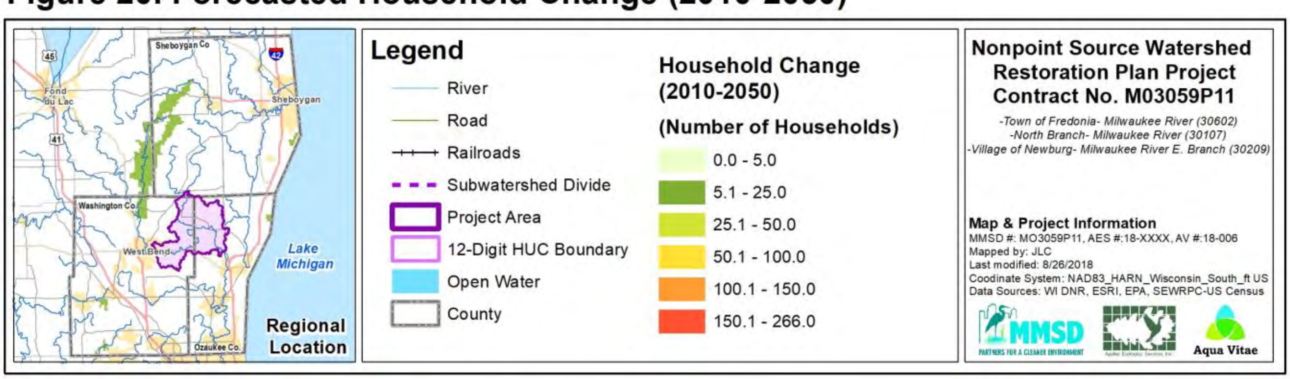


Figure 20. Forecasted Household Change (2010-2050)



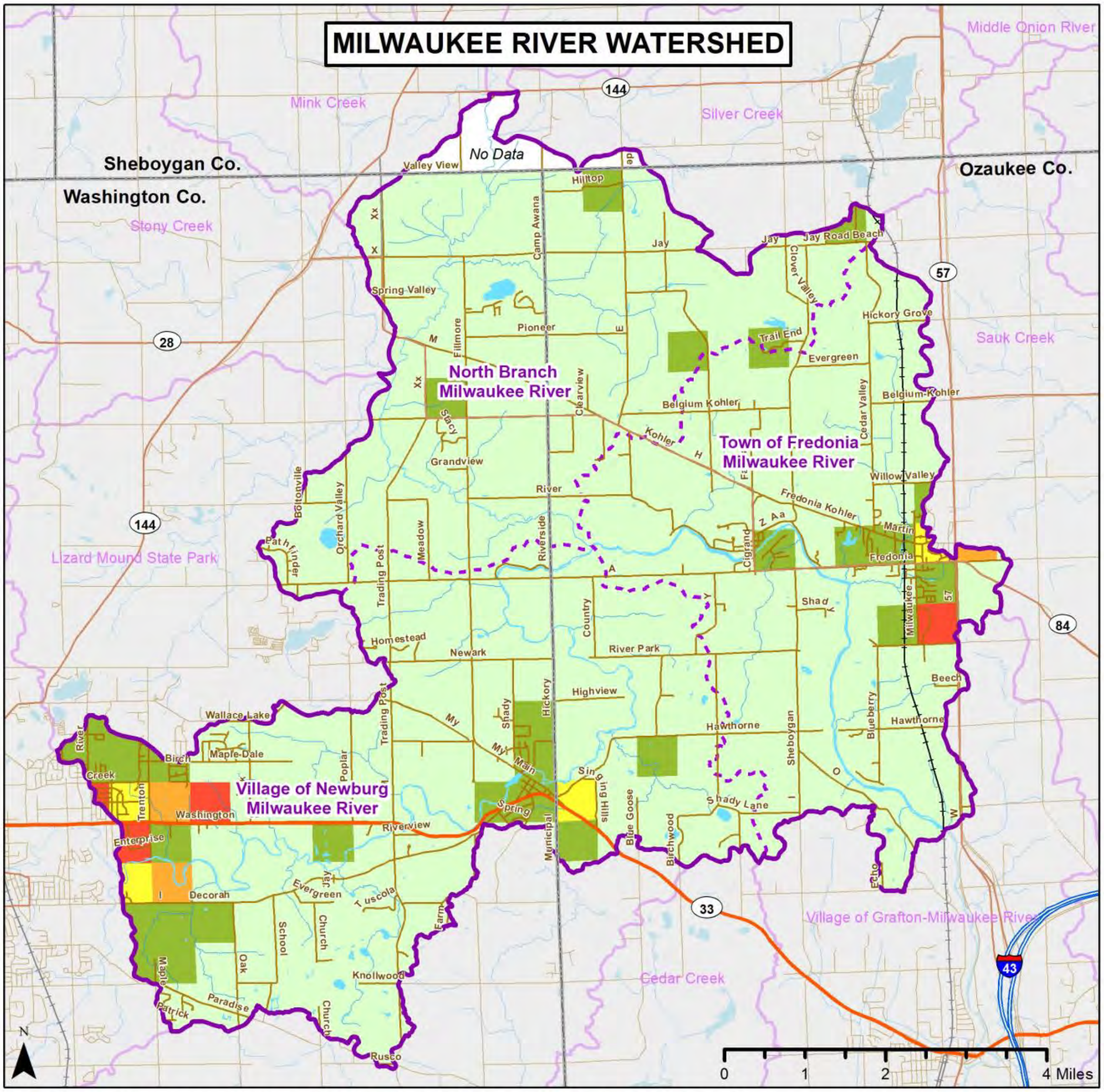
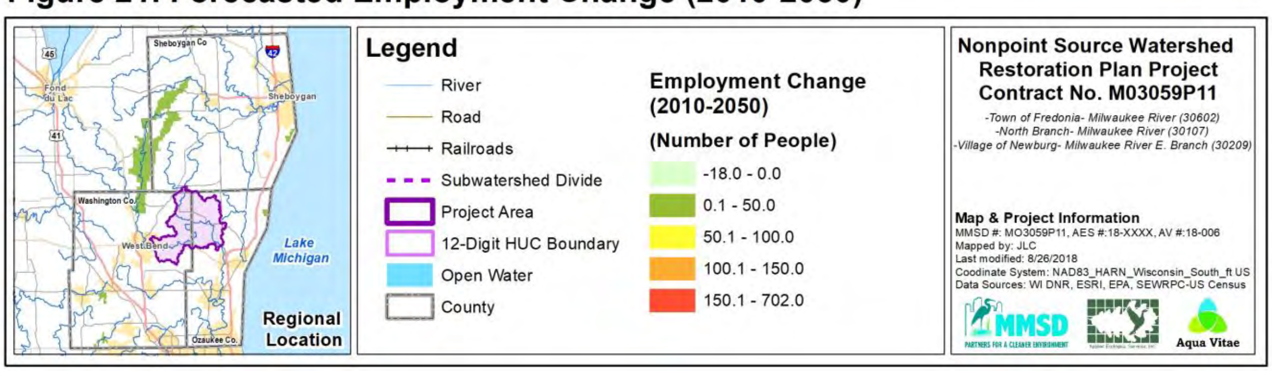


Figure 21. Forecasted Employment Change (2010-2050)



3.8 Transportation Network

Roads

A grid of mostly small, low-traffic roads spans the Fredonia-Newburg Area watersheds (Figure 22). Wisconsin State Highway 33 only passes through the Village of Newburg watershed, but the east-west running road is the most traveled road in the watershed; seeing 7,600-23,000 annual travelers, a number which is expected to grow to 8,700-28,300 by 2030 (WisDOT 2009). Another, smaller connector route, Wisconsin Highway 57, briefly runs north-south through the Town of Fredonia-Milwaukee River watershed, connecting I-43 and the Town of Fredonia. Fredonia-Kohler Road (or County Highway H) runs east-west through the North Branch Milwaukee river watershed into the Town of Fredonia Milwaukee River watershed and connects these areas to State Highway 57.

Railroads

Within the Town of Fredonia- Milwaukee River watershed, the Plymouth Line of the Wisconsin and Southern Railroad publicly owned railroad runs north and south through the Town of Fredonia. The railroad is headquartered from Madison, WI and operates on tracks formerly owned by the Milwaukee Road which were abandoned in the late 1970's and became state owned. The rails are freight-only and transport a variety of commodities, most frequently chemicals and transload products. According to the WISDOT 2030 Long-Range Multimodal Transportation Plan, rail freight corridors are to be maintained and preserved, but expansion is not anticipated (WisDOT 2009).

Airports

West Bend Municipal Airport is located on 430 acres of land in the City of West Bend (Figure 22) and provides services to corporate, business, private, freight, and military aircraft. In 2016, the airport saw 46,000 operations (take offs and landings), and as of October 2018, there are 95 aircraft based out of the air field. The terminal is classified by FAA as a regional reliever airport facility and is complete with pilot lounge, weather office and a refueling depot. The airport was founded in 1928 as a grass landing field, and remained as such until the 1950's when the first concrete runway was installed.

West Bend Airport

Trails/Bike Paths

There are no designated single or shared-use bicycle/pedestrian trails within the watershed area.

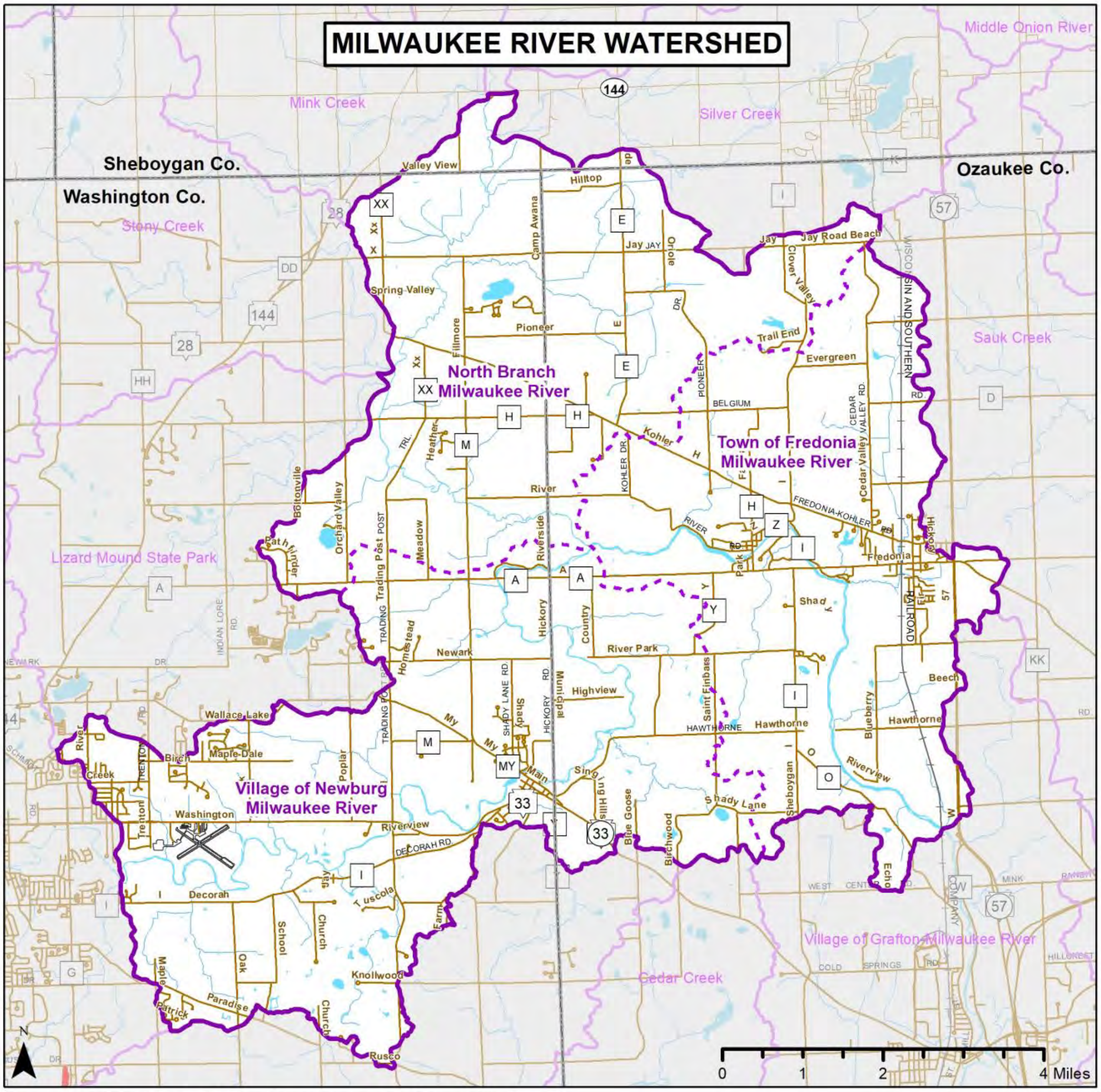
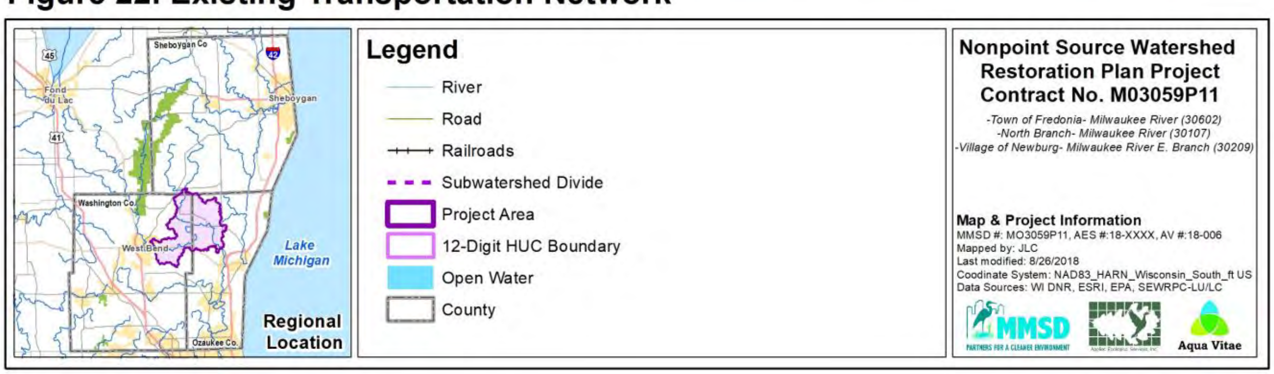


Figure 22. Existing Transportation Network



3.9 Existing & Future Land Use/Land Cover

2015 Land Use/Land Cover

Highly accurate land use/land cover data was produced for the Village of Newburg, Town of Fredonia, and North Branch Milwaukee River watersheds using several sources of data. First, the most recent land use/land cover data from Southeastern Wisconsin Regional Planning Commission (SEWRPC) was used as a base layer. No base layer was available for Sheboygan County. Recent aerial photography of the watershed was also overlaid on SEWRPC land use data in GIS so that additional discrepancies could be corrected, including for the missing portion of Sheboygan County. 2015 land use/land cover data and map for the tri-watershed area is included in Table 10 and depicted on Figure 23.

In all three watersheds agriculture is far and away the most prevalent land use. In the Village of Newburg, Town of Fredonia, and North Branch Milwaukee River watersheds this amounts to 8,390.6 acres (44.9%), 7,154.7 acres (50.7%), and 7,499.2 acres (53.1%) respectively. This includes row crop agriculture (largely corn and soybean) as well as livestock (largely dairy.) As seen in Figure 23, this acreage is spaced evenly throughout the watersheds.

Wetlands make up the next most abundant land use within all three watersheds. The wetland areas are largely adjacent to the Milwaukee River and accompanying floodplain areas, as well as a large lowland area in the North Branch watershed. The Village of Newburg, Town of Fredonia, and North Branch Milwaukee River watersheds this amounts to 3,117.7 acres (16.7%), 1,929.9 acres (13.7%), and 3,392.9 acres (24.0%) respectively.

Roadway flooding observed in lowland areas within North Branch-Milwaukee River watershed.

Table 10. 2015 land use/land cover classifications and acreage.

Watershed/Description	Acres	Pct of 12-Digit HUC
North Branch Milwaukee River		
AGRICULTURAL	7,499.2	53.1%
WETLANDS	3,392.9	24.0%
WOODLAND	822.2	5.8%
OPEN LANDS	742.7	5.3%
RESIDENTIAL	721.0	5.1%
TRANSPORTATION	419.9	3.0%
OPEN WATER	220.3	1.6%
RECREATIONAL	140.1	1.0%
EXTRACTIVE	132.4	0.9%
COMMERICAL	13.1	0.1%
INDUSTRIAL	8.6	0.1%
GOVT, INST, COMM AND UTILITIES	6.4	0.0%
CEMETERY	4.8	0.0%
Total	**14,123.6**	**100.0%**
Town of Fredonia-Milwaukee River		
AGRICULTURAL	7,154.7	50.7%
WETLANDS	1,929.9	13.7%
WOODLAND	1,327.4	9.4%
OPEN LANDS	1,308.2	9.3%
RESIDENTIAL	992.6	7.0%
TRANSPORTATION	589.8	4.2%
RECREATIONAL	336.9	2.4%
OPEN WATER	283.2	2.0%
INDUSTRIAL	109.1	0.8%
GOVT, INST, COMM AND UTILITIES	41.2	0.3%
COMMERICAL	34.7	0.2%
EXTRACTIVE	8.0	0.1%
CEMETERY	6.7	0.0%
Total	**14,122.5**	**100.0%**
Village of Newburg-Milwaukee River		
AGRICULTURAL	8,390.6	44.9%
WETLANDS	3,117.7	16.7%
OPEN LANDS	1,980.9	10.6%
WOODLAND	1,877.2	10.1%
RESIDENTIAL	1,554.1	8.3%
TRANSPORTATION	881.4	4.7%
OPEN WATER	400.1	2.1%
RECREATIONAL	229.8	1.2%
GOVT, INST, COMM AND UTILITIES	72.8	0.4%
EXTRACTIVE	71.8	0.4%
INDUSTRIAL	45.7	0.2%
COMMERICAL	37.6	0.2%
CEMETERY	9.5	0.1%
Total	**18,669.2**	**100.0%**

Within the Town of Fredonia and North Branch watersheds the third largest land use results from woodland areas. These account for 822.2 acres (5.8%) and 1,327.4 acres (9.4%) respectively. These woodland areas are also largely adjacent to the Milwaukee River. Woodlands are the fourth largest land use type within the Village of Newburg watershed spanning 1,877.2 acres (10.1%).

The third largest land use within the Village of Newburg is open land which makes up 1,980.9 acres (10.6%); this is generally defined as undeveloped land which has no discernable natural resource type. Open land is the fourth largest land use in both the Town of Fredonia and North Branch watersheds, covering 1,308.2 acres (9.3%) and 742.7 acres (5.3%) respectively.

Another important land use within the three watersheds is combined residential land use; meaning a combination of low density, medium density, multi-family, suburban, and two-family residential types. Within the Village of Newburg, Town of Fredonia, and North Branch Milwaukee River watersheds this is currently the 5th highest land use total with amounts of 1,554.1 acres (8.3%), 992.5 acres (7.0%), and 721.0 acres (5.1%) respectively. These percentages are projected to double, as we see relatively high rates of population growth within the watersheds.

Noteworthy: North Branch Milwaukee River Wildlife and Farming Heritage Area

Established in 2009, this project includes 13 parcels of state owned-land totaling 765 acres and two privately owned properties - totaling 171 acres - with easements that allow for public use. Within the area, other conservation partners own land open to some public uses, including 407 acres that are federally owned under the waterfowl production area program and 134-acre parcel owned by the Ozaukee-Washington County Land Trust and open for passive uses and limited hunting opportunities.

This project area is one of the largest blocks on undeveloped land in southeastern Wisconsin, yet within 20 miles of the Milwaukee metropolitan area. Although located just outside of the largest urban area in the state, the project area is predominantly open and rural with large wetland complexes, riparian corridors and agriculture dominating the landscape.

The project area includes nine miles of the North Branch Milwaukee River and five tributary streams, expansive areas of floodplain forest, coniferous swamps, other wetlands, three small lakes and large blocks of agricultural lands. Because of its location and natural resource features, the property has potential for preserving farmland or "stabilizing the rural landscape" while providing low impact, nature-based, outdoor recreational opportunities. The property is located within the "Southeast Glacial Plains" ecological landscape, which is characterized as one of the landscapes with the highest wetland and river productivity for plants, insects and invertebrates in the state (WI DNR, 2017).

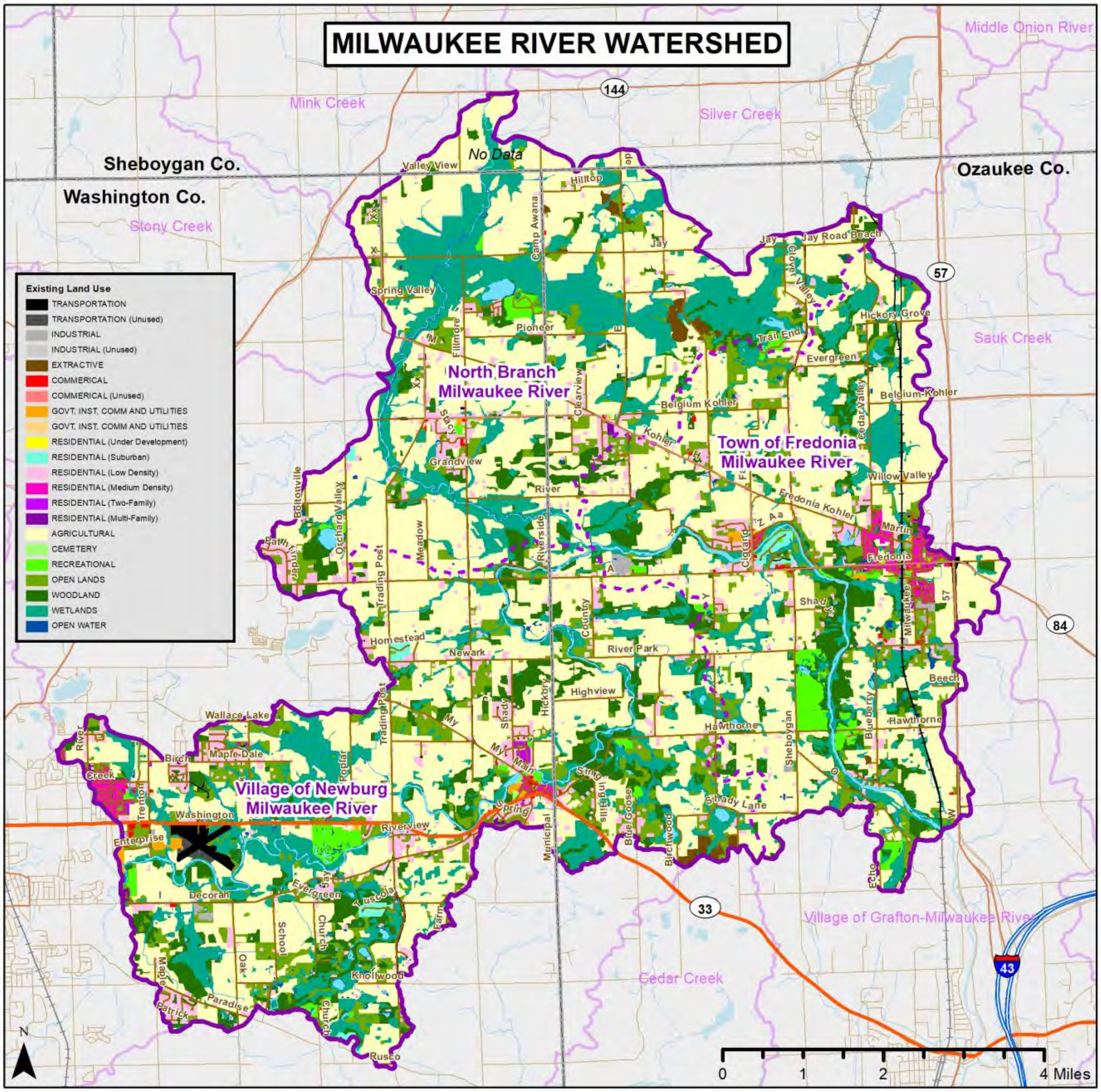
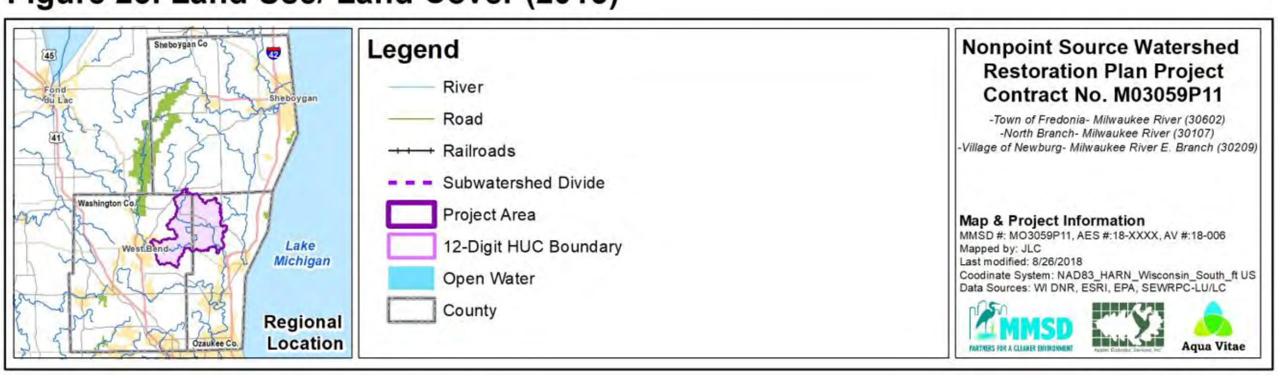


Figure 23. Land Use/ Land Cover (2015)



Noteworthy-Land Use/Land Cover Definitions:

Agricultural: Land use that includes out-buildings and barns, row & field crops and fallow field farms and pasture, includes dairy and other livestock agricultural processing. Also includes nurseries, greenhouses, orchards, tree farms, and sod farms.

Cemetery: Local and regional cemeteries of any size and related administration buildings, maintenance areas, and landscaped areas within the cemetery ownership.

Commercial/Retail: Land use that includes food and drug stores, eating and drinking places, general merchandise stores, legal, insurance, and real estate offices, doctors' offices, personal services, business services, shopping malls and their associated parking, single structure office/hotels.

Extractive: Land use utilized for the extraction of products from the earth, including stone, sand, and minerals, have been identified as extractive use areas.

Government/Institutional: Land use that includes administration, safety, assembly, group quarters, medical facilities, educational facilities, government buildings, religious facilities, and others.

Industrial: Land use that includes manufacturing and processing, industrial, warehousing and wholesale trade, such as mineral extraction, associated parking areas, truck docks, etc.

Open Lands: Land cover that includes rural non-cultivated land.

Open Water: Land cover that includes rivers, streams and canals, lakes, reservoirs, and lagoons.

Recreational: Land use that includes parks, playgrounds, athletic fields, museums, zoos, historic sites, amphitheaters, stadiums, race tracks, conference centers, fairgrounds, and amusement parks.

Residential-Suburban: Land use that includes single family homes and farmhouses and immediate residential area around them with lot sizes ≥ 1.44 ac ≤ 5.0. ac and impervious cover less than 20%.

Residential-Low Density: Land use that includes single family homes and farmhouses and immediate residential area around them with lot sizes ≥ 0.45 ac ≤1.43 ac and impervious cover less than 20%.

Residential-Medium Density: Land use that includes single family homes and farmhouses and immediate residential area around them with lot sizes ≥ 0.16 ac ≤0.44 ac and impervious cover around 30%.

Residential-Multifamily: Land use that includes multifamily residences of more than one family per residence. These include duplex and townhouse units, apartment complexes, condominiums, and associated parking.

Transportation: Land use that includes railroads, rail rapid transit and associated stations, rail yards, linear transportation such as streets and highways, and airport transportation.

Wetlands: Land cover that includes all wetlands on public and private land characterized by both hydric soils and the growth of hydrophytes. Note: wetland mapping is based off SEWRPC 2000 land use data and not 2005 wetland inventory.

Woodland: Land cover generally consisting of remnant or second growth forest.

Future Land Use/Land Cover Predictions

Table 11 shows the forecasted 2035 land use/land cover acreage that was determined from available municipal comprehensive plans and SEWRPC data. Figure 24 compares data shown in Table 11 to existing 2015 land use/land cover, showing those areas where the type of land use is forecast to change. Within the North Branch, Town of Fredonia, and Village of Newburg watersheds, the largest loss of current land use/land cover acreage is expected to occur on areas considered open land, woodland, and wetland.

These land uses collectively are expected to see decreases of 966 acres (6.8%), 1,236 acres (8.8%), and 1,347 acres (7.2%) respectively. Just as significant are the losses of cropland and pastureland where losses of 499 acres (3.5%), 141 acres (1.0%), and 1,005 acres (5.4%) are expected across the respective watersheds. This anticipated loss of open space is contributed to by the expectation of housing growth within the North Branch, Fredonia, and Newburg watersheds. Parcel land use of suburban to medium density housing is expected to increase by 615 acres (4%), 980 acres (7%), and 2,504 acres (11%) across the respective watersheds.

This development is largely localized in the surrounding areas of Fredonia, Newburg, Waubeka, and West Bend. The loss of open lands and subsequent development expansion means it will be important to develop around these using conservation/low impact development design standards.

Table 11. Projected future land use (2035) across the Fredonia-Newburg Area watersheds.

Watershed/Description	Acres	Pct of 12-Digit HUC
North Branch Milwaukee River		
AGRICULTURAL	6,999.9	49.6%
OPEN LANDS	3,951.3	28.0%
RESIDENTIAL	1,313.2	9.3%
No Data	701.0	5.0%
TRANSPORTATION	403.1	2.9%
EXTRACTIVE	279.0	2.0%
RECREATIONAL	218.0	1.5%
OPEN WATER	203.5	1.4%
WETLANDS	40.6	0.3%
GOVT, INST, COMM AND UTILITIES	7.8	0.1%
COMMERICAL	6.3	0.0%
Total	**14,123.7**	**100.0%**
Town of Freedonia-Milwaukee River		
AGRICULTURAL	7,013.5	49.7%
OPEN LANDS	3,329.0	23.6%
RESIDENTIAL	1,976.5	14.0%
TRANSPORTATION	581.8	4.1%
RECREATIONAL	467.9	3.3%
INDUSTRIAL	428.7	3.0%
OPEN WATER	255.9	1.8%
COMMERICAL	39.3	0.3%
GOVT, INST, COMM AND UTILITIES	27.8	0.2%
EXTRACTIVE	2.1	0.0%
Total	**14,122.5**	**100.0%**
Village of Newburg-Milwaukee River		
AGRICULTURAL	7,385.9	39.6%
OPEN LANDS	5,583.8	29.9%
RESIDENTIAL	3,593.8	19.2%
TRANSPORTATION	1,026.3	5.5%
OPEN WATER	373.9	2.0%
RECREATIONAL	363.3	1.9%
INDUSTRIAL	151.4	0.8%
COMMERICAL	116.4	0.6%
WETLANDS	44.8	0.2%
GOVT, INST, COMM AND UTILITIES	29.6	0.2%
Total	**18,669.1**	**100.0%**

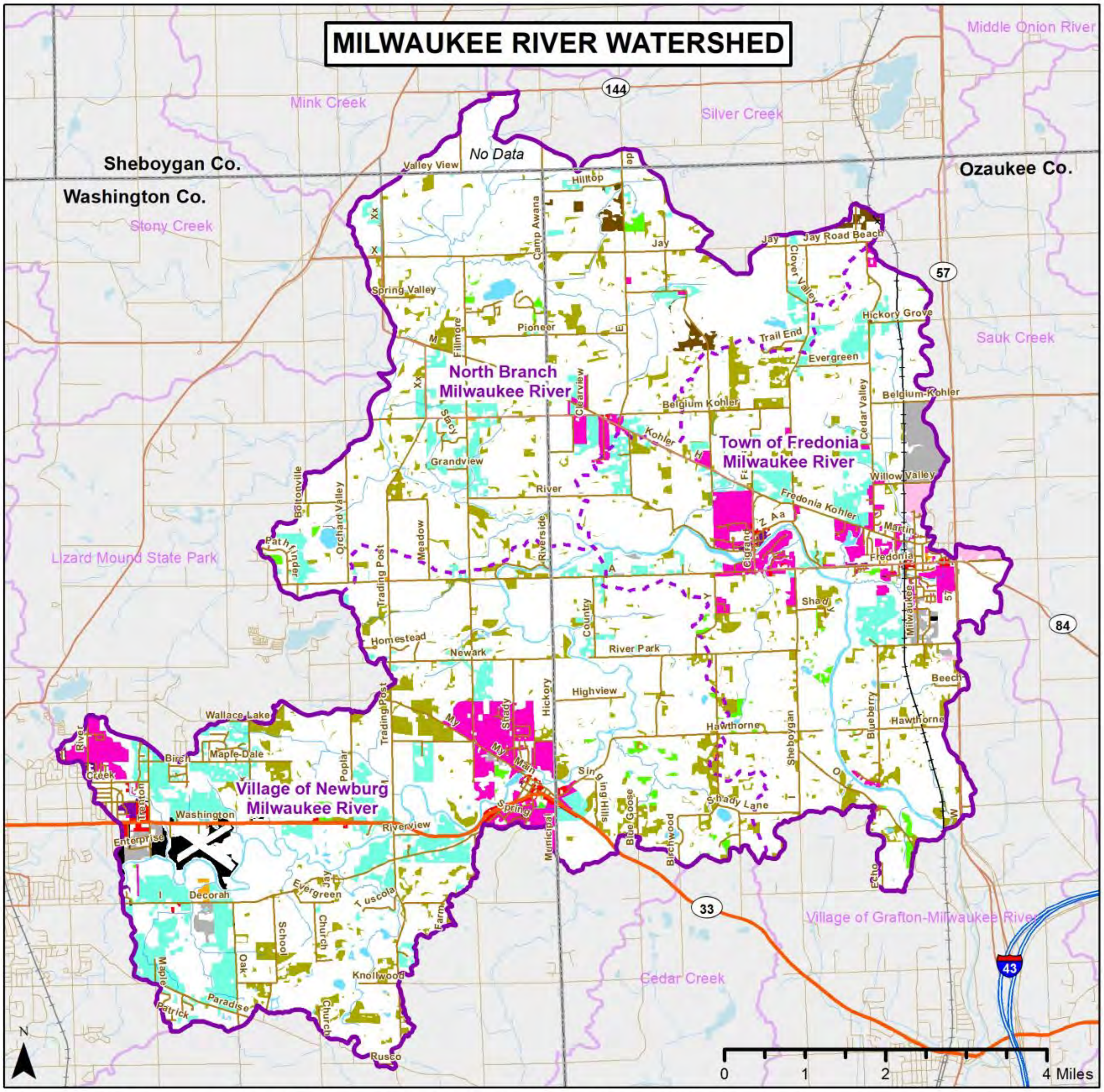
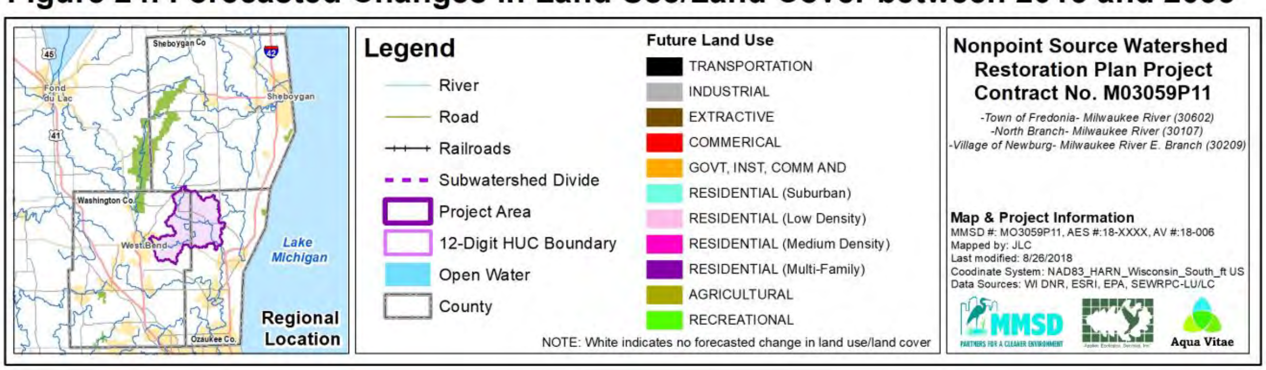
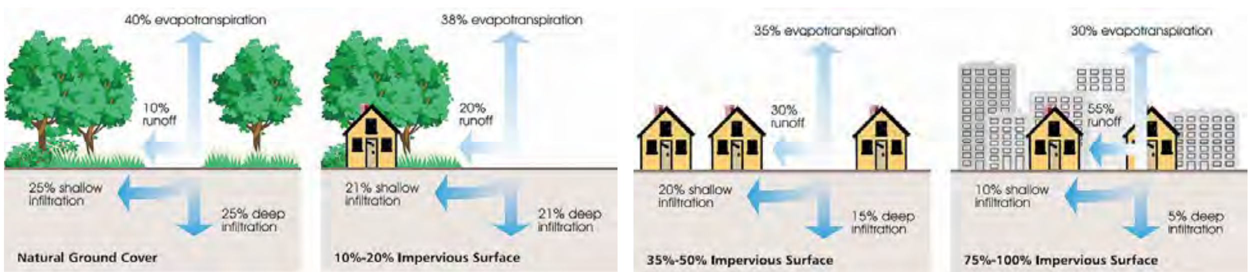


Figure 24. Forecasted Changes in Land Use/Land Cover between 2015 and 2035



3.10 Impervious Cover Impacts

Impervious cover is defined as surfaces of an urban landscape that prevent infiltration of precipitation (Schueler 1994). Imperviousness is an indicator used to measure the impacts of urban land uses on water quality, hydrology and flows, flooding/depressional storage, and habitat related to streams (Figure 25). Based on studies and other background data, Scheuler (1994) and the Center for Watershed Protection (CWP) developed an Impervious Cover Model used to classify streams within subwatersheds into three quality categories: Sensitive, Impacted, and Non-Supporting (Table 12). In general, Sensitive subwatersheds have less than 10% impervious cover, stable stream channels, good habitat, good water quality, and diverse biological communities. Impacted subwatersheds have between 10% and 25% impervious cover, somewhat degraded streams, altered habitat, and decreasing water quality. Non-Supporting subwatersheds generally have greater than 25% impervious cover, highly degraded streams, degraded habitat, poor water quality, and poor-quality biological communities. In addition, runoff over impervious surfaces collects pollutants and warms the water before it enters a stream resulting in negative biological impacts.



Source: The Federal Interagency Stream Restoration Working Group, 1998 (Rev. 2001).

Figure 25. Relationship between impervious surfaces, evapotransporation, & infiltration.

Table 12. Impervious category & stream condition via the Impervious Cover Model.

Category	% Impervious	Stream Condition within Subwatershed
Sensitive	<10%	Stable stream channels, excellent habitat, good water quality, and diverse biological communities
Impacted	>10% but <25%	Somewhat degraded stream channels, altered habitat, decreasing water quality, and fair-quality biological communities.
Non-Supporting	>25%	Highly degraded stream channels, degraded habitat, poor water quality, and poor-quality biological communities.

Source: (Zielinski 2002)

Sensitive Stream

Impacted Stream

Non-Supporting Stream

The following paragraphs describe the implications of increasing impervious cover:

Water Quality Impacts
Imperviousness affects water quality in streams and lakes by increasing pollutant loads and water temperature. Impervious surfaces accumulate pollutants from the atmosphere, vehicles, roof surfaces, lawns and other diverse sources. During a storm event, pollutants such as nutrients (nitrogen and phosphorus), metals, oil/grease, and bacteria (*E. coli*) are delivered to streams and lakes. According to monitoring and modeling studies, increased imperviousness is directly related to increased urban pollutant loads (Schueler 1994). Furthermore, impervious surfaces can increase stormwater runoff temperature as much as 12 degrees compared to vegetated areas (Galli, 1990). Water temperatures exceeding 90°F (32.2°C) can be lethal to aquatic fauna and can generally occur during hot summer months.

Hydrology and Flow Impacts
Higher impervious cover translates to greater runoff volumes thereby changing hydrology and flows in streams. If unmitigated, high runoff volumes can result in higher floodplain elevations (Schueler 1994). In fact, studies have shown that even relatively low percentages of imperviousness (5% to 10%) can cause peak discharge rates to increase by a factor of 5 to 10, even for small storm events. Impervious areas come in two forms: 1) disconnected and 2) directly connected. Disconnected impervious areas are represented primarily by rooftops, so long as the rooftop runoff does not get funneled to impervious driveways or a storm sewer system. Significant portions of runoff from disconnected surfaces usually infiltrate into soils more readily than directly connected impervious areas such as parking lots that typically end up as stormwater runoff directed to a storm sewer system that discharges directly to a waterbody.

Flooding and Depressional Storage Impacts
Flooding is an obvious consequence of increased flows resulting from increased impervious cover. As stated above, increased impervious cover leads to higher water levels, greater runoff volumes, and high floodplain elevations. Higher floodplain elevations usually result in more flood problem areas. Furthermore, as development increases, wetlands and other open space decrease. A loss of these areas results in increased flows because wetlands and open space typically soak up rainfall and release it slowly via groundwater discharge to streams and lakes. Detention basins can and do minimize flooding in highly impervious areas by regulating the discharge rate of stormwater runoff, but detention basins do not reduce the overall increase in runoff volume.

Habitat Impacts
A threshold in habitat quality exists at approximately 10% to 15% imperviousness (Booth and Reinelt 1993). When a stream receives more severe and frequent runoff volumes compared to historical conditions, channel dimensions often respond through the process of erosion by widening, downcutting, or both, thereby enlarging the channel to handle the increased flow. Channel instability leads to a cycle of streambank erosion and sedimentation resulting in physical habitat degradation (Schueler 1994). Streambank erosion is one of the leading causes of sediment suspension and deposition in streams leading to turbid conditions that may result in undesirable changes to aquatic life (Waters 1995). Sediment deposition alters habitat for aquatic plants and animals by filling interstitial spaces in substrates important to benthic macroinvertebrates and some fish species. Physical habitat degradation also occurs when high and frequent flows result in loss of riffle-pool complexes.

Impervious Cover Estimate & Future Vulnerability

In 1998, the Center for Watershed Protection (CWP) published the Rapid Watershed Planning Handbook. This document introduced rapid assessment methodologies for watershed planning. The CWP released the Watershed Vulnerability Analysis as a refinement of the techniques used in the Rapid Watershed Planning Handbook (Zielinski 2002). The vulnerability analysis focuses on existing and predicted impervious cover as the driving forces impacting potential stream quality within a watershed. It incorporates the Impervious Cover Model described at the beginning of this subsection to classify Subwatershed Management Units (SMUs). SMUs are defined and examined in more detail in Section 3.3.

AES used a modified Vulnerability Analysis to compare each SMU's vulnerability to predicted land use changes across Fredonia-Newburg Area watersheds, detailed in the following paragraphs. Three steps were used to generate a vulnerability ranking of each SMU. The results were used to make and rank recommendations in the Action Plan related to curbing the negative effects of predicted land use changes on the watershed. The three steps are listed below and described in detail on the following pages:

Step 1: Classify SMUs relative to existing impervious cover based on 2015 land use/land cover

Step 2: Classify SMUs relative to forecasted impervious cover based on forecasted 2035 land use/land cover

Step 3: Assign each SMU a vulnerability ranking based on forecasted changes in impervious cover and classification

Step 1: Existing Impervious Cover Classification

Step 1 in the Vulnerability Analysis is an existing classification of each SMU based on 2015 land use/land cover and measured impervious cover. 2015 impervious cover was calculated by assigning an impervious cover percentage for each land use/land cover category based upon the United States Department of Agriculture's (USDA) Technical Release 55 (TR55) (USDA 1986). Highly developed land such as commercial/retail for example is estimated to have over 70% impervious cover while a typical medium density residential development exhibits around 25% impervious cover. Open space areas generally have less than 5% impervious cover. GIS analysis was used to estimate the percent impervious cover for each SMU in the watershed using 2015 land use/land cover data. Each SMU then received an initial classification (Sensitive, Impacted, or Non-Supporting) based on percent of existing impervious cover (Table 13; Figure 26).

To summarize, 27 SMUs (SMUs 1-5, 9-10, 12-14, 16-27, 29, 31-33, and 35) were classified as Sensitive, eight as Impacted (SMUs 6-8, 11, 15, 28, 30, and 34), and zero as Non-Supporting based on 2015 impervious cover estimates. Sensitive SMUs are spaced evenly throughout the watersheds. Most of the Impacted SMUs are found around municipal areas West Bend (SMU 34), Newburg (28, 30), Fredonia/Waubeka (6-8, 11) and in areas of residential development.

Table 13. 2015 & predicted (2035) future impervious cover by Subwatershed Management Unit.

SMU #	Step 1: Existing Impervious %	Existing (2015) Impervious Classification	Step 2: Predicted Impervious %	Predicted (2035) Impervious Classification	Percent Change	Step 3: Vulnerablity
SMU 1	6.8%	Sensitive	7.1%	Sensitive	0.3%	Low
SMU 2	8.9%	Sensitive	9.0%	Sensitive	0.2%	Medium
SMU 3	8.8%	Sensitive	11.4%	Impacted	2.6%	High
SMU 4	3.8%	Sensitive	4.4%	Sensitive	0.6%	Low
SMU 5	6.1%	Sensitive	7.5%	Sensitive	1.5%	Low
SMU 6	12.3%	Impacted	17.6%	Impacted	5.3%	Medium
SMU 7	13.0%	Impacted	17.4%	Impacted	4.4%	Medium
SMU 8	16.1%	Impacted	26.3%	Non-Supporting	10.2%	High
SMU 9	8.0%	Sensitive	9.8%	Sensitive	1.8%	Medium
SMU 10	6.4%	Low	8.5%	Low	2.1%	Low
SMU 11	20.5%	Impacted	27.8%	Non-Supporting	7.3%	High
SMU 12	5.8%	Sensitive	13.0%	Impacted	7.2%	High
SMU 13	6.0%	Sensitive	6.7%	Sensitive	0.7%	Low
SMU 14	7.0%	Sensitive	7.7%	Sensitive	0.7%	Low
SMU 15	10.9%	Impacted	11.9%	Impacted	1.0%	Low
SMU 16	5.6%	Sensitive	6.3%	Sensitive	0.7%	Low
SMU 17	3.7%	Sensitive	4.0%	Sensitive	0.3%	Low
SMU 18	8.1%	Sensitive	9.7%	Sensitive	1.6%	Medium
SMU 19	5.5%	Sensitive	5.7%	Sensitive	0.2%	Low
SMU 20	5.0%	Sensitive	5.8%	Sensitive	0.8%	Low
SMU 21	6.2%	Sensitive	7.5%	Sensitive	1.2%	Low
SMU 22	5.4%	Sensitive	6.3%	Sensitive	0.8%	Low
SMU 23	6.5%	Sensitive	7.3%	Sensitive	0.9%	Low
SMU 24	8.4%	Sensitive	8.8%	Sensitive	0.4%	Low
SMU 25	8.0%	Sensitive	10.7%	Impacted	2.7%	High
SMU 26	3.0%	Sensitive	3.5%	Sensitive	0.5%	Low
SMU 27	6.2%	Sensitive	6.4%	Sensitive	0.2%	Low
SMU 28	10.3%	Impacted	17.0%	Impacted	6.7%	Medium
SMU 29	4.8%	Sensitive	5.2%	Sensitive	0.4%	Low
SMU 30	10.2%	Impacted	12.9%	Impacted	2.7%	Low
SMU 31	7.6%	Sensitive	9.2%	Sensitive	1.5%	Medium
SMU 32	5.4%	Sensitive	6.0%	Sensitive	0.6%	Low
SMU 33	9.0%	Sensitive	14.1%	Impacted	5.0%	High
SMU 34	17.6%	Impacted	35.5%	Non-Supporting	17.9%	High
SMU 35	7.5%	Sensitive	13.4%	Impacted	5.9%	High

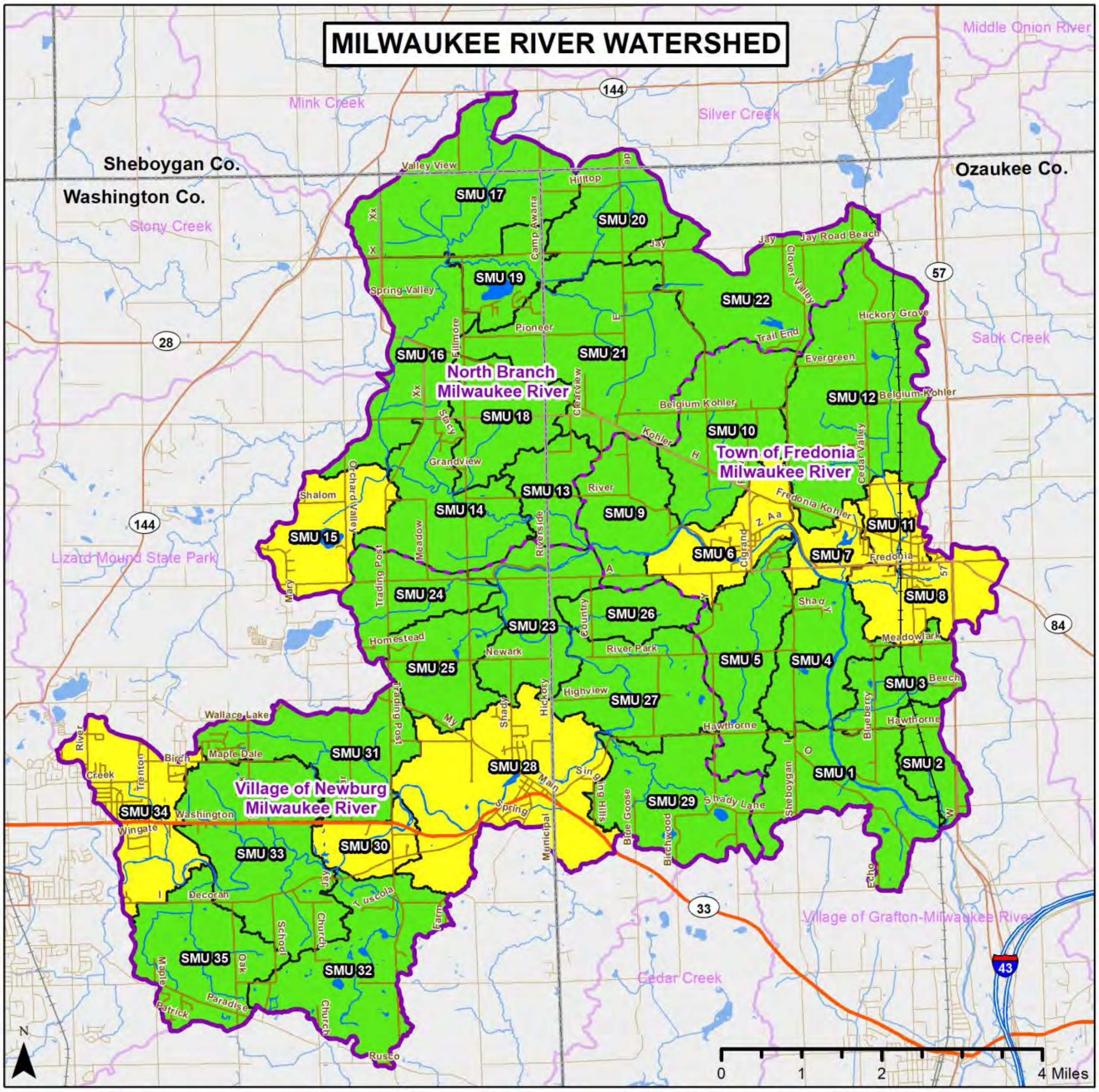
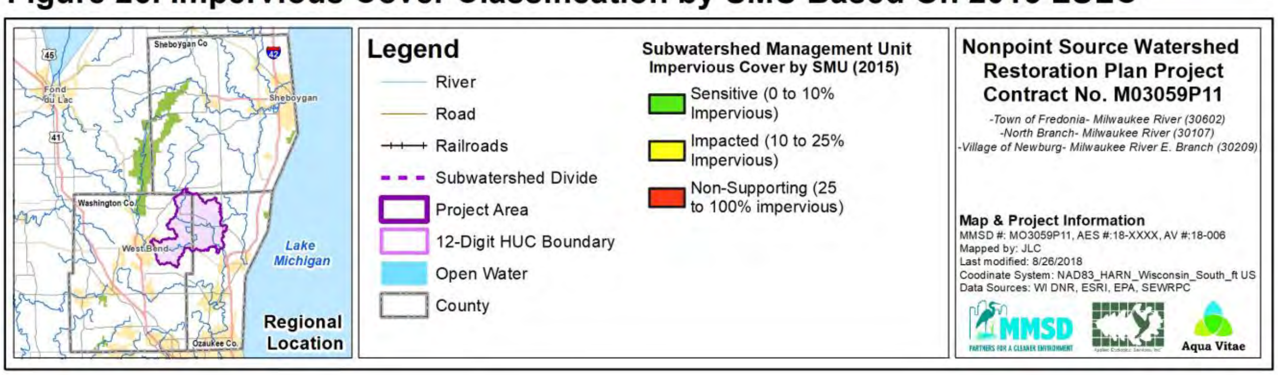


Figure 26. Impervious Cover Classification by SMU Based On 2015 LULC



Step 2: Predicted Future Impervious Cover Classification
Predicted future impervious cover (2035) was evaluated in Step 2 of the vulnerability analysis by classifying each SMU as Sensitive, Impacted, or Non-Supporting based on predicted land use changes. Table 13 and Figure 27 summarize and depict predicted future impervious cover classifications for each SMU. This step identifies Sensitive and Impacted SMUs that are most vulnerable to future development pressure. SMUs 3, 12, 25, 33, and 35 are predicted to change from Sensitive to Impacted while SMUs 8, 11, and 34 change from Impacted to Non-Supporting. These changes are attributed to mostly predicted medium density and suburban residential as well as industrial development localized near West Bend and Fredonia. It is also interesting to note that much of the medium impacted SMUs are localized around the county highway H corridor through the Village of Fredonia and North Branch watersheds.

Step 3: Vulnerability Ranking
The vulnerability of each SMU to predicted future land use changes was determined by considering the following questions:

1. Will the SMU classification change?
2. Does the SMU classification come close to changing (within 2%)?
3. What is the absolute change in impervious cover from existing to predicted conditions?

Vulnerability to future development for each SMU was categorized as Low, Medium, or High:
Low = no change in classification; <5% change in impervious cover
Medium = classification close to changing (within 2%) and/or 5-10% change in impervious cover
High = classification change or close to changing (within 2%) and/or >10% change in cover

The vulnerability analysis resulted in 8 High, 7 Medium, and 20 Low ranked SMUs (Table 13; Figure 28). SMUs 3, 8, 11, 12, 25, 33, 34, and 35 are ranked as highly vulnerable to future problems associated with impervious cover because each is expected to change classification from Sensitive to Impacted or Impacted to Non-Supporting. Predicted medium density and suburban residential as well as industrial development largely concentrated east of West Bend, as we all around Fredonia in areas that are currently agricultural are the largest source of increased impervious cover.

SMUs 2, 6, 7, 9, 18, 28, and 31 are ranked as moderately vulnerable to predicted land use changes. SMUs 6 and 28 exhibit between 5 and 10 percent increases in impervious cover while SMUs 2, 9, 18, and 31 are Sensitive but nearly reach Impacted status. Again, a shift from agricultural, woodland, wetland, and open land use to residential contribute most to increased impervious cover.

The remaining SMUs are not vulnerable to predicted future land use changes based on the Center for Watershed Protection's methodology.

The results of this analysis clearly point to the potential negative impacts of traditional development. It will be important to consider developing these areas using Conservation/Low Impact Development standards that incorporate the most effective and reliable Stormwater Treatment Train practices whereby stormwater is routed through various water quality and infiltration Management Measures prior to being released from the development site. The use of Conservation/Low Impact Development is discussed in the Programmatic Action Plan section of this report.

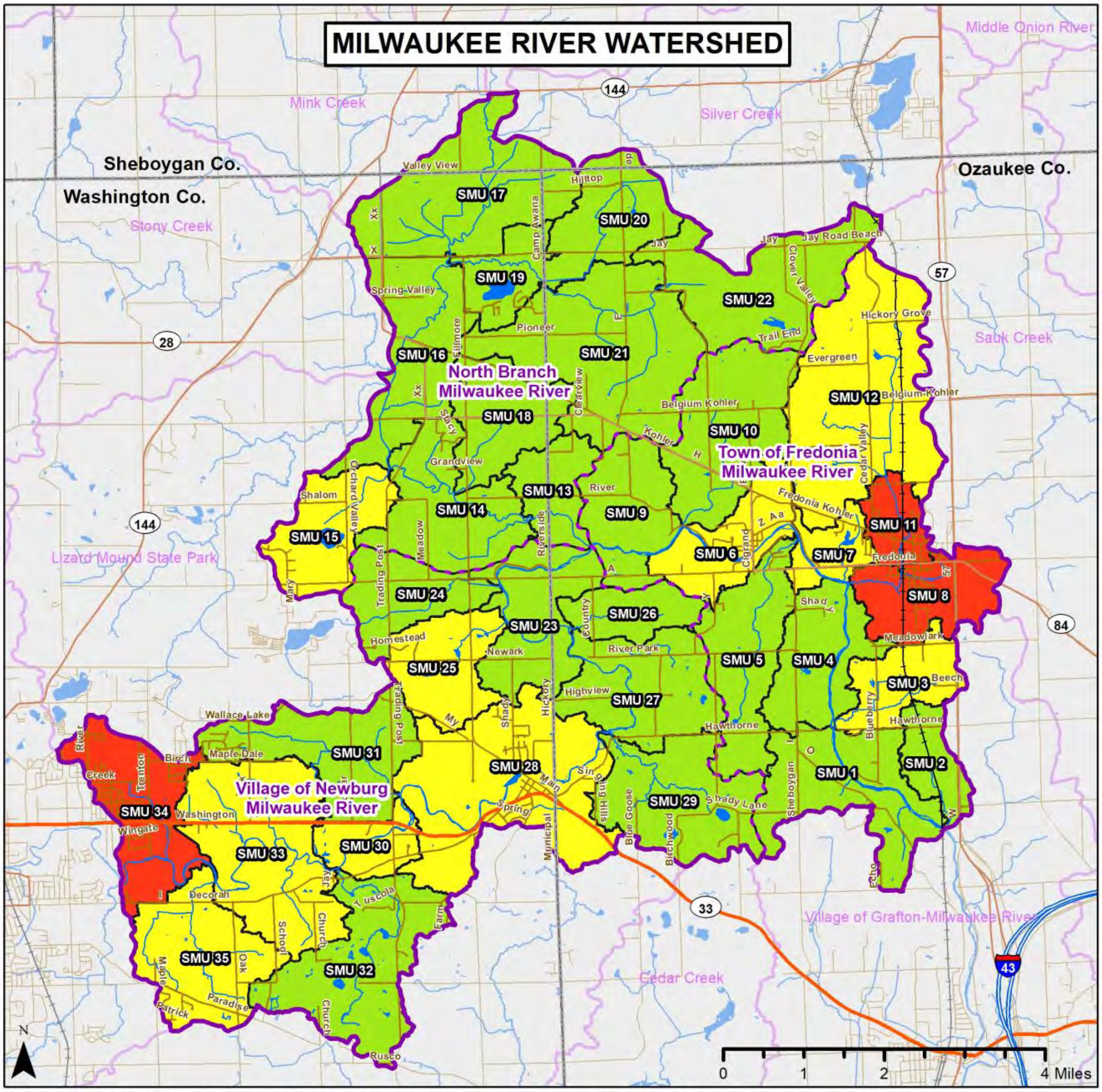
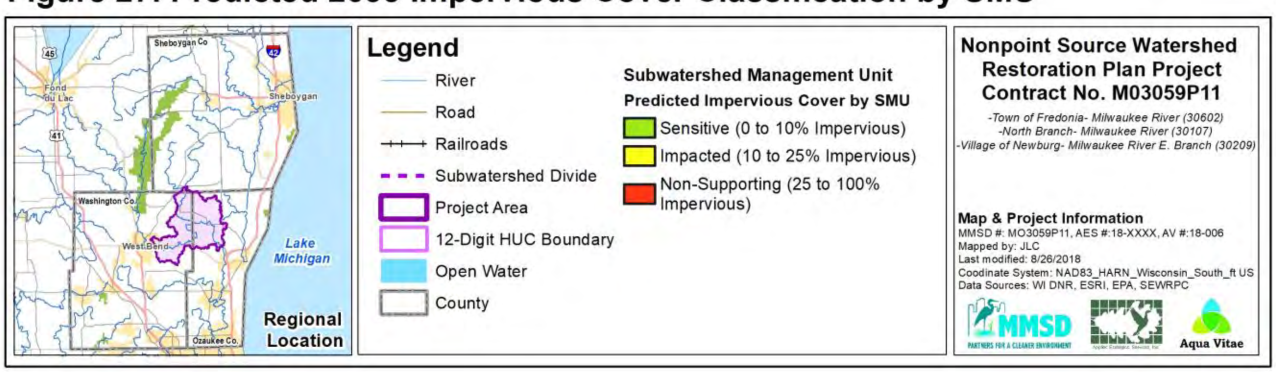


Figure 27. Predicted 2035 Impervious Cover Classification by SMU



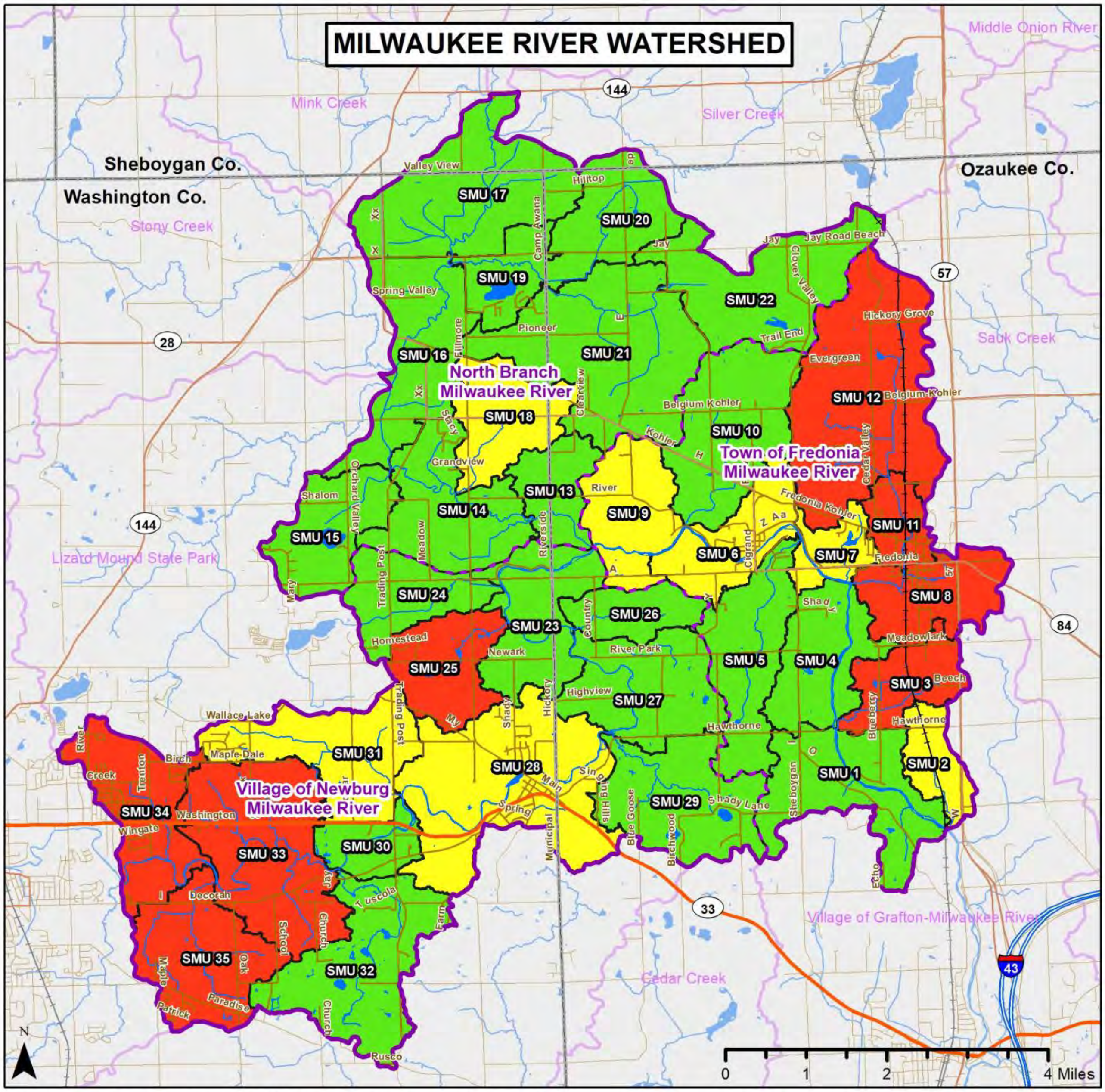
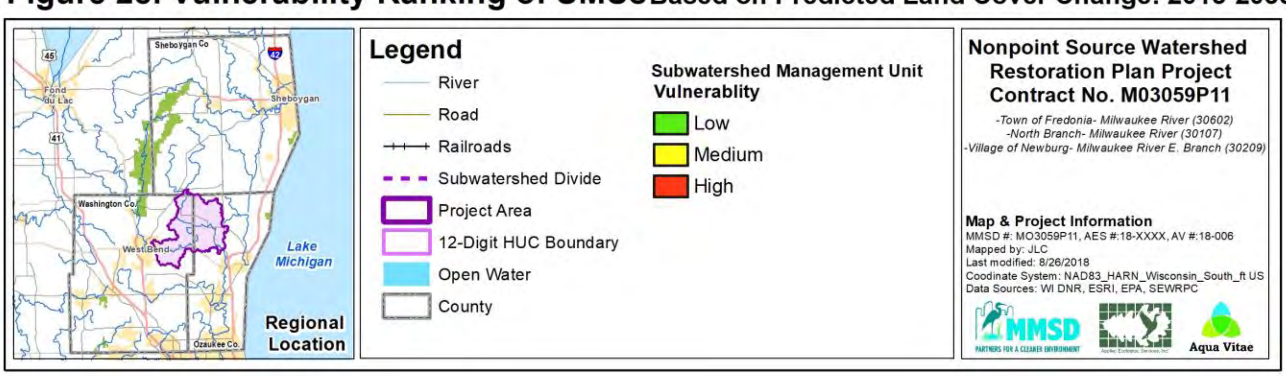


Figure 28. Vulnerability Ranking of SMUs Based on Predicted Land Cover Change: 2015-2035



3.11 Open Space Inventory, Prioritization, & Green Infrastructure Network

A major component of watershed planning includes an examination of open space to determine how it best fits into a "Green Infrastructure Network". Green infrastructure is best defined as an interconnected network of natural areas and other open space that conserves natural ecosystem values and functions, sustains clean air and water, and provides a wide array of benefits to people and wildlife (Benedict 2006). Natural features such as stream corridors, wetlands, floodplain, woodlands, and grassland are the primary components of green infrastructure. Working lands such as farms parks/ball fields, golf courses, school grounds, detention basins, and large residential parcels can also be considered green infrastructure components. A three-step process was used to create a parcel-based Green Infrastructure Network for the Fredonia-Newburg Area watersheds:

Step 1: All parcels of land in the watershed were categorized as open space, partially open space, or developed.
Step 2: All open and partially open parcels were prioritized based on a set of criteria important to green infrastructure.
Step 3: Prioritized open and partially open parcels and some developed but linking parcels were combined to form a Green Infrastructure Network.

For this watershed plan, an "open space" parcel is generally defined as any parcel that is not developed such as a protected natural area or agricultural field. "Partially open" parcels have been developed to some extent, but the parcels still offer potential green infrastructure opportunities. Examples of partially open parcels include some school grounds, residential lots generally greater than two acres with minimal development, vacant industrial areas, and portions of airports. Parcels that are mostly built out such as medium and high-density residential development, transportation, and commercial/retail areas are considered "developed". Public versus private and protected versus unprotected status of open and partially open space parcels are other important green infrastructure attributes that are discussed in more detail below.

Open, Partially Open, & Developed Parcels

Step 1 in creating a Green Infrastructure Network was completed by categorizing all parcels in the watershed as "open", "partially open", or "developed" as described above. Figures 29 and 32 summarize and depict Step 1 results. Open space parcels (defined as less than 10% developed) within the Village of Newburg, Town of Fredonia, and North Branch Milwaukee River watersheds largely dominate the landscape and comprise approximately 44,656 acres or 78% of the watershed. Open parcels range from less than 1 acre to 286 acres with a 24-acre average. Partially open parcels (10-50% developed) make up another 9,681 acres or 17% of the watershed. Partially open parcels range from less than 1 acre to 347 acres with a 8.6-acre average. Developed parcels account for the remaining 3,229 acres or 6% of the watershed, hence the rural feel of the watershed. Most open and partially open parcels are located on agricultural land, County preserves, an airport, and large residential lots.

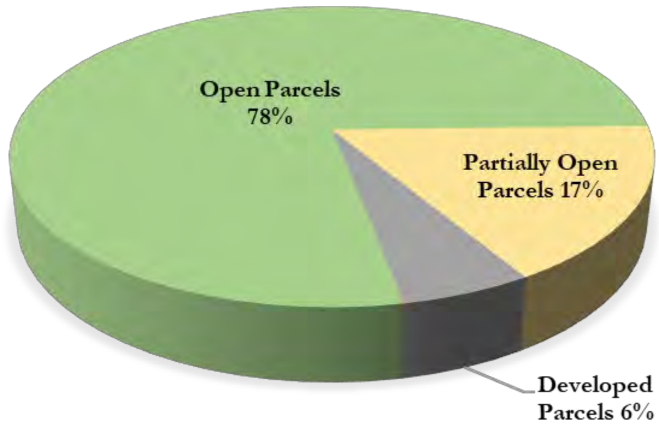


Figure 29. Distribution of open, partially open, and developed parcels (2015).

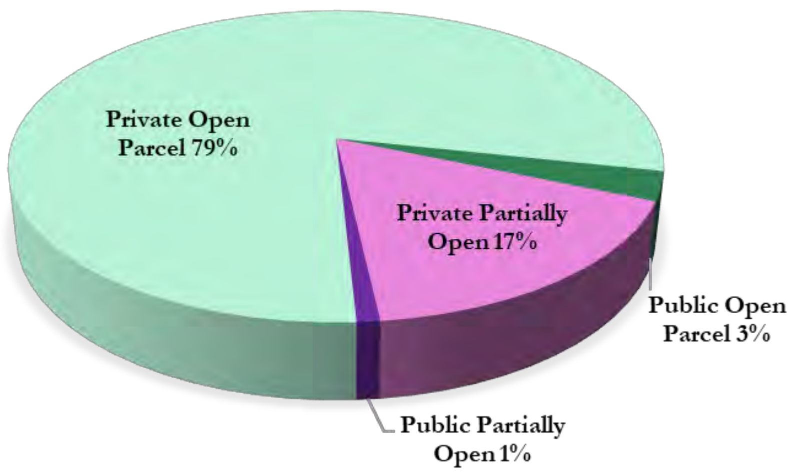


Figure 30. Distribution of private vs. public open and partially open parcels (2015).

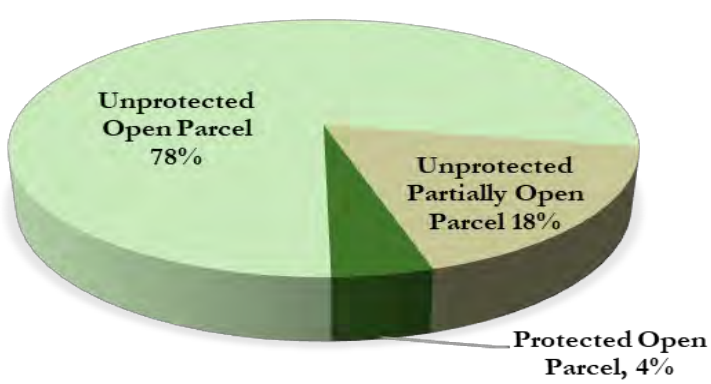


Figure 31. Distribution of protected vs unprotected open and partially open parcels (2015).

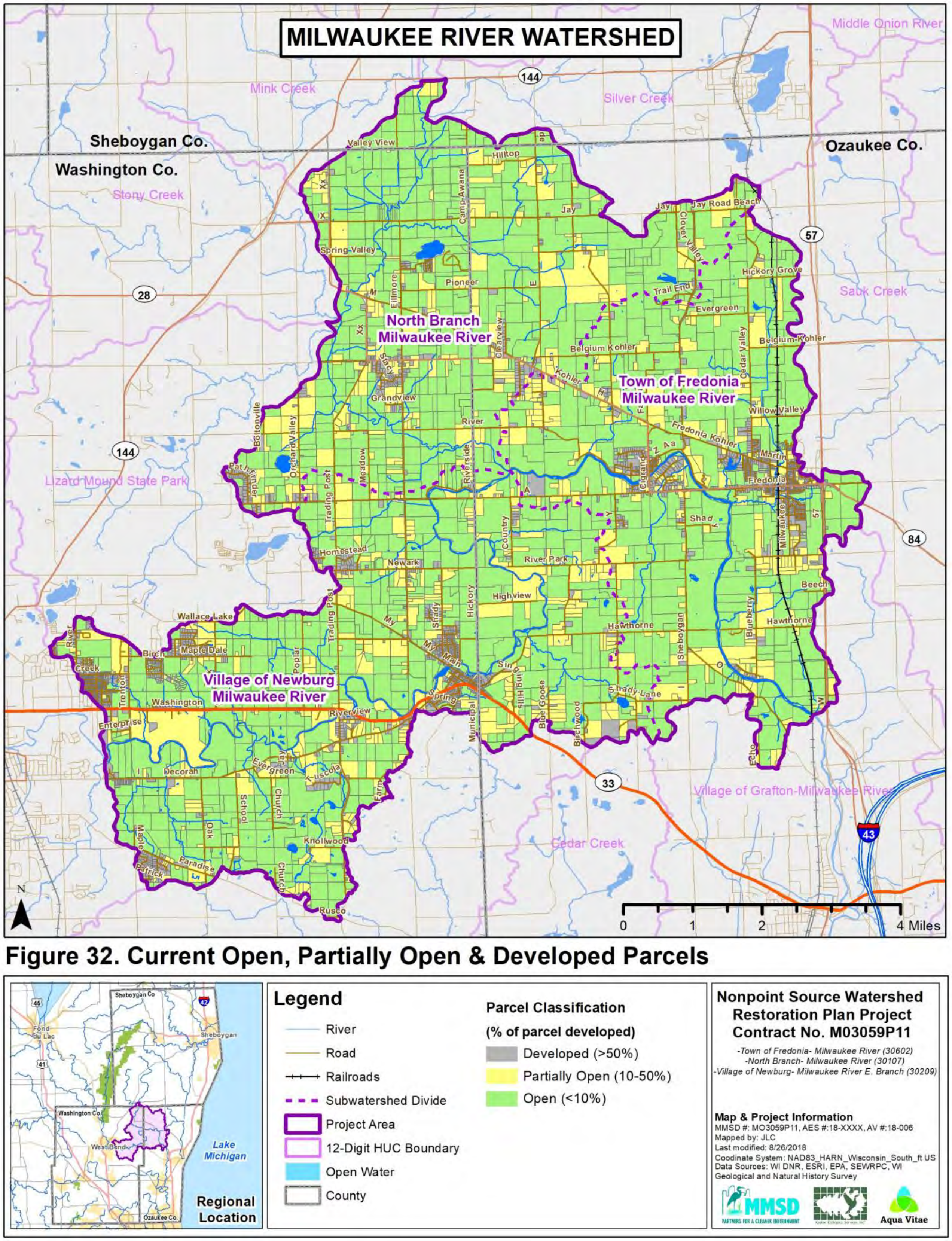


Figure 32. Current Open, Partially Open & Developed Parcels

Public/Private Ownership of Open and Partially Open Parcels

The public or private ownership of each open and partially open parcel was determined from available parcel data. Developed parcels are not included in this summary. Publicly owned parcels generally include those owned by state, county, municipal government, school districts, and park districts. Public open and partially open parcels account for 3% and 1% of the open and partially open acreage respectively (Figures 30 & 33). Private ownership types include residential, businesses, commercial, industrial, non-profit, agricultural, etc. Private open parcels comprise 79% of the open and partially open acreage whereas private partially open parcels comprise 17%. Public open and partially open parcels are mostly owned by counties and municipalities.

Protected Status of Open and Partially Open Parcels

Preservation of open space is critical to maintaining and expanding green infrastructure and is an important component of sustaining water quality, hydrological processes, ecological function, and the general quality of life for both wildlife and people. Without preservation, open space can be converted to other less desirable land uses in the future. Typically, parcels that are protected from future development are considered protected, while those open to development changes if the property changes hands are considered unprotected. Protected open and partially open parcels account for about 4% of the open and partially open parcel acreage in the watershed while unprotected open and partially open parcels account for the remaining 96% at 78% and 18% respectively (Figures 31 & 34). Most protected open or partially open parcels are owned by counties, municipalities, homeowner associations, and non-profit groups such as Ozaukee-Washington Land Trust.

The most crucial unprotected open and partially open parcels are agricultural lands. Most agricultural areas will likely be developed to residential unless agricultural preservation tools are leveraged. Utilizing the Wisconsin Working Lands Initiative and future development that incorporates conservation design or low impact development will be extremely important in many of these areas to improve water quality and reduce stormwater runoff volume.

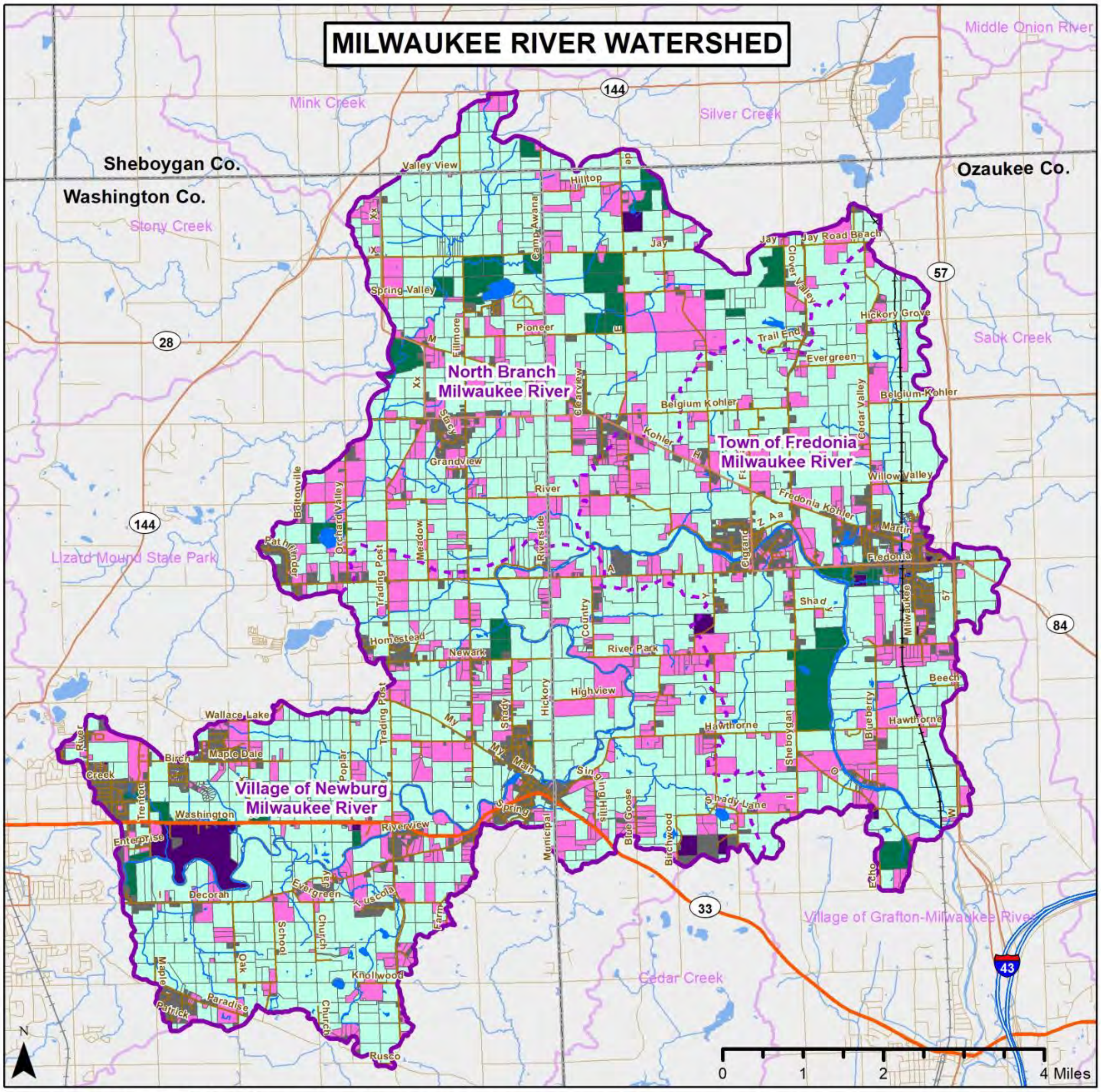
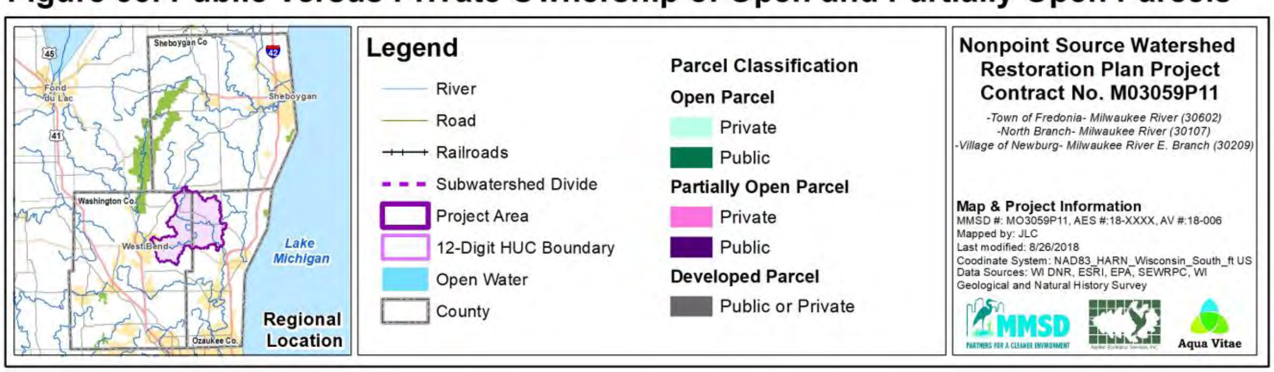


Figure 33. Public Versus Private Ownership of Open and Partially Open Parcels



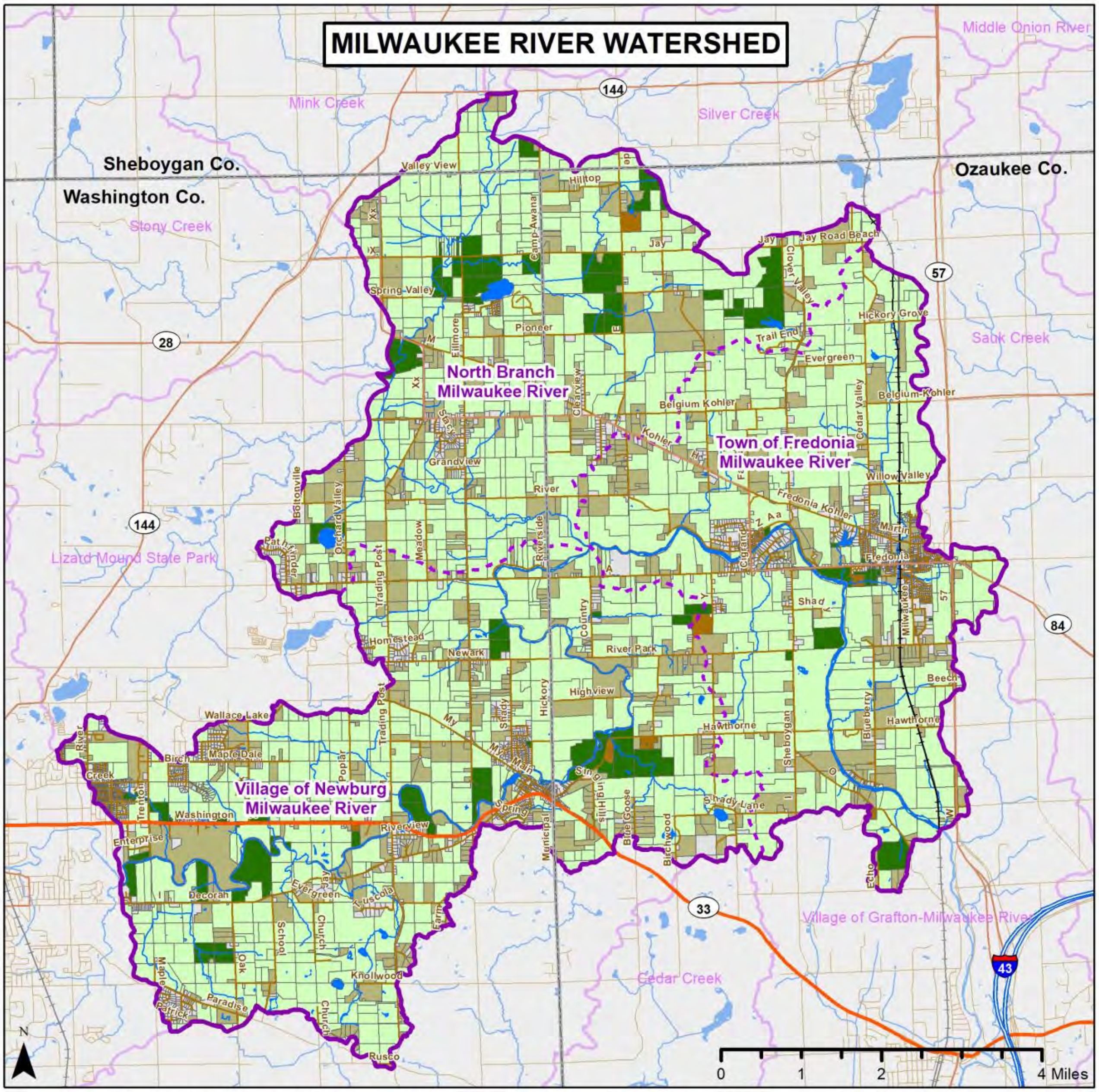
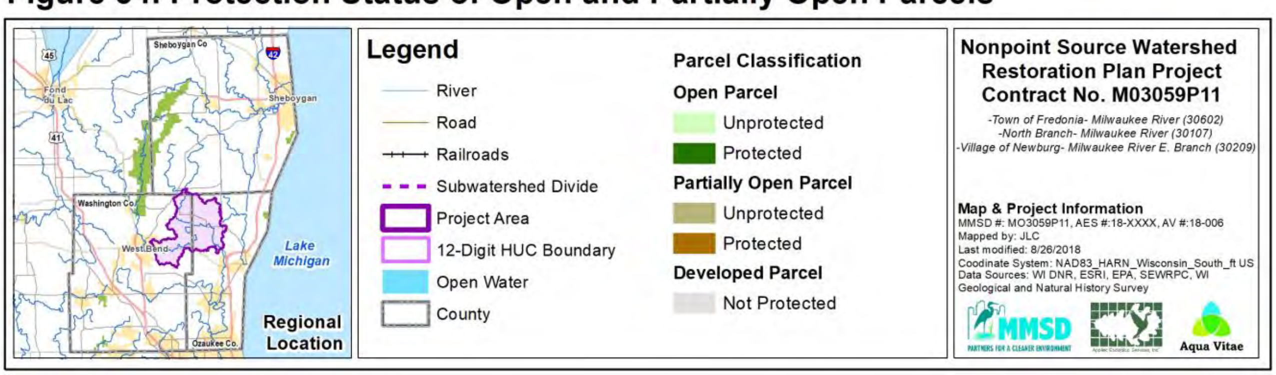


Figure 34. Protection Status of Open and Partially Open Parcels



Open Space Parcel Prioritization

Step 2 in creating a Green Infrastructure Network for the Fredonia-Newburg Area watersheds was completed by prioritizing open and partially open parcels. For this step, 10 prioritization criteria important to green infrastructure were examined via a GIS analysis (Table 14). If an open or partially open parcel met a criterion it received one point. If the parcel did not meet that criterion, it did not receive a point. This process was repeated for each open and partially open parcel and for all criteria. Due to the extent to which additional planning work around threatened and endangered species are being looked at in the watershed, those parcels meeting Criteria 11 were given 2 points. The prioritization process was not completed for developed parcels. The total points received for each parcel were summed to determine parcel importance for developing the Green Infrastructure Network; parcels with the highest number of points are more important to green infrastructure than parcels that met fewer criteria.

The combined possible total of points any one parcel could accumulate was 12 (11 of 11 total criteria met, with one extra point if it met Criteria 11). The highest total value received by a parcel in the weighting process was 12 (having met 11 of 11 criteria). After completion of the prioritization, parcels were mapped according to their score (Figure 35) and reviewed as a whole.

Table 14. Criteria used to prioritize parcels for a Green Infrastructure Network.

Green Infrastructure Criteria
1. Open/partially open parcels that include the FEMA 100-year floodplain
2. Open/partially open parcels within 0.25 miles of a headwater stream
3. Open/partially open parcels that include a wetland (WI Wetland Inventory)
4. Open/partially open parcels that include an ADID wetland (SEWRPC)
5. Open/partially open parcels that are within 100 feet of a stream or open water
6. Open/partially open parcels in a "Highly Vulnerable" Land Use/Land Cover SMU
7. Open/partially open parcels adjacent to or including private or public protected open space
8. Open/partially open parcels that include an existing or planned trail
9. Open/partially open parcels that include SEWRPC environmental corridors
10. Open/partially open parcels that include "Highly Productive Agricultural Land"
11. Open/partially open parcels that include "Historic or Potential Areas for Threatened and Endangered Species".

Green Infrastructure Network

The final step (Step 3) in creating a Green Infrastructure Network for the Fredonia-Newburg Area watersheds involves laying out the network by using prioritized open space results from Step 2 as the base layer that includes all prioritized parcels and adding back in developed parcels along streams, wetlands and open space corridors if they provided *links*, expanded existing green infrastructure, or connected isolated sites such as protected parks. In this watershed, parcels that scored 6 or higher were kept in the Green Infrastructure Network and then additional parcels were added/included where individual parcels were needed to link all portions of the network to form a whole.

County and regional green infrastructure plans generally focus on natural features such as stream corridors, wetlands, floodplain, buffers, and other natural components. The Green Infrastructure Network created for the Fredonia-Newburg Area watersheds captures all the natural components including the majority of SEWRPC's environmental corridors and other green infrastructure such as recreational parks, large residential lots, and school grounds at the parcel level. Parcel level green infrastructure planning is important because land purchases, acquisitions, and land use changes almost always occur at the parcel level. The Green Infrastructure Network for the Fredonia-Newburg Area watersheds is illustrated on Figure 36. In total, the Green Infrastructure Network covers 33,520 acres, only 2,521 acres of which are currently protected.

Perhaps the most important aspect of green infrastructure planning is that it helps communities identify and prioritize conservation opportunities and plan development in ways that optimize the use of land to meet the needs of people and nature (Benedict 2006). Green infrastructure planning provides a framework for future growth that identifies areas not suitable for development, areas suitable for development but that should incorporate conservation or low impact design standards, and areas that do not affect green infrastructure. The Action Plan section of this report includes various programmatic and site-specific green infrastructure recommendations.

Noteworthy: Green Infrastructure Network

A Green Infrastructure Network is a connected system of *Hubs* and linking *Corridors*. Hubs generally consist of the largest and least fragmented areas. Corridors are generally formed by smaller private/unprotected parcels along swales and streams. Corridors are extremely important because they provide biological conduits between hubs. However, most parcels forming corridors are not ideal green infrastructure until residents, businesses, industries, and farmers embrace the idea of naturalizing stream corridors. Unique to the three Fredonia-Newburg watersheds in this plan, are very undeveloped riparian corridors. The main branches of these rivers are still currently wooded, diverse and have limited development impacts and limited agricultural encroachments.

Source: greeninfrastructure.net

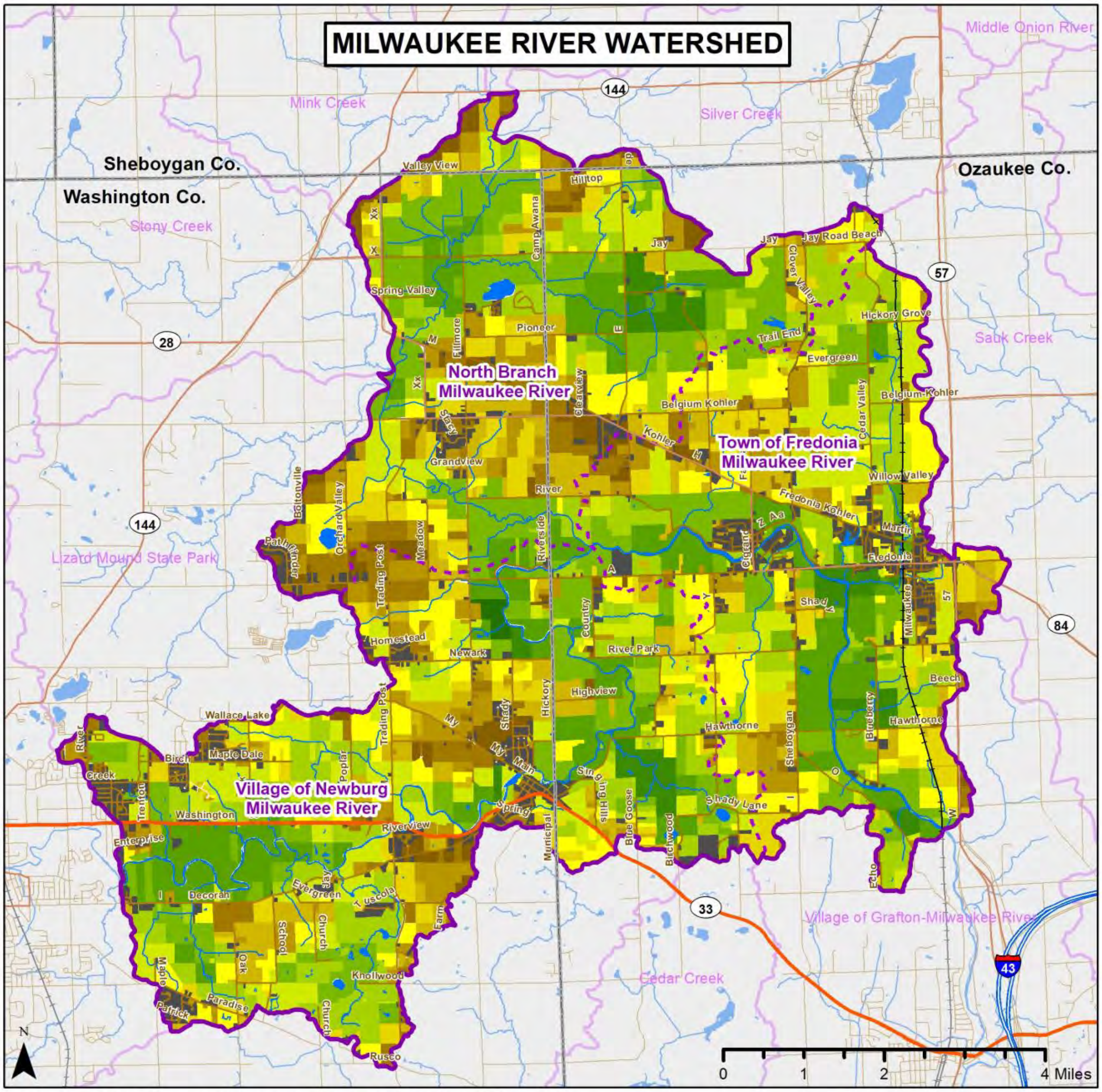
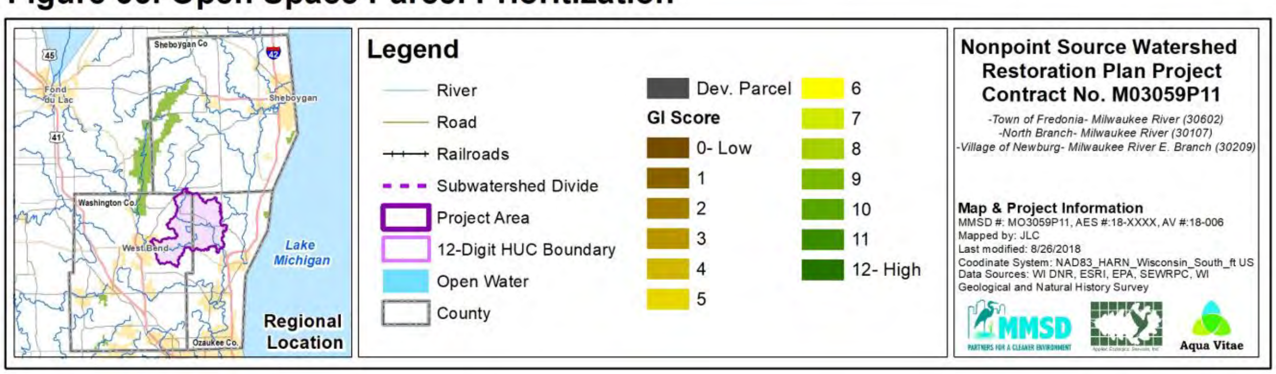


Figure 35. Open Space Parcel Prioritization



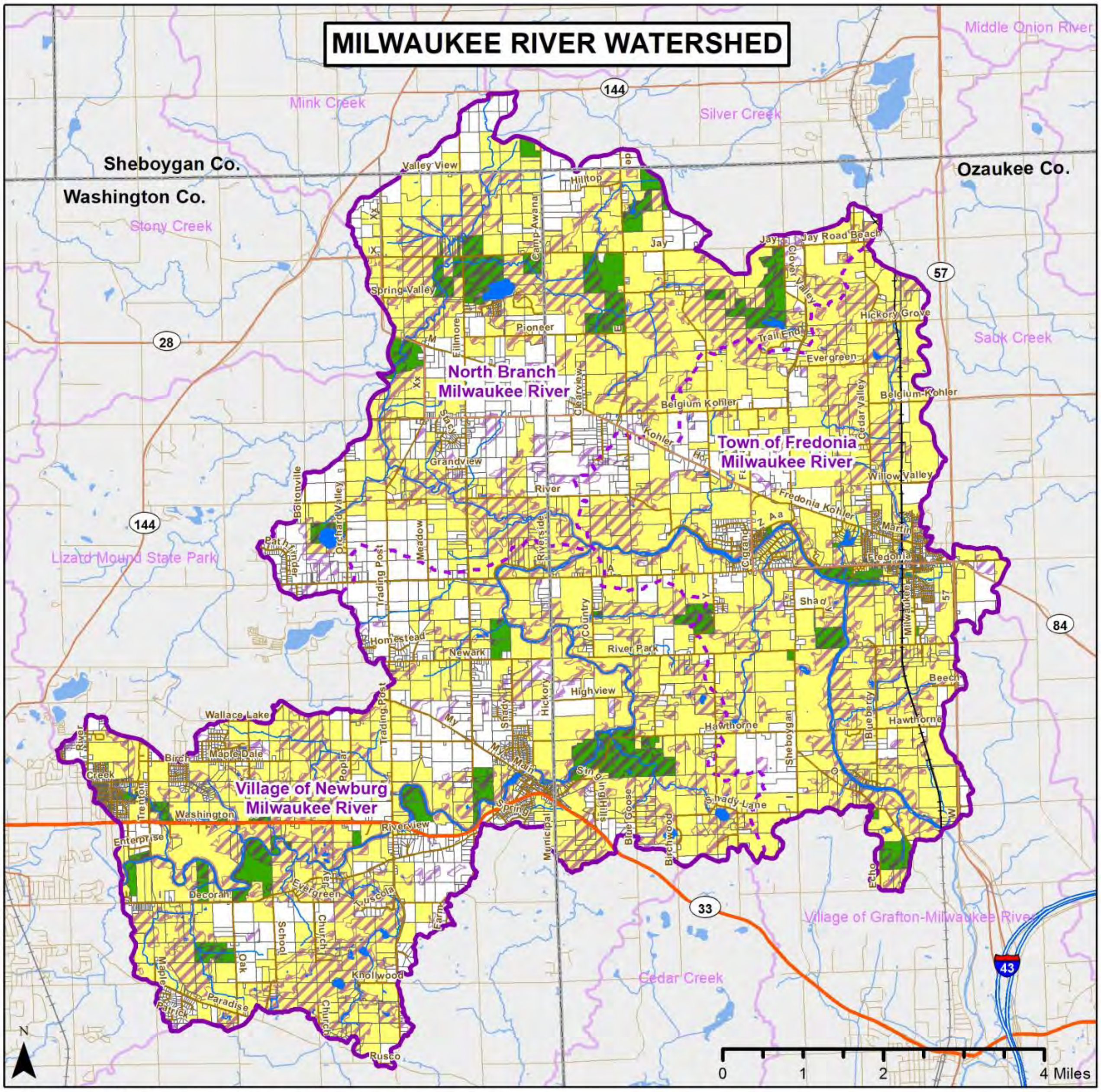
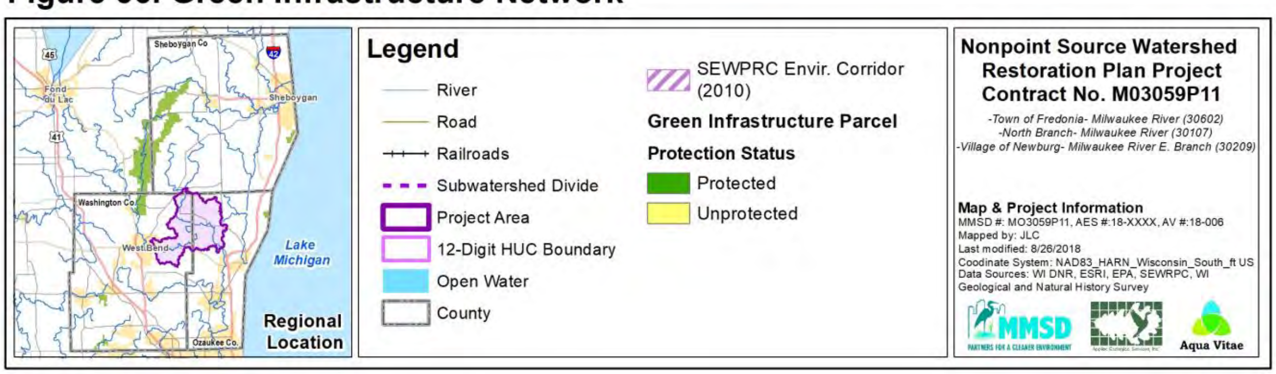


Figure 36. Green Infrastructure Network



3.12 Highly Productive Agricultural Land

The preservation of agricultural land in the Fredonia-Newburg Area watersheds can play a crucial role in retaining valuable open space as part of the green infrastructure network. These areas allow for greater groundwater infiltration than those lands that have been converted to urban land uses. Southeastern Wisconsin Regional Planning Commission's (SEWRPCs) 2016 *Vision 2050: One Region, Focusing on Our Future,* calls for the preservation of as much of the most productive farmland as practicable.

SEWRPC defines the most productive farmland (National Prime Farmlands) according to the agricultural capability of the soils on that land – specifically those classified by the U.S. Natural Resources Conservation Service (NRCS) as Class I and Class II soils. Agricultural land classified as Class III soils are categorized as Farmland of Statewide Importance. In the Fredonia-Newburg Area watersheds, 17,514 acres have been classified as National Prime Farmlands (worthy of preservation. Farmlands of Statewide Importance account for 8,470 acres. Figure 37 depicts the location of the National Prime Farmlands, as well as Farmlands of Statewide Significance. The breakdown of each of the three watersheds farmland data is as follows: North Branch Milwaukee River has 4,886 acres of National Prime Farmlands with 2,856 acres of Statewide Importance; Town of Fredonia-Milwaukee River has 6,836 acres of National Prime Farmlands with 1,636 acres of Statewide Importance and Village of Newburg-Milwaukee River has 5,792 acres of National Prime Farmlands with 3,978 acres of Statewide Importance.

Rolling hills and corn along Hwy M near Filmore

Farmland and rolling hills coexist and define these three watersheds but as more and more family farms give way to development pressure and aggregate to larger agricultural operations in the near future, the rural character of this area will change. The 2009 Wisconsin Working Lands Initiative was an effort introduced which includes the Farmland Preservation Program, Agricultural Enterprise Area Program, and the Purchase of Agricultural Conservation Easement Program. An opportunity may exist to expand agricultural preservation within the Fredonia-Newburg Area watersheds.

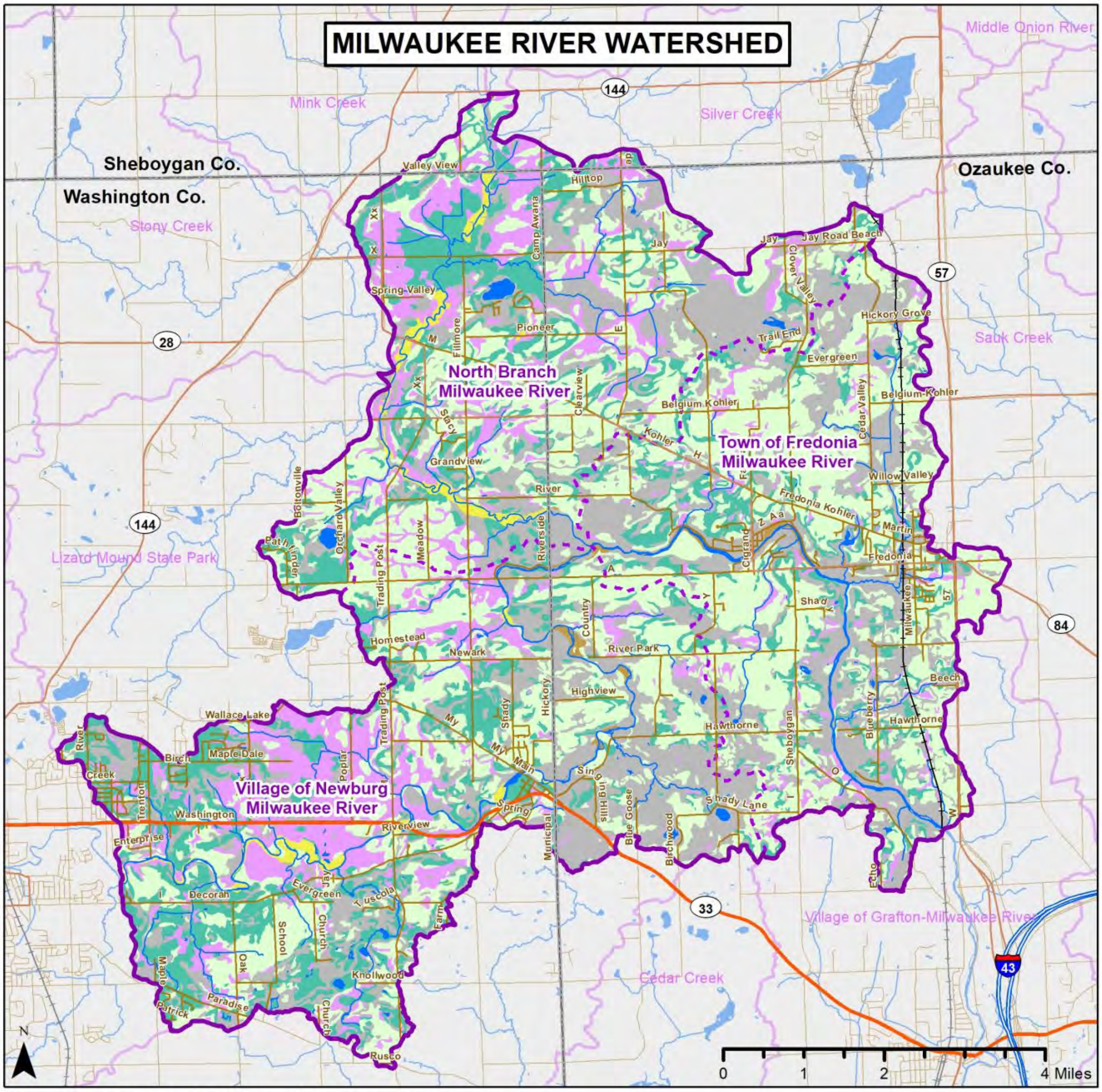
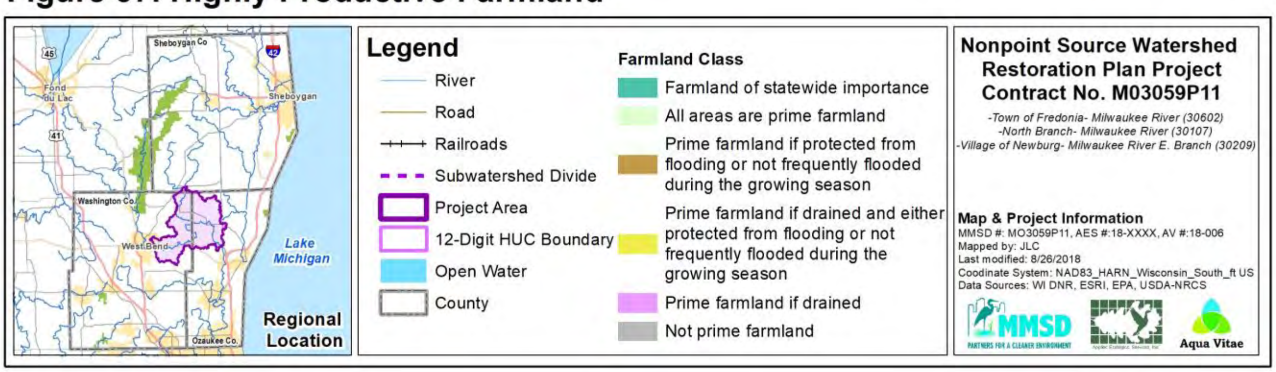


Figure 37. Highly Productive Farmland



3.13 Important Natural Areas

Wetlands, woodlands, stream corridors and other natural features that fall within concentrated corridors of the natural resource base are all considered "Important Natural Areas" within the Fredonia-Newburg Area watersheds. Many of these areas are public and owned/managed by local county, non-profit, or municipal entities. Important Natural Areas often provide high quality habitat for and harbor uncommon or even threatened and endangered (T&E) species. These areas also provide large greenway corridors that interconnect land and waterways, support native species, maintain natural ecological processes, and contribute to the quality of life for communities of people. For this plan, SEWRPC Environmental Corridors were adopted as Important Natural Areas. SEWRPC Environmental Corridors total 46,215 acres and data layers are broken down and expressed by acreage and percentage of each of the three watersheds (Table 15). ADID designated wetlands areas total 7,325 acres, the three watersheds had the following ADID wetlands totals: North Branch Milwaukee River 3,060 acres, Town of Fredonia-Milwaukee River 1,616 acres and Village of Newburg-Milwaukee River 2,649 acres. There are also 595 acres in other Natural Areas are located in the watershed (Table 16; Figures 38 & 39).

Table 15. SEWRPC Environmental Corridors by type, acreage and percent of watershed.

Watershed/Corridor Type	Acres	Percent of HUC 12
North Branch Milwaukee River	**13,423.6**	**95%**
Water	12.9	0%
Primary	3,602.1	25%
Primary Water	163.8	1%
Secondary	147.1	1%
Secondary Water	37.9	0%
Isolated Natural Area	330.6	2%
Water in INRA	5.3	0%
OUT	9,123.8	65%
Town of Freedonia-Milwaukee River	**14,123.1**	**100%**
Water	22.2	0%
Primary	2857.7	20%
Primary Water	243.2	2%
Secondary	102.7	1%
Secondary Water	5.5	0%
Isolated Natural Area	340.3	2%
Water in INRA	13.1	0%
OUT	10,538.4	75%
Village of Newburg-Milwaukee River	**18,669.1**	**100%**
Water	23.8	0%
Primary	4,524.4	24%
Primary Water	360.3	2%
Secondary	137.3	1%
Secondary Water	7.8	0%
Isolated Natural Area	538.1	3%
Water in INRA	13.1	0%
OUT	13,064.3	70%

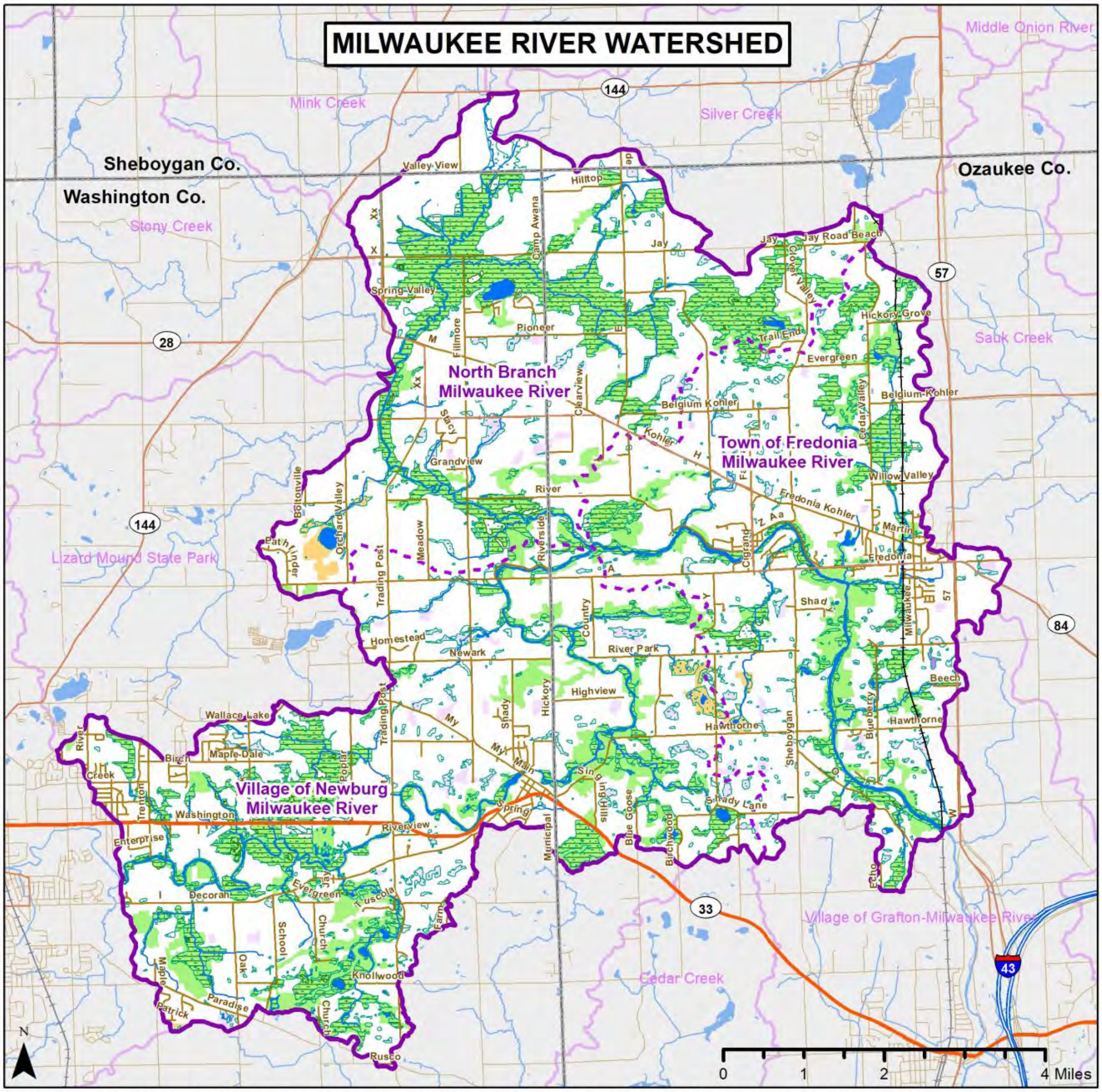
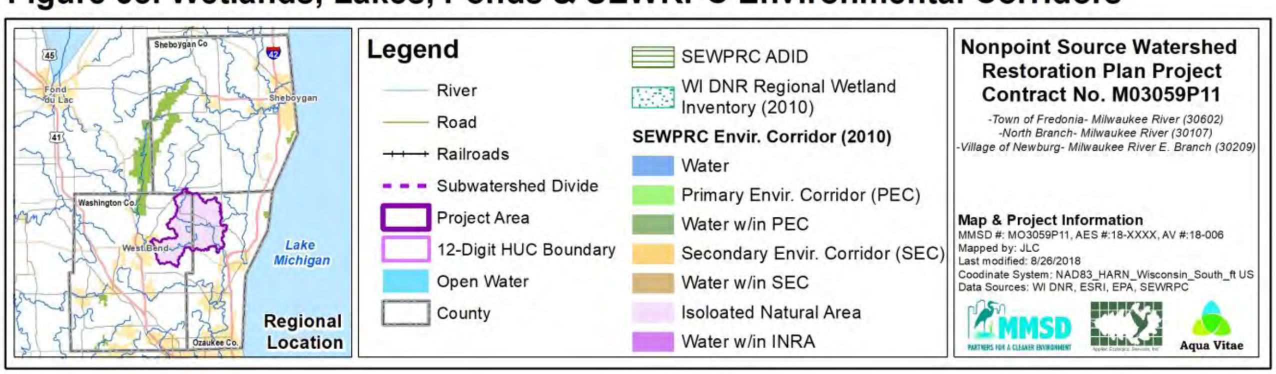


Figure 38. Wetlands, Lakes, Ponds & SEWRPC Environmental Corridors



SEWRPC Environmental Corridors

As part of their regional planning efforts, Southeastern Wisconsin Regional Planning Commission (SEWRPC) identified primary and secondary environmental corridors within southeastern Wisconsin. These environmental corridors were designated to identify and protect important natural resources in the area. The Environmental Corridors for the Fredonia-Newburg Area watersheds serve as an important catalogue of important natural areas within the watershed and form the backbone of the Green Infrastructure Network. The SEWRPC 2005 Environmental Corridors within the Fredonia-Newburg Area watersheds are mapped on Figure 38.

Native Jewelweed (Impatiens capensis) thrives along a creek bank on the North Branch-Milwaukee River.

SEWRPC's Environmental Corridors were determined based on the presence of water bodies, watercourses, wetlands, remnant plant communities, wildlife habitat areas, areas containing hydric or partially hydric soils, and areas of rugged terrain or high-relief topography. Additionally, the corridors take into account the relation of open space, historic sites, scenic areas, natural areas, and critical species habitat sites within the area. Primary and Secondary Environmental Corridors, as well as Isolated Natural Resource Areas were delineated for the planning area. Primary Environmental Corridors are defined as being at least 400 acres in size, two miles long, and 200 feet in length. Secondary Corridors are at least 100 acres in size and one mile long, unless they connect primary environmental corridors. Isolated Natural Resource Areas include those from 200 feet wide down to a 5-acre minimum (SEWRPC 2000).

ADID Wetlands, Lakes, & Ponds

The United States Environmental Protection Agency (USEPA) has a planning process known as advanced identification of disposal areas (ADID) in place that is used to identify wetlands and other waters that are unsuitable for the discharge of dredged and fill materials (USEPA 2009). For the Fredonia-Newburg Area watersheds, these identifications were made by the USEPA in conjunction with the United States Army Corps of Engineers (USACOE) and Wisconsin Department of Natural Resources (WDNR). The ADID wetland inventory was completed for Washington and Ozaukee Counties in 2005. SEWRPC provided technical assistance in producing these maps by combining this data with their Primary Environmental Corridors. These inventories identify wetlands where special protection should be implemented and enforced. There are 7,325 acres of ADID wetlands as shown on Figure 38.

Other Important Natural Areas

The Wisconsin Department of Natural Resources (WDNR) manages the State Natural Areas Program (SNA) which works to identify ecological communities that remain predominantly undisturbed from pre-European settlement times. These areas have been assessed according to field inventories conducted by WDNR staff and account for the quality, diversity, extent of past disturbance, context within the greater landscape, and rarity of features. Areas that meet these qualifications and have also been identified as areas of statewide significance are designated as State Scientific Areas. Within the Fredonia-Newburg Area watersheds, there are two SNAs, Riveredge Creek & Ephemeral Pond (SNA No. 197) and Huiras Lake (SNA No. 353). There are an additional five sites of high-quality natural areas, most are owned by Ozaukee Washington Land Trust (OWLT). There are also a number of other sites that serve as critical species habitat for plants or wildlife that lie just outside the boundary of these three HUC12 Milwaukee River watersheds (Figure 39).

North Branch Milwaukee River Wildlife and Farming Heritage Area

WDNR in conjunction with Ozaukee, Sheboygan, and Washington Counties has designated an area covering 25 square miles as the North Branch Milwaukee River Wildlife and Farming Heritage Area. According to WDNR, "This unique project seeks to preserve the strong agricultural farming tradition of the area while maintaining wildlife habitat, restoring plant communities and wetlands and providing recreational opportunities. A policy of 'passive' management is used in some self-sustaining community types such as lowland forests, with the exception of where invasive species control is necessary. Over the years, many wetlands have been degraded, filled or destroyed. One primary effort will be to manage and restore wetlands on the property, including the reestablishment of vegetative and riparian buffers to protect the watershed, improve wildlife habitat and reduce soil erosion. Where open areas are to be maintained, several management systems will be used - prescribed burning, brush cutting, herbicide treatments and sharecropping or grazing - to facilitate habitat health. Ponds, lakes, rivers and streams will be managed to improve water quality and wildlife habitat through a variety of best management practices. (WDNR, 2009)"

Ozaukee County has included three easements/acquisitions as identified in the project as a goal in their Land & Water Plan and the project has identified other project areas, many of which fall within the Fredonia-Newburg Area watersheds. The goals of the project are in line with the goals of the Fredonia-Newburg Area watershed-Based Plan and the action plan recommendation found in Section 6 of this plan. More detailed information regarding the North Branch Milwaukee River Wildlife and Farming Heritage Area, including maps of the project areas, can be found online at https://dnr.wi.gov/topic/lands/WildlifeAreas/northbranch.html.

Table 16. Important Natural Area summary data.

Natural Area	Size (acres)	Description
SEWRPC Environmental Corridors		
Primary Environmental Corridors	7,382	≥ 400 acres in size, two miles long, and 200 feet in length
Secondary Environmental Corridors	387	≥ 100 acres in size and one mile long, unless they connect primary environmental corridors
Isolated Natural Resource Area	1,209	200 feet wide down to a 5-acre minimum
ADID Wetlands, Lakes, & Ponds		
ADID Wetlands, Lakes, & Ponds	7,325	As delineated by USEPA, USACOE, & WDNR, with assistance provided by SEWRPC, in 2005
Other Important Natural Areas		
Riveredge Creek & Ephemeral Pond (SNA No. 197)	61	Unique State Natural Area (SNA) containing a low velocity, cold, hard water stream of exceptionally high water quality. Supports ecologically conservative aquatic insect community including *Molanna spp* and *Glossosomatid caddis*. Seasonally dry pond with fen-like areas surrounded by northern wet-mesic forest. Owned and managed by Riveredge Nature Center.
Huiras Lake (SNA No. 353)	198	Woodland and high-quality natural area SNA with 26AC pristine, hardwater seepage lake. Open water of the bog is surrounded by sphagnum moss and a ring of tamarack, eastern white cedar and black ash. The undeveloped shoreline and woods have marsh ferns, yellow blue-bead lily and other uncommon species. Hiking, birding and hunting with a boardwalk. Owned by OWLT and WDNR.
Fellenz Woods	160	High quality woodland with some undeveloped Milwaukee River frontage. Prairie restoration and tree plantings. Hiking, birding, fishing, hunting and xc skiing. Owned by OWLT.
Hepburn Woods	20	Hardwood forest located in the City of West Bend. Hiking and birding. Owned and managed by OWLT.
Kratzsch Conservancy	73	Grasslands, wetlands and woodlands on this farm to natural areas restoration. Hiking, birding, boating, fishing, hunting, xc skiing. Managed and owned by OWLT.
Lake Twelve	12	Partially forested kettle lake ringed by yellow birch and tamarack. Birding, fishing and hunting, public access for non-motorized boats.
Mayhew Preserve	71	Upland forests, lowland hardwood, conifer plantings, shrub- carr and wetlands. Sandhill cranes can be observed seasonally as are fish such as longear sunfish, greater redhorse, lake sturgeon and northern pike. Owned by OWLT.

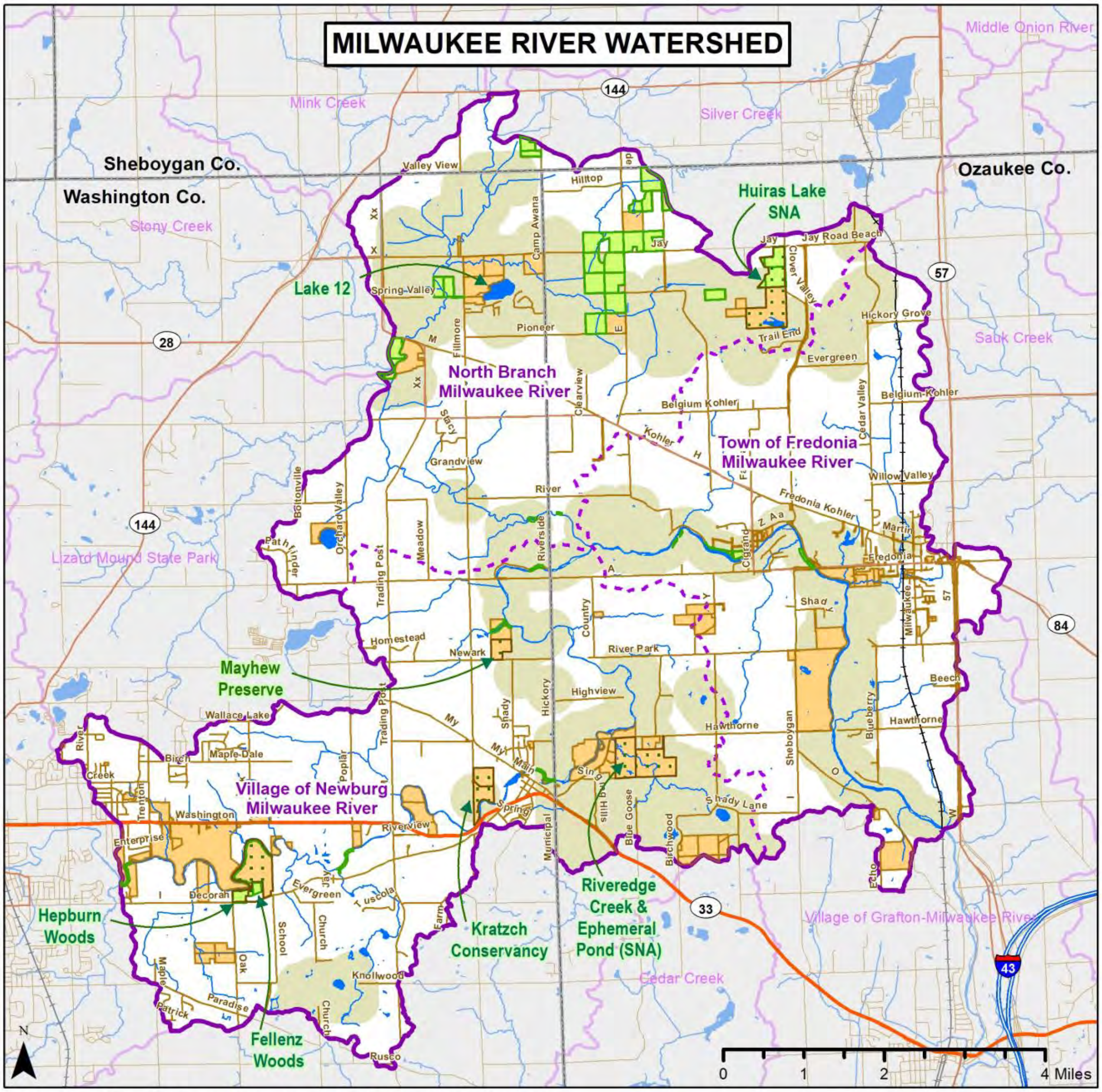
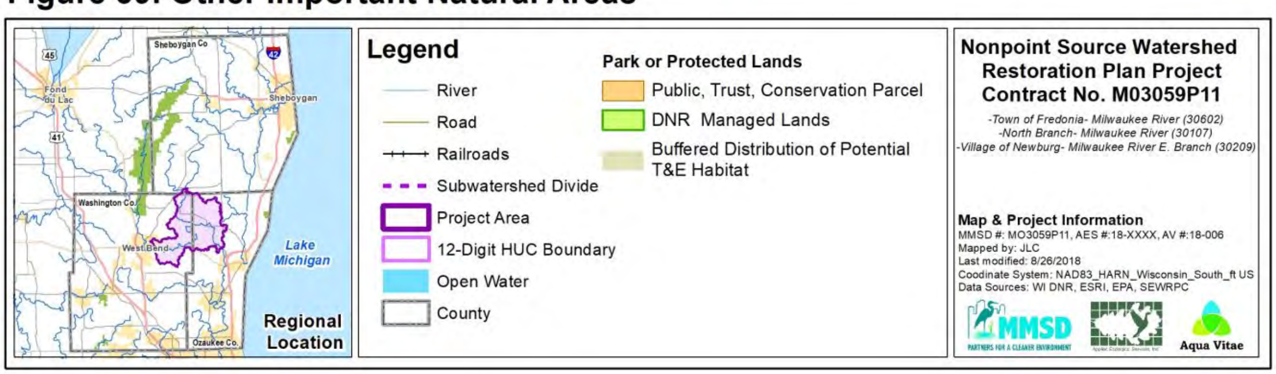


Figure 39. Other Important Natural Areas



Lake Twelve owned and managed by OWLT has a rich composition of native flora and fauna.

Lake Twelve has access for nonmotorized boats.

Riveredge Creek & Ephemeral Pond (SNA No. 197)

Riveredge Creek and Ephemeral Pond contains a slow, cold, hard water stream of exceptionally high water quality which supports a stable, diverse invertebrate community. Riveredge Creek's upper reach, consisting of three branches, has an invertebrate fauna dominated by the caddisfly (Molanna); the lower reach is dominated by Glossoma caddisflies; and the middle reach exhibits a diverse, extremely well-balanced fauna including at least five other species of caddisfly, stoneflies, mayflies, beetles, true bugs, flies (including blackflies), scuds, aquatic sow bug, and snails. This aquatic assemblage appears to be stable. The leaf litter is well processed, reflecting the productivity of shredders. The stream has a flow of 4 cubic feet per second, a dissolved oxygen content of 12 ppm (exceptionally high), and a temperature not known to exceed 65F. Two fen-like areas are associated with this complex. The forest is second-growth northern wet-mesic. The ephemeral pond is rich in plant and animal species including caddisflies, fairy shrimp, predacious diving beetles, backswimmers, and diptera (midges and true flies). The pond shrinks annually but dries up completely only during extreme droughts. Riveredge Creek and Ephemeral Pond is owned by Riveredge Nature Center, Inc (a nonprofit, privately owned environmental education facility) and was designated a State Natural Area in 1985 (WDNR 2018).

Riveredge Creek & Ephemeral Pond SNA #197 has beautiful stands of mature mixed hardwoods.

Boardwalk at Riveredge Nature Center (Source: Riveredge Nature Center)

Huiras Lake (No. 353)
Huiras Lake features a 26-acre pristine, hardwater seepage lake with an undeveloped shoreline contained within a larger wooded matrix. Plant communities include dry-mesic forest, mixed conifer and hardwood swamp, and a relict kettle bog. Located within a lowland hardwood swamp of black ash, the open water of the bog is surrounded by a narrow band of sphagnum moss and cattails and grades into shrub-carr and a tamarack-white cedar swamp. Several white pines are present and poison sumac is scattered throughout. Species include round-leaved sundew, pitcher plant, leather-leaf, huckleberry, small cranberry, round-leaved shinleaf, bog St. John's wort, and bogbean. Surrounding the eastern edge of the lake are extensive forested wetlands dominated by black ash, green ash, red maple, silver maple, yellow birch, paper birch, and basswood. Near the lake large tamarack and white cedar are co-dominant and the ground layer is patchy to continuous with a good diversity of both southern and northern species including Canada mayflower, yellow blue-bead-lily, jack-in-the-pulpit, and marsh fern. Pockets of mature mesic hardwoods with sugar maple, beech, red oak, basswood, and white pine are found to the south. The lush growth of emergent vegetation and partial seclusion make this an excellent waterfowl nesting and migration site. Additionally, the undeveloped nature of the site and its location within a rapidly urbanizing area make this site a highly valuable waterfowl and wildlife habitat site in the southeastern portion of Wisconsin. Huiras Lake is owned by the Ozaukee Washington Land Trust (OWLT) and DNR. It was designated a State Natural Area in 2002 (WDNR 2018, OWLT 2019).

Huiras Lake SNA #353 is tucked away in the hills of Town of Fredonia-Milwaukee River (Source: OWLT)

Fellenz Woods

Fellenz Woods is owned and managed by Ozaukee Washington Land Trust. Located in West Bend, it is 160 acres and includes virgin floodplain forest, lowland forest, and undeveloped riparian areas along the Milwaukee River in the Newburg watershed. Natural springs can be found within the preserve and it serves as valuable habitat for amphibians, birds and waterfowl. Ozaukee Washington Land Trust has been working to restore the portions of the property since 2002, including prairie restoration and ongoing management of invasive species (OWLT 2019).

Path within Fellenz Woods (Source: OWLT)

Kratzsch Conservancy

The Kratzsch Conservancy is a restored farm in Newburg that is owned and managed by Ozaukee Washington Land Trust. The preserve includes 73 acres of grasslands, woodlands, and wetlands, as well as some riparian areas along the Milwaukee River and includes examples of glacial remnant topography such as eskers, kettle depressions and kames. Various work has been done to restore this property and it is also home to OWLT's stewardship program and tree nursery (OWLT 2019).

Trails and topography of Kratzsch Conservancy (Source: OWLT)

Other Natural Areas

Located just north of Newburg and recently acquired by OWLT, Mayhew Preserve includes 71 acres of upland forests, lowland hardwood forests, conifer plantations, upland meadows, shrub carr, and wetlands, as well as riparian areas along the Milwaukee River (OWLT 2019). Hepburn woods in West Bend is also owned by OWLT and includes 20 acres highlighting glacial remnant topography such as glacial ridges and kettles. The hardwood forest is undergoing restoration and control of invasive species (OWLT 2019). Also owned by OWLT, Lake Twelve in the North Branch watershed consists of a 53-acre lake and 12 acres of land partially forested with yellow birch and tamarack (OWLT 2019).

3.14 Watershed Drainage System

3.14.1 Streams and Tributaries

Waterways such as streams and tributaries are a barometer of the health of their watersheds. The story of waterways, as with so many natural resources, has been one of exploitation and lack of understanding. Few waterways throughout the world have escaped pollution, channel modifications, and increased flooding as a result of mismanagement of development in the watershed (Apfelbaum & Haney 2010). Fortunately, many waterways can be restored if stressors in the watershed can be mitigated.

Streams in the three Fredonia-Newburg Area watersheds have seen many changes since European settlement in the mid-1800s. The results of the watershed field inventory suggest that alterations to streams and stream conditions have been subtle but also chronic and continual, from streams flowing through woodlands and wetlands and other high-quality natural areas to that of a highly agricultural setting. Some of these changes can be observed by looking at the pre-settlement stream mapping depicted on Figure 9 in Section 3.1.

<u>Stream Inventory</u>

In summer 2018, Applied Ecological Services, Inc. (AES) completed a field inventory of each of the primary streams in the Fredonia-Newburg Area watersheds. There are also numerous smaller secondary tributaries branching off many of the primary tributaries. However, mapping and describing all secondary tributaries is beyond the scope of this project.

Two important observations were made during the August/September 2018 field reconnaissance and inventory: 1) many streams in the watershed are intermittent and 2) the southern half of Wisconsin had just received an unprecedented amount of rainfall (~>500-year event). In intermittent stream systems, the stream may dry up entirely during dry periods that usually occur in summer and early fall. This was not the case during the sampling and while the water had come down significantly during the subsequent September 2018 site visits, the water was still very high. This concerned the field team for fear of sampling bias at first but the high water had an added benefit of seeing what streams looked like when they were "all online" and in some cases flooded/beyond bankfull, though it may have masked some of the channelization, erosion and headcutting damage (it would have been underwater at the time or concealed by vegetation), potentially under-portraying some of these issues.

All primary tributary streams were assessed based on divisions into "Stream Reaches" (Table 17; Figure 40). Reaches are defined as stream segments having similar hydraulic, geomorphic, riparian condition, and adjacent land use characteristics.

Methodology used in the stream inventory included walking portions of each stream reach, collecting measurements, taking photos, and noting channel, streambank, and riparian corridor conditions on Stream Inventory/BMP Data Forms. Detailed notes were also recorded related to potential Management Measure recommendations and their corresponding priority for eventual inclusion into the Action Plan section of this report. Results of the inventory can be found in Appendix C and in the Fredonia-Newburg Area watersheds GIS dataset.

Thirty (30) stream and tributary reaches (including distinct reaches of main branches) were identified, totaling 378,341 linear feet or 71.6 miles of stream were identified within the Fredonia-

Newburg Area watersheds (Table 17; Figure 40). This includes distinct reaches of the main stems of the Milwaukee River and the North Branch of the Milwaukee River. Each stream and tributary was assigned a unique stream reach code. The main stem of the Milwaukee River was divided into 7 reaches, 4 of which fall in the Village of Newburg watershed, with the remaining 3 falling in the Town of Fredonia watershed. These reaches range is size from 10,766 to 32,682 linear feet. The North Branch Milwaukee River was divided into 3 reaches, ranging in size from 15,430 to 19,980 linear feet.

Of the 20 tributaries, Tr6 (also called Fredonia Creek) which is located in the eastern portion of the watershed, is the longest at approximately 24,441 linear feet or about 4.6 miles. Tributaries Tr13 and Tr19, the second and third longest streams in the watershed, are 16,208 linear feet (3.07 miles) and 14,218 linear feet (2.69 miles) respectively. The remaining 17 streams account for a total of 139,917 linear feet or 26.5 miles. Stream conditions vary greatly depending on their location, surrounding land uses, ownership, etc.

Table 17. Summary of stream and tributary reaches and length.

Stream Reach Name	Stream Reach Code	Linear Feet	HUC 12
North Branch Milwaukee River, Reach 1	NBR1	15,430	North Branch
North Branch Milwaukee River, Reach 2	NBR2	19,980	North Branch
North Branch Milwaukee River, Reach 3	NBR3	18,620	North Branch
Tributary 1a	Tr1a	8,513	North Branch
Tributary 1b	Tr1b	4,727	North Branch
Tributary 2	Tr2	8,273	North Branch
Tributary 3	Tr3	13,542	North Branch
Tributary 4	Tr4	8,253	North Branch
Tributary 5	Tr5	7,413	North Branch
Tributary 8	Tr8	6,746	North Branch
Milwaukee River, Reach 5	MR5	13,137	Fredonia
Milwaukee River, Reach 6	MR6	19,309	Fredonia
Milwaukee River, Reach 7	MR7	10,766	Fredonia
Tributary 13	Tr13	16,208	Fredonia
Tributary 14	Tr14	6,600	Fredonia
Tributary 6, Fredonia Creek	Tr6	24,441	Fredonia
Tributary 7	Tr7	12,031	Fredonia
Milwaukee River, Reach 1	MR1	32,682	Newburg
Milwaukee River, Reach 2	MR2	18,953	Newburg
Milwaukee River, Reach 3	MR3	19,693	Newburg
Milwaukee River, Reach 4	MR4	14,985	Newburg
Tributary 9	Tr9	3,146	Newburg
Tributary 10	Tr10	7,845	Newburg
Tributary 11	Tr11	7,605	Newburg
Tributary 12	Tr12	12,056	Newburg
Tributary 15	Tr15	6,939	Newburg
Tributary 16	Tr16	8,474	Newburg
Tributary 17	Tr17	11,810	Newburg
Tributary 18	Tr18	3,765	Newburg
Tributary 19	Tr19	14,218	Newburg
Tributary 20	Tr20	2,180	Newburg

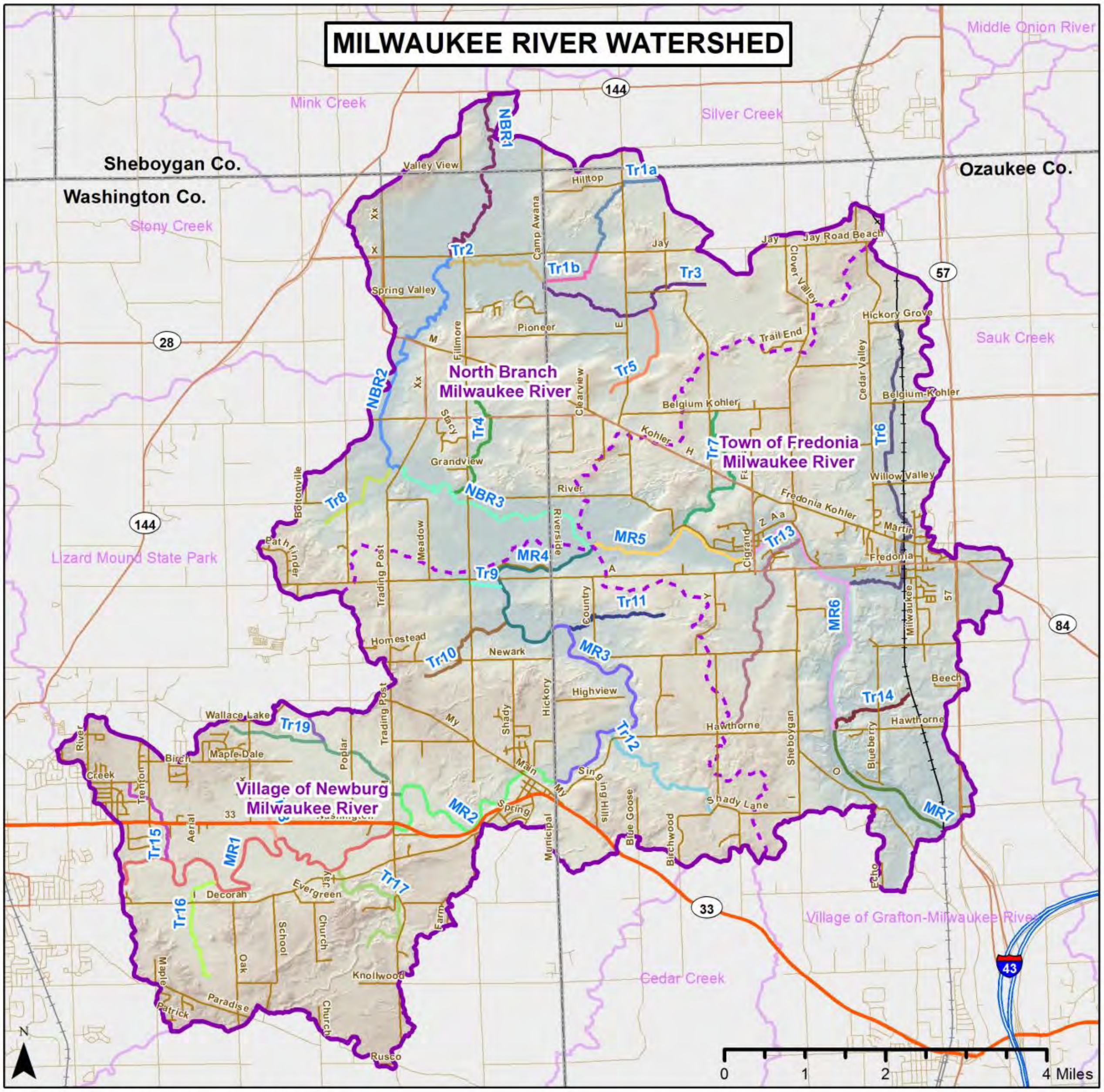
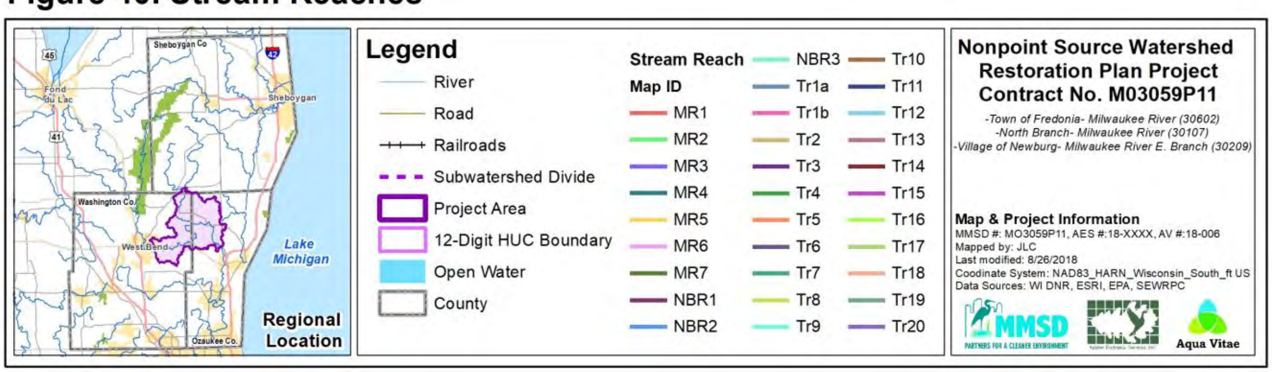


Figure 40. Stream Reaches



Milwaukee River

The Milwaukee River was broken into seven reaches, with Reaches MR1 through MR4 falling in the Newburg watershed and Reaches MR5 through MR7 flowing through the Fredonia watershed (Figure 40, Table 17). These reaches travel along areas that are generally characterized as a mix of urban/suburban and agricultural areas. Additionally, there are 14 tributaries that drain to the Milwaukee River. Tributaries Tr9-Tr12 and Tr15-Tr20 in the Newburg watershed collectively drain the east edge of the city limits of the City of West Bend and parts surrounding the Village of Newburg. Another 4 tributaries drain to the Milwaukee River in the Fredonia watershed, including Tr 6, also known as Fredonia Creek, Tr 7, Tr13, and Tr14.

Milwaukee River Reach 1 (MR1)

Milwaukee River Reach 1 (MR1, 32,682 lf) extends from the westernmost portion of the watershed in West Bend to County Rd M west of Newburg. Milwaukee River Reach 2 (MR2) continues for 18,953 lf from there to Hickory Rd in Newburg. Milwaukee River Reach 3 (MR3, 19,693 lf) winds to the east of Hickory Rd to meander back to where it crosses Hickory Rd a second time north of E Newark Rd. Milwaukee River Reach 4 (MR4) continues east and north for 14,985 lf to the confluence with the North Branch Milwaukee River north of County Hwy A. Reaches MR1 through MR4 all have very similar conditions, exhibiting no channelization, average riparian area conditions, and minimal to no buffers. The lack of channelization is likely due to the difficulties in manipulating streams of this size. The lack of substantial buffers reflects development pressures and a lack of riparian area management. Bank erosion on these tributaries is relatively limited, with the upper two

Milwaukee River Reach 3 (MR3)

reaches being stable while MR3 and MR4 are moderately stable. Common species found along the banks and floodplain include silver maple, willows some green & white ash.

Milwaukee River Reach 6 (MR6) at Waubedonia Park

Reaches MR5 through MR7 continue from the confluence of the Milwaukee River and the North Branch Milwaukee River, to the outlet of the watershed south of Fredonia. Reach MR5 flows east for 13,137 lf from the confluence to Cigrand Dr in Waubeka. From there Reach MR6 (19,309 lf) takes a sharp turn south, through Waubedonia Park, to Hawthorne Dr. The final reach of the Milwaukee River, MR7, continues to flow south for 10,766 lf from Hawthorne Dr. to the outlet, roughly where the River crosses the Wisconsin and Southern Railroad. Reaches MR5 through MR7 all show more variation in conditions than upstream reaches. Reach MR5 is moderately channelized, having road beds along a good portion of this stretch that prohibit further meandering, as well as moderately stable. Reach MR6 shows no signs of channelization and is stable and both reaches MR5 and MR6 have riparian areas in good condition, with healthy maple, oak, willow riparian woods along the banks of MR6. Reach MR7 shows low levels of channelization and erosion, with an average quality riparian area.

Tributary 6 (Tr6) / Fredonia Creek

Tributary 6 (Tr6), also identified as Fredonia Creek, is by far the longest tributary in the watershed at 24,441 lf. This tributary begins near the northeastern most portion of the watershed and flows south along portions of the Wisconsin and Southern Railroad to Fredonia, where it makes a hard, westerly turn to join the Milwaukee River in Waubedonia Park. Tributary 6 is highly channelized, with the channel confined between the railroad bed and road beds for much of its length; it is moderately stable with a riparian area in poor condition, due to the fact that it is both heavily manipulated and urbanized relative to other portions of the watershed.

The remaining tributaries to the Milwaukee River range in size from 2,180 to 14,218 lf and include Tributaries Tr 7 and Tr9 through Tr20. Many of these tributaries share the same general ailments of invasive species, overgrown canopies and some undesirable native trees of low quality and poor ecological value (box elders, dead green ash, etc.) along with reed canary grass. Tributary 16 (Tr16, pictured right) is representative of some of the challenges many of the tributaries of the Milwaukee River face - agricultural pressures and invasive species overrunning to the point that first or second order streams are often hard to locate during the summer growing season (the stream channel here is the dark shadowed area center-right).

Tributary 16 (Tr16)

North Branch Milwaukee River

North Branch Reach 1 (NBR1, 15,430 lf) is in the northernmost portion of the watershed. This stream reach exemplifies the streams that weave through the rolling hills of the North Branch watershed. It flows south to Jay Rd, and while it is relatively low gradient, it is slowed from time to time by forested floodplain wetlands consisting primarily of silver maples. This reach is in very good shape with stable banks, moderate channelization, and with riparian areas that are reasonably healthy. The exception to this here and elsewhere is the drastic loss of the ash canopy (primarily green and white as *Fraxinus spp*). This event decimated ash trees throughout the Midwest just a few years ago because of the invasive Emerald Ash Borer (EAB), a beetle that bores into the tree resulting in almost 100% mortality within 3-5 years. It is unclear whether any negative impacts related to water quality erosion, or changes to habitat are associated with EAB

North Branch Milwaukee River Reach 1 (NBR1) infestation. Watershed BMPs to address the impacts of EAB infestation include forest management efforts such as removing dead and dying ash trees and planting and otherwise encouraging the growth of other native species of trees. These management efforts are important because the increased light penetration resulting from the loss of forest canopy can result in colonization of the area by undesirable woody and herbaceous invasive species.

North Branch Reach 2 (NBR2) begins at Jay Rd, crosses Kohler Road and Belgium-Kohler Road along the far western edge of the watershed boundary to end at Trading Post Rd (Co Hwy XX). The North Branch here is much larger as it flows south for 19,980 lf, gaining the character of more of a river than that of a larger stream. It is approximately 30-40 ft wide with a silver maple canopy lining the edges. The decaying ash canopy is evident throughout its course. This reach is moderately channelized, moderately stable, with a riparian area in good condition.

North Branch Milwaukee River Reach 3 (NBR3)

North Branch Reach 3 (NBR3) flows east for 18,620 lf from Trading Post Rd to the confluence with the Milwaukee River. Very similar in characteristics to NBR2, this reach is moderately channelized, moderately stable, with a riparian area in good condition. NBR3 is lined with floodplain forest trees for its entire course.

The North Branch Milwaukee River receives five tributaries from the east (Tr1a, Tr1b, Tr2 through Tr5, and Tr8) totaling approximately 57,467 lf and ranging in size from 4,727 to 13,542 lf. These tributaries, on average, are generally moderately channelized, moderately stable, and have riparian areas in average condition. The substrate in these tributaries consists primarily of gravel which is not silted in. Most of these tributaries have well-vegetated banks that meander through hills and woodlands with average quality riparian buffers consisting of destroyed ash canopy and hybridized invasive cattail *(Typha spp)*."

Left: Tr1 and many of its sister tributaries are ecologically fair quality intact stream systems. Right: A low-quality wetland in the foreground catches the eye but hides the decimated ash canopy in the background at Tr5

Stream Channelization

Naturally meandering streams generally provide riffles and pools that benefit the system by creating habitats while oxygenating the water during low flow or summer heat. Channelized or ditched streams often lack or have poorly developed riffles and pools. Berms along channelized streams are often common where landowners deposited soils excavated from the channel. These spoil piles often inhibit or alter natural flooding into adjacent floodplains.

It is important to understand that although some of the images that represent each of the three HUC 12 watersheds give the appearance that channelization at that given point was not an issue, a closer look of a map showed highly altered/straightened reaches that were not accessed (private lands). Therefore, it is important to understand that a degree of judgment and field expertise was necessary to derive these data. Practically speaking, looking down on a valley and seeing a half-mile or so of dead ash canopy along a stream that was straight along the edge of an agricultural field that correlated with a stream that appeared straight on the map was characterized accordingly.

Each stream reach in the Fredonia-Newburg Area watersheds was characterized as either having none or low channelization (highly sinuous, no human disturbance), moderate channelization (some sinuosity but altered), or highly channelized (straightened by humans) (Table 18; Figure 41). According to the stream inventory, North Branch Milwaukee River is classified as 30% highly channelized, 56% moderately and 14% with no channelization. Town of Fredonia-Milwaukee River is classified as 24% highly channelized, 44% low, 13% moderate and 19% with no channelization. Village of Newburg-Milwaukee River is classified as 15% highly channelized, 6% low and 5% moderately and 73% with little or no channelization, suggesting that while this portion of the watershed has its water quality challenges, channelization is much less significant than the other two branches. This is likely due to agricultural impacts in North Branch Milwaukee River and Town of Fredonia Milwaukee River in addition to both of those systems being higher gradient, draining the hills and exacerbating channelization. Most noteworthy is Tr6 (Fredonia Creek, pictured right), just north of Fredonia along the railroad grade that most severe channelization is found.

Channelized areas present opportunities for Management Measure projects such as artificial riffle and pool restoration and regrading or breaking of adjacent spoil piles for reconnection of the stream to adjacent floodplains. The Action Plan section of this report addresses opportunities for improving many of the channelized reaches.

Table 18. Summary of stream and tributary channelization.

HUC12/Degree of Channelization	Linear Feet	Pct of HUC 12
North Branch Milwaukee River	**111,498**	**100%**
High	33,956	30%
Moderate	62,283	56%
None	15,260	14%
Town of Fredonia Milwaukee River	**102,491**	**100%**
High	24,441	24%
Moderate	13,137	13%
Low	45,604	44%
None	19,309	19%
Village of Newburg Milwaukee River	**161,206**	**100%**
High	24,923	15%
Moderate	8,474	5%
Low	10,025	6%
None	117,784	73%

Native Jewelweed found along streambanks on the North Branch-Milwaukee River

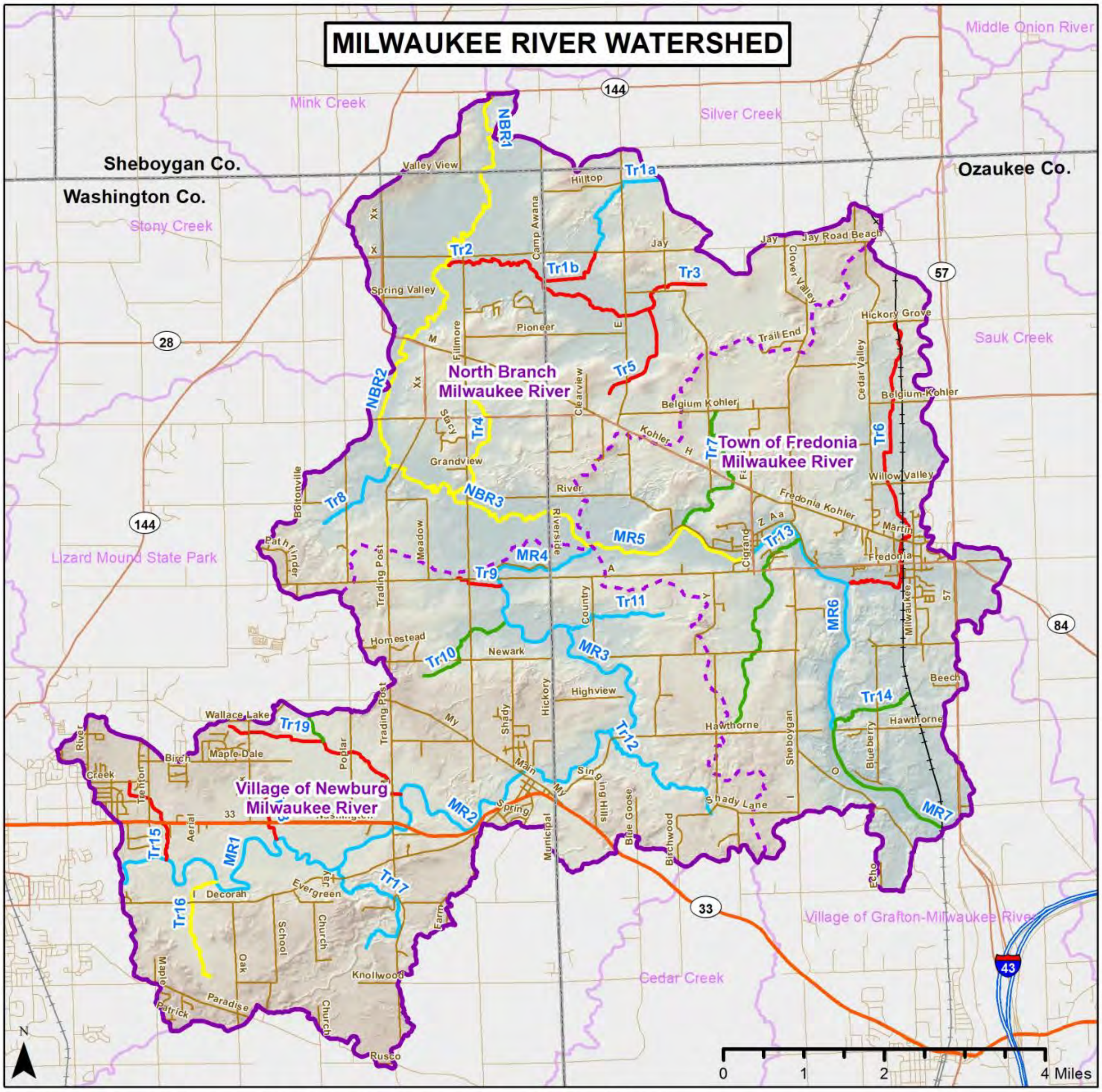
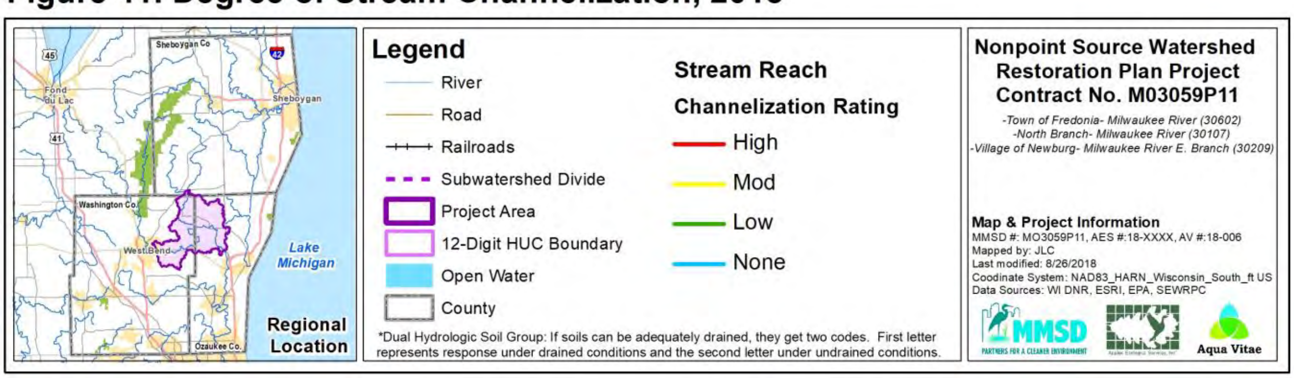


Figure 41. Degree of Stream Channelization, 2018



Streambank Erosion

Unnatural streambank erosion generally occurs following an instability in flow rate or volume in the stream channel, human alteration such as channelization, or change in streambank vegetation. Resulting sediment transportation downstream can cause significant water quality problems. During the inventory process, streams were assessed for levels of erosion. Reaches in which less than 5% of the banks were affected by erosion were considered Stable. Reaches in which at least 5% but less than 33% of the banks had areas of erosion were considered Moderately Stable. Reaches in which at least 33% but less than 66% of banks had areas of erosion were considered Moderately Unstable. Reaches in which 66% or more of the banks had areas of erosion were considered Unstable.

Streambank erosion is stable to moderately stable on average throughout the watershed but becomes moderately unstable along Tributaries Tr19 and Tr8 in the Village of Newburg and North Branch Milwaukee River watersheds, respectively. Due to the generally undeveloped nature of the watershed and the lack of impervious surfaces, excessive streambank erosion in not currently an issue watershed-wide; there are no reaches within the watersheds that were categorized as unstable or highly eroded.

The location and severity of streambank erosion in the watershed is summarized in Table 19 and depicted on Figure 42. Within the North Branch, Town of Fredonia, and Village of Newburg watersheds respectively, approximately 21% (23,944 lf), 36% (36,675 lf), and 56% (90,951 lf) of the total stream lengths exhibit stable banks while moderately stable conditions occur along 72% (80,808 lf), 64% (65,816 lf), and 35% (26,036 lf) of streambanks. Moderately unstable streambanks account respectively for 6% (6,746 lf), 0%, and 9% (14,218 lf) of the total stream length.

Moderately stable or moderately unstable streambanks provide excellent opportunities for streambank or riparian are restorations. The Action Plan section of this report addresses and prioritizes opportunities for reducing streambank erosion.

Table 19. Summary of stream and tributary bank erosion.

HUC12/Degree of Erosion	Linear Feet	Pct of HUC 12
North Branch Milwaukee River	**111,498**	**100%**
Moderately unstable; 33-66% of banks have areas of erosion.	6,746	6%
Moderately stable; 5-33% banks have areas of erosion.	80,808	72%
Stable; less than 5% of banks affected.	23,944	21%
Town of Fredonia Milwaukee River	**102,491**	**100%**
Moderately stable; 5-33% banks have areas of erosion.	65,816	64%
Stable; less than 5% of banks affected.	36,675	36%
Village of Newburg Milwaukee River	**161,206**	**100%**
Moderately unstable; 33-66% of banks have areas of erosion.	14,218	9%
Moderately stable; 5-33% banks have areas of erosion.	56,036	35%
Stable; less than 5% of banks affected.	90,951	56%

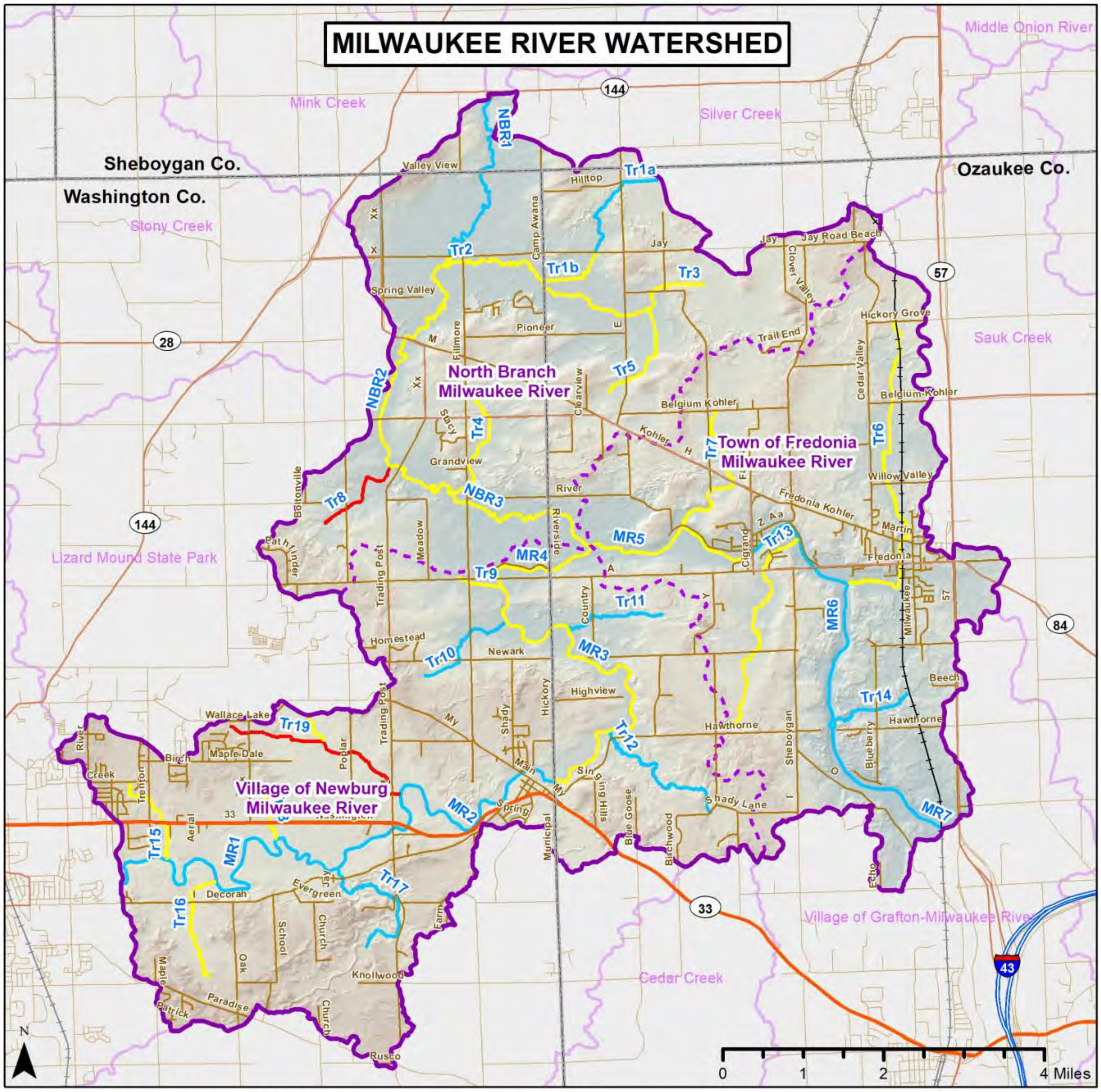
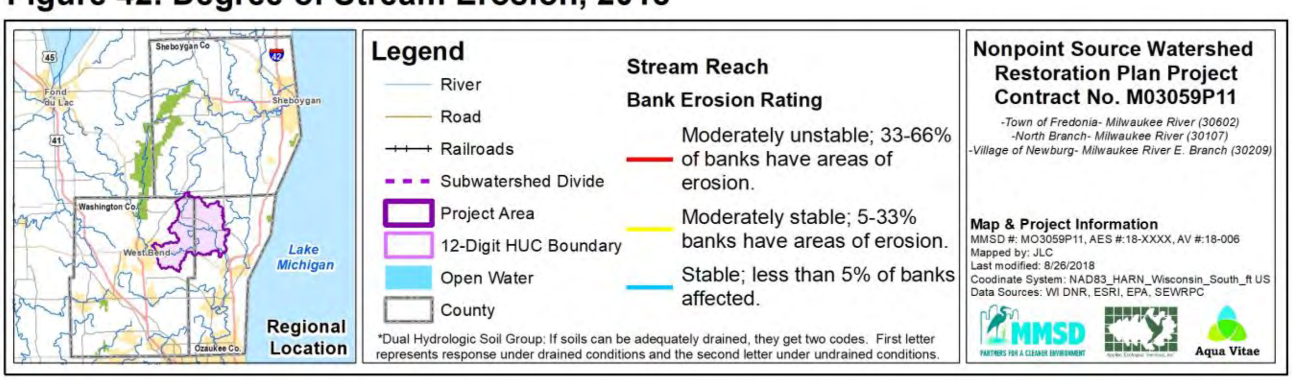


Figure 42. Degree of Stream Erosion, 2018



Riparian Area Condition

Riparian areas that are in good ecological condition buffer streams by filtering pollutants, providing beneficial wildlife habitat, and connecting green infrastructure. Riparian areas along streams were assessed during the stream inventory by noting their ecological condition related to functionality, the quality of their plant communities, and their hydrologic connection with the stream. Areas in "Good" condition connect hydrologically with streams during flood events and have remnant native plant communities. "Average" condition riparian areas retain some hydrological connection to the adjacent stream with somewhat degraded plant communities. Areas in "Poor" condition are usually found along channelized streams that have been intensively farmed causing degraded plant communities to establish or where riparian buffers are non-existent.

Example of non-existent riparian areas on a stream

The location and condition of riparian areas in the watershed is summarized in Table 20 and Figure 43. Within the North Branch, Town of Fredonia, and Village of Newburg watersheds respectively, approximately 33%, 32%, and 7% of the riparian areas are in "Good" ecological condition, 41%, 11%, and 71% are in "Average" ecological condition, and 7%, 58%, and 22% are in "Poor" condition. The best riparian areas are found along the main branch of the Milwaukee River (MR5, MR6) and the North Branch Milwaukee River (NBR1-3) where floodplains are relatively intact and remnant woodlands persist. There are several common attributes of riparian areas in poor condition. All are associated with past or present development and farming. Some are narrow and degraded by invasive species including reed canary grass (*Phalaris arundinacea*), buckthorn (*Rhamnus sp.*), honeysuckle (*Lonicera sp.*), and box elder (*Acer negundo*), while others are missing entirely. Fortunately, ecological restoration or the establishment of buffers helps eradicate invasive species and encourages native plant establishment. The Action Plan lists and prioritizes opportunities for improving riparian areas.

Table 20. Summary of stream and tributary riparian area condition.

HUC12/Rank Riparian Condition	Linear Feet	Pct of HUC 12
North Branch Milwaukee River	**111,498**	**100%**
Poor	7,413	7%
Ave	45,327	41%
Good	58,758	53%
Town of Fredonia Milwaukee River	**102,491**	**100%**
Poor	59,279	58%
Ave	10,766	11%
Good	32,446	32%
Village of Newburg Milwaukee	**161,206**	**100%**
Poor	35,577	22%
Ave	113,819	71%
Good	11,810	7%

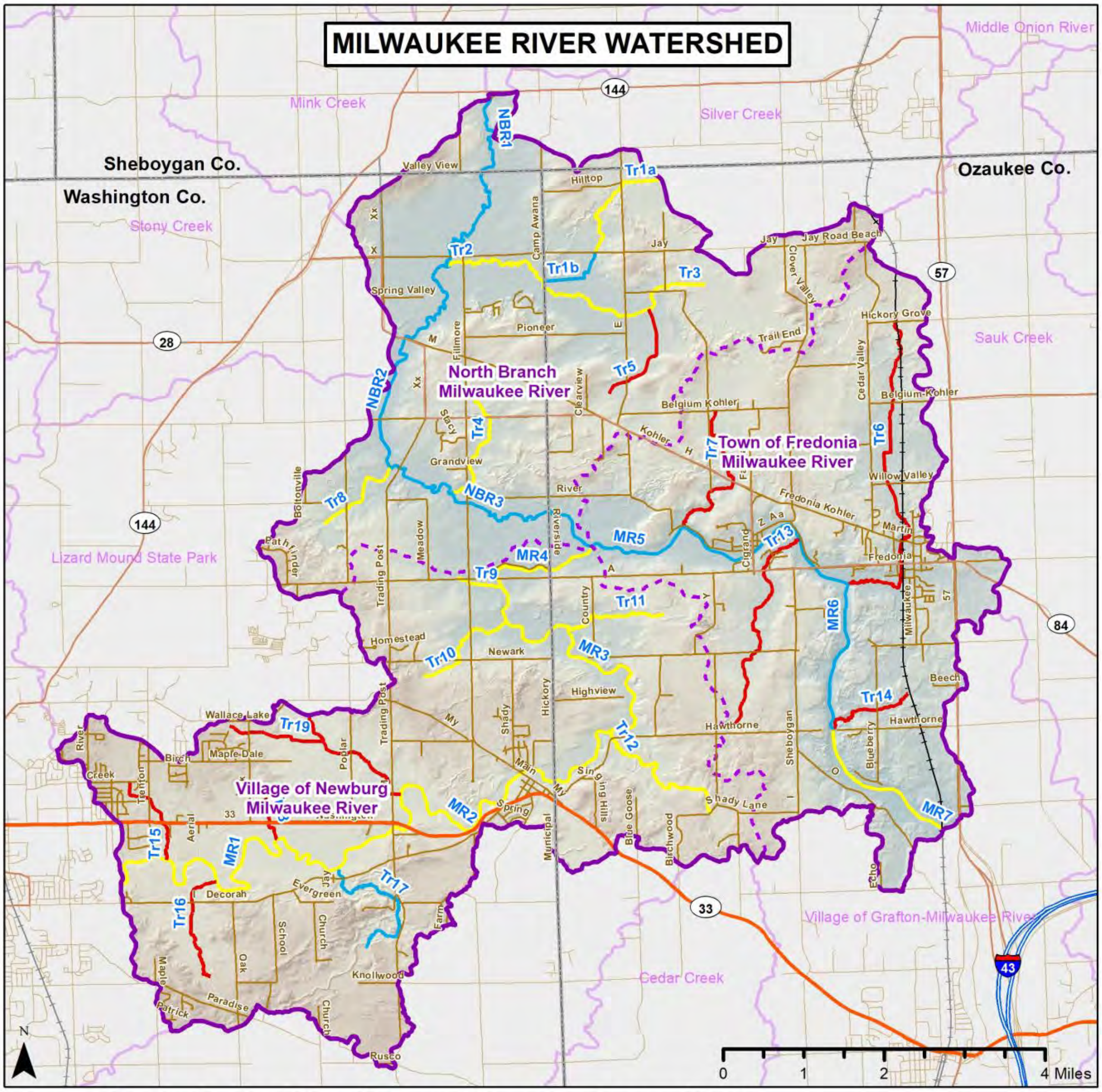
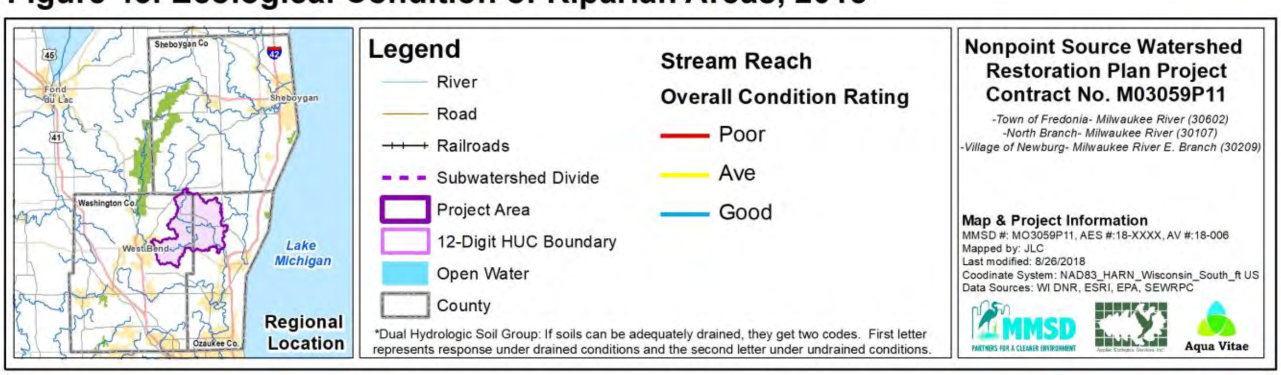


Figure 43. Ecological Condition of Riparian Areas, 2018



3.14.2 Wetlands & Potential Wetland Restoration Sites

Wetlands are a crucial part of the earth's hydrologic system, receiving water from snowmelt and rain and slowly releasing it from the land to recharge streams and lakes (Apfelbaum & Haney 2010). Functional wetlands do more for water quality improvement and flood reduction than any other natural resource. In addition, wetlands typically provide habitat for a wide variety of plant and animal species. They also provide some groundwater recharge capabilities and filter sediments and nutrients. A diverse network of wetlands remained intact in the Fredonia-Newburg Area watersheds until the late 1800's when European settlers began to alter significant portions of the watersheds' natural hydrology and wetland processes. Where it was feasible, wetlands were drained, streams channelized, and existing vegetation cleared to farm the rich soils.

Identification of historical wetland acreage is difficult due to inconsistencies in the methods employed by surveyors in the 1800s and differences in the definitions of what constitutes a wetland. By cross-referencing historical surveys of vegetative cover with the locations of hydric soils within the region, it was estimated that there were approximately 18,171 acres (39%) of wetlands across all three watersheds prior to European settlement. According to existing wetland inventories, about 8,441 acres or 46% of the pre-European settlement wetlands remain (Figure 44). The largest loss of wetlands occurred along WI-57 corridor in the eastern portion of the watershed and in the areas near West Bend. The remainder of wetland loss is scattered throughout the watershed where small wetlands could be readily drained for settlement. Early vegetation mapping suggests this area was lowland hardwoods and swamp conifers. The largest wetland complexes adjacent to the Milwaukee River floodplains, especially in the North Branch watershed, remain intact.

Existing wetland information and mapping is available for the entire Fredonia-Newburg Area watersheds via the 2005 Regional Wetland Inventory and 2005 Advanced Identification of Disposal Areas (ADID) Wetland Inventory conducted by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) in conjunction with the Wisconsin Department of Natural Resources (WDNR). The wetland features were delineated according to the definitions of the Wisconsin Wetland Inventory Classification Guide, with the addition of special features such as drained wetlands and drainage ditches. ADID wetlands and waters include all aquatic resources located within Primary Environmental Corridors and natural areas as identified by SEWRPC and categorized as either "Wetlands", "Lakes/Ponds", or "Natural Area Wetlands". "Other Wetlands" are located outside Primary Environmental Corridors. Of the 9,204.3 total acres of wetlands in Fredonia-Newburg Area watersheds, 7,325.3 acres have been identified as ADID wetlands by SEWRPC (Table 21; Figure 44). The remaining 1879.0 acres consist of "Other Wetlands".

Table 21. Fredonia-Newburg Area watersheds ADID wetlands.

Wetland Category	Acres	Wetland Attributes
ADID Wetlands	7,325.3	The intersection of 2005 wetlands and primary environmental corridors as defined by SEWRPC
Other Wetlands	1,879.0	Additional wetlands outside of the SEWRPC primary corridors that are to be protected

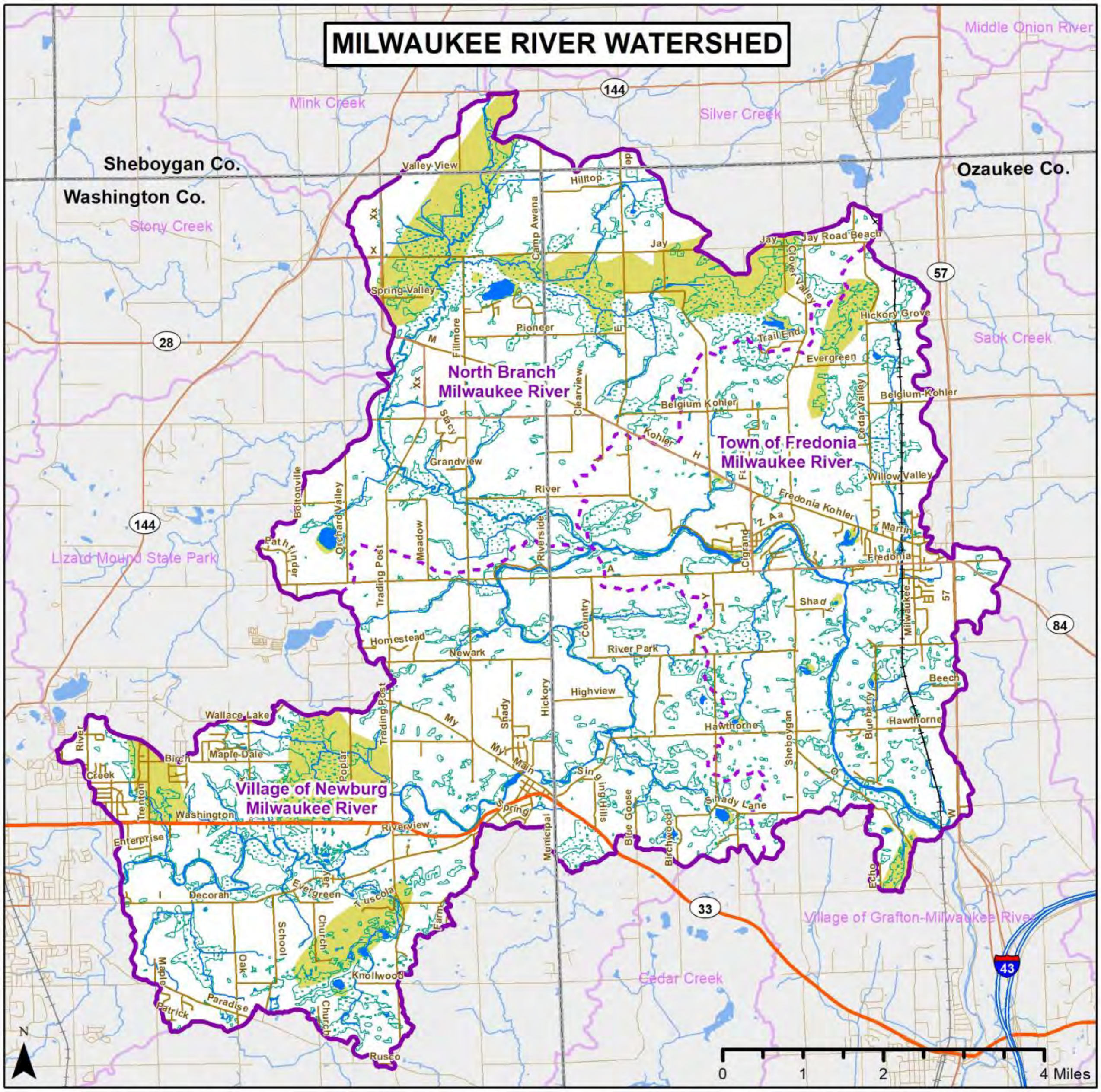
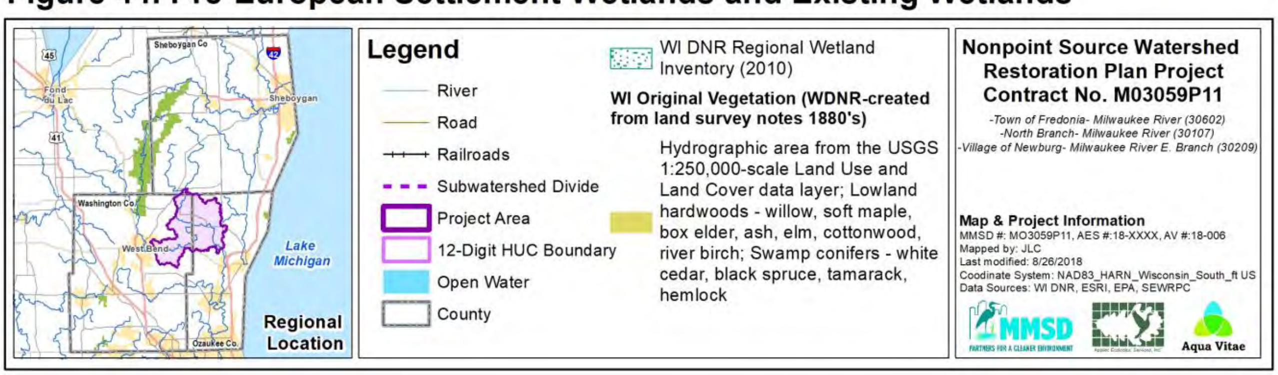


Figure 44. Pre-European Settlement Wetlands and Existing Wetlands



Most existing wetlands in the Fredonia-Newburg Area watersheds are concentrated around stream reaches and are relatively small and fragmented. Many of the existing wetlands were inspected by Applied Ecological Services, Inc. in summer of 2018 during reconnaissance of the watershed. Most have been negatively impacted by farming and other human practices at some point in the last 150 years to the extent that hydrology has changed and invasive species such as narrow leaved cattail (*Typha angustifolia*), common and glossy buckthorn (*Rhamnus sp.),* reed canary grass (*Phalaris arundinacea*), and common reed (*Phragmites australis*) now dominate.

Some of the largest existing wetland complexes can be found near the headwaters of the North Branch - Milwaukee River watershed.

Potential Wetland Restoration Sites

Wetland restoration projects are among the most beneficial in the context of improving watershed health. Wetlands are vitally important because they improve basic environmental functions such as storing floodwaters, increasing biodiversity, creating green infrastructure, and improving water quality. The wetland restoration process involves returning hydrology (water) and vegetation to soils that once supported wetlands but no longer do because of human impacts such as tile or ditch draining and/or filling. Potential wetland restoration sites were identified using a Geographic Information Systems (GIS) exercise whereby sites were selected that include at least 10 acres of drained hydric soils located on an open or partially open parcel where no wetlands currently exist.

The GIS exercise resulted in 29 sites (Table 22) meeting the above criteria, ranging in size from 10.1 acres to 86.4 acres. As seen in Figure 45, many of the larger sites are within the North Branch Milwaukee River Watershed, with a few scattered in the Village of Newburg watershed. The remainder of small sites are scattered throughout the watersheds. It is important to note that a feasibility study beyond the scope of this project and will need to be completed prior to the planning and implementation of any potential wetland restoration. Where future development or land use changes are planned where these sites are located, municipalities should strongly consider requiring "Conservation" or "Low Impact Design" development that incorporates wetland restoration.

Another potential option is to restore large wetland complexes as part of a wetland mitigation bank. In this case, wetlands are restored on private or public land and must meet certain performance criteria before they become "fully certified." Following certification, developers are able to buy wetland mitigation credits from the wetland bank for wetland impacts occurring elsewhere in the watershed. A fully certified acre of restored wetland can sell between $40 and $100 thousand dollars. Although this may seem like an enormous expense to a developer, it is often cheaper than going through a long permitting process to impact wetlands and provide mitigation on the development site. It is also possible that entities such as wastewater treatment plants could purchase water quality trading credits from wetland mitigation banks as a way to offset phosphorus in plant effluent.

Table 22. Potential wetland restoration sites.

Site ID	Acres	HUC12 Watershed
1	69.5	North Branch Milwaukee River
2	86.4	North Branch Milwaukee River
3	11.7	North Branch Milwaukee River
4	11.5	North Branch Milwaukee River
5	10.8	North Branch Milwaukee River
6	19.8	North Branch Milwaukee River
7	13.8	North Branch Milwaukee River
8	39.4	North Branch Milwaukee River
9	12.5	North Branch Milwaukee River
10	13.3	North Branch Milwaukee River
11	21.5	North Branch Milwaukee River
12	19.9	North Branch Milwaukee River
13	11.6	Town of Fredonia Milwaukee River
14	13.2	North Branch Milwaukee River
15	10.6	North Branch Milwaukee River
16	10.1	Village of Newburg Milwaukee River
17	14.8	Village of Newburg Milwaukee River
18	10.4	Village of Newburg Milwaukee River
19	13.9	Village of Newburg Milwaukee River
20	10.4	Village of Newburg Milwaukee River
21	17.8	Village of Newburg Milwaukee River
22	14.8	Village of Newburg Milwaukee River
23	17.9	Village of Newburg Milwaukee River
24	49.6	Village of Newburg Milwaukee River
25	11.0	Village of Newburg Milwaukee River
26	10.3	Village of Newburg Milwaukee River
27	57.1	Village of Newburg Milwaukee River
28	18.0	Village of Newburg Milwaukee River
29	11.3	Town of Fredonia Milwaukee River

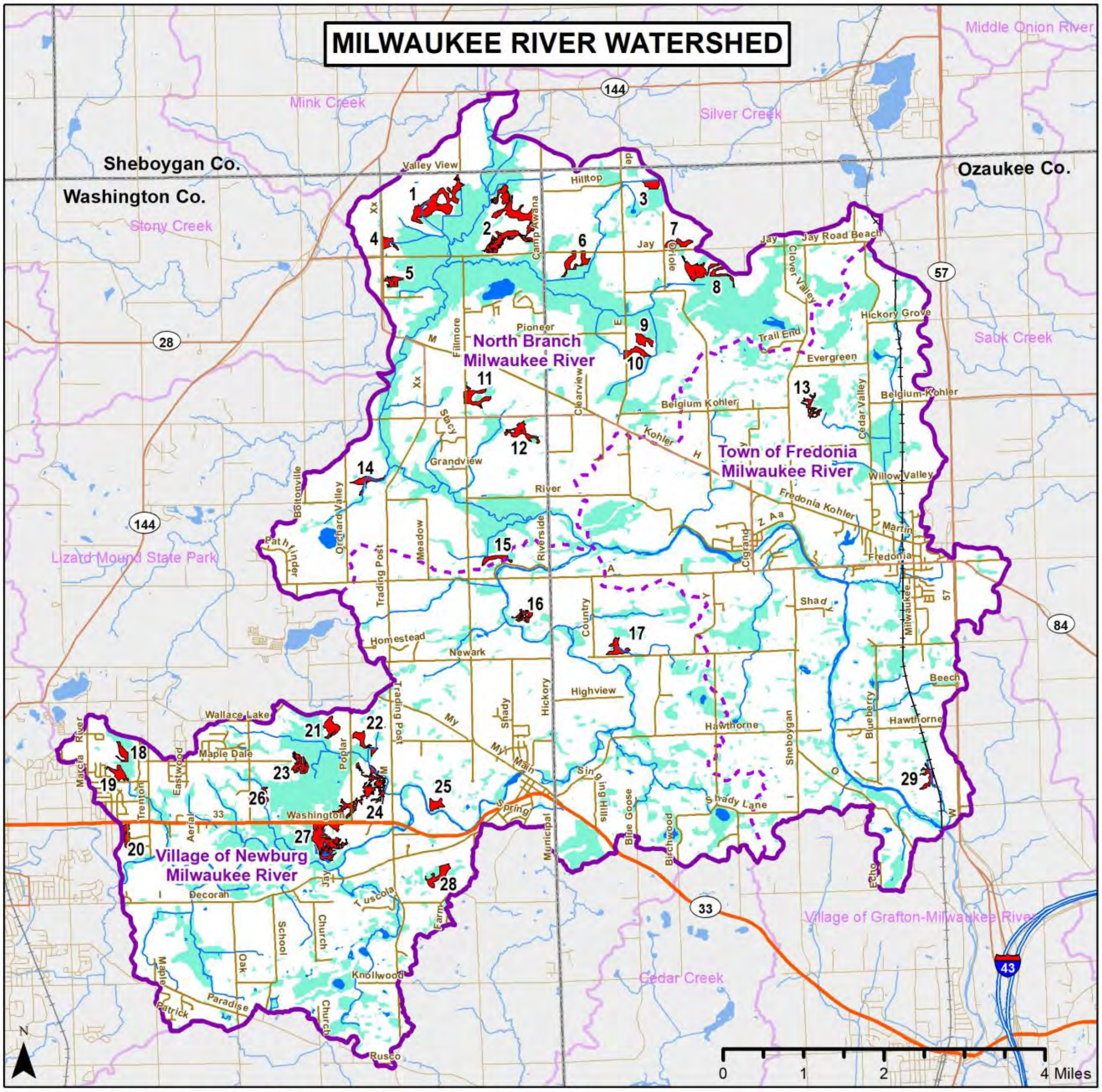
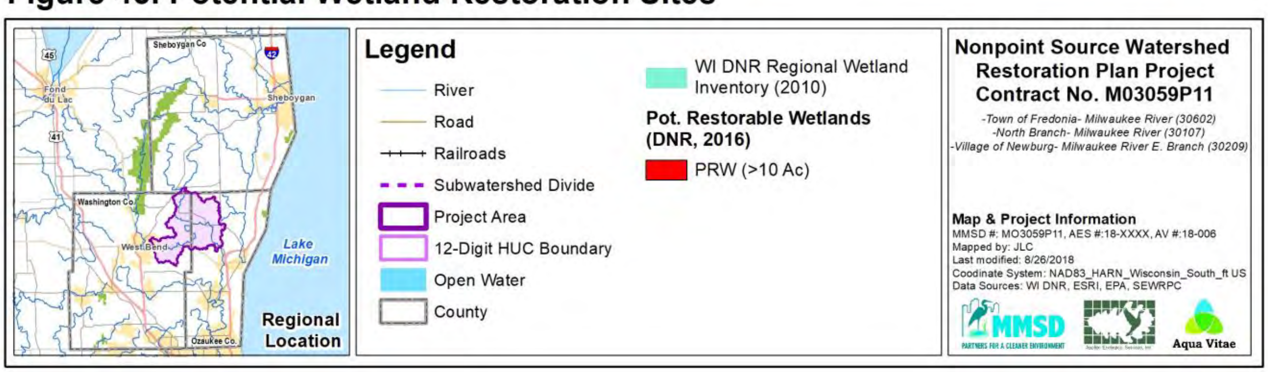


Figure 45. Potential Wetland Restoration Sites



3.14.3 Floodplain

FEMA 100-Year Floodplain

Functional floodplains along stream, river, and lake corridors perform a variety of green infrastructure benefits such as flood storage, water quality improvement, passive recreation, and wildlife habitat. The most important function however is the capacity of the floodplain to hold water following significant rain events to minimize flooding downstream. The 100-year floodplain is defined by the Federal Emergency Management Agency (FEMA) as the area that would be inundated during a flood event that has a one percent chance of occurring in any given year (100-year flood). 100-year floods can and do occur more frequently, however the 100-year flood has become the accepted national standard for floodplain regulatory and flood insurance purposes and was developed in part to guide floodplain development to lessen the damaging effects of floods.

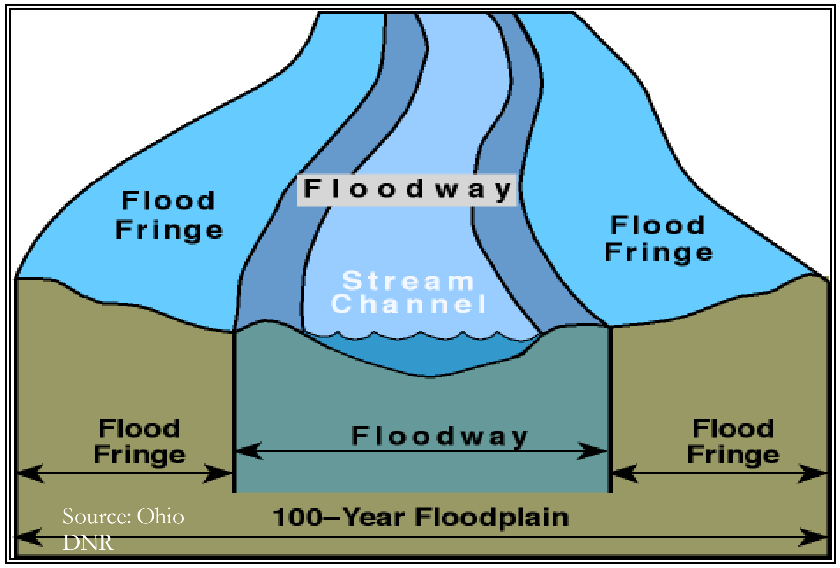


Figure 46. 100-year floodplain and floodway depiction along streams.

The 100-year floodplain along streams also includes the floodway. The floodway is the portion of the stream or river channel that comprises the adjacent land areas that must be reserved to discharge the 100-year flood without increasing the water surface. Figure 46 depicts the 100-year floodplain and floodway in relation to a hypothetical stream channel.

Figure 47 depicts the FEMA Flood Hazard Boundaries, including the 100-year floodplain, in the Fredonia-Newburg Area watersheds which occupies 3,412 acres (24%), 1,313 acres (9%), and 3,420 acres (18%) of the North Branch, Town of Fredonia, and Village of Newburg watersheds respectively. The most extensive floodplain areas are associated with the lowland areas in the northern North Branch watershed and central Village of Newburg watershed. Other floodplain areas have been delineated throughout the lower reaches of the Milwaukee River near the Village of Newburg.

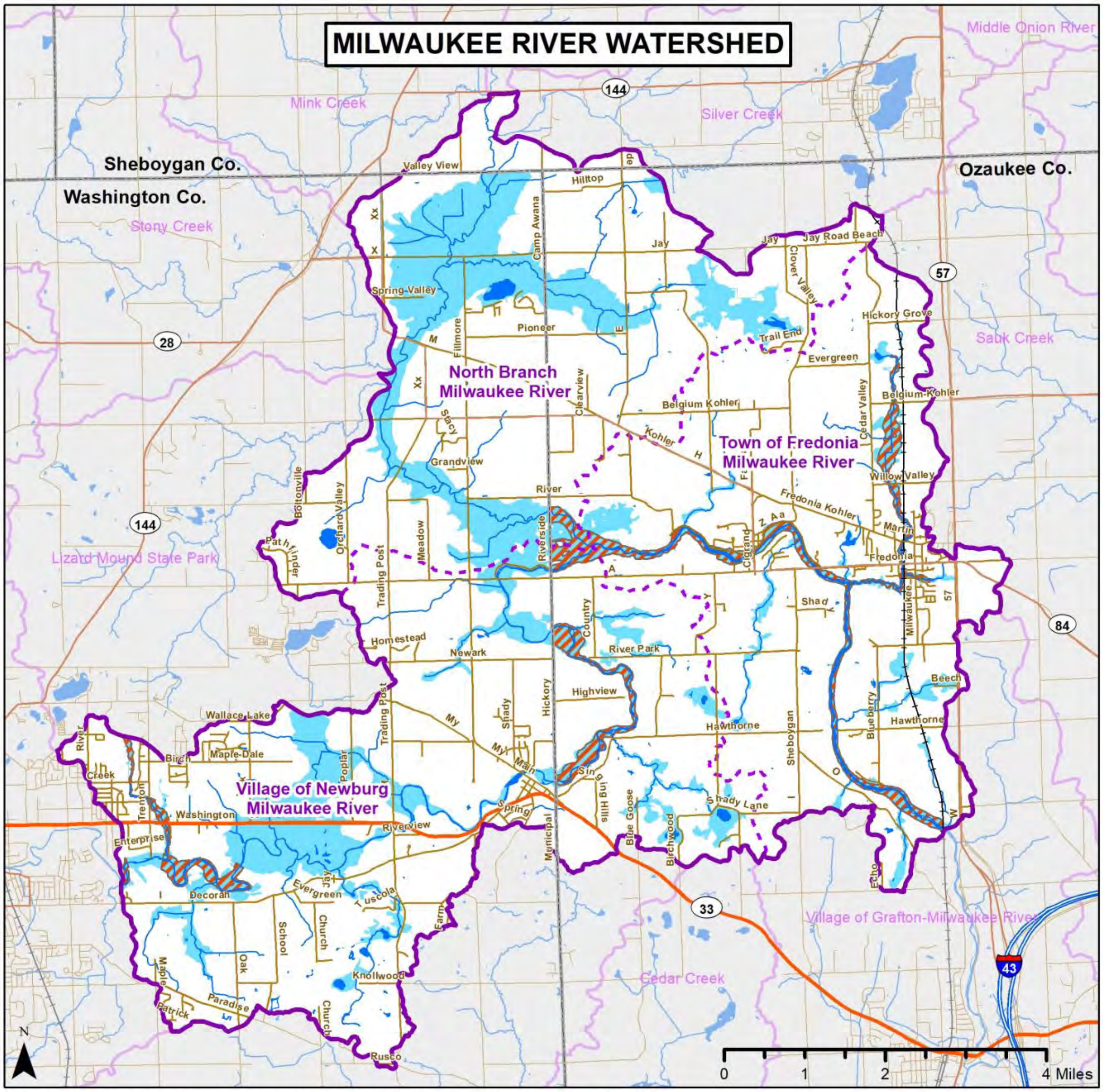
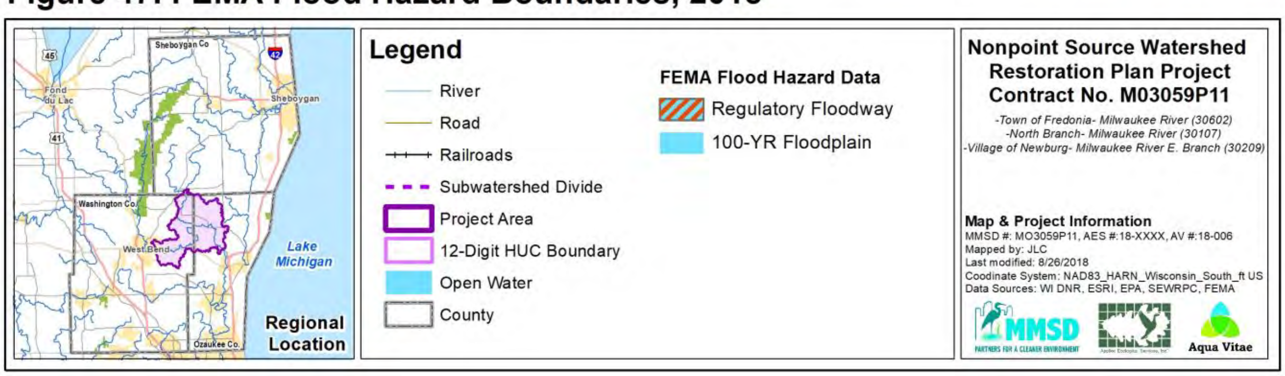


Figure 47. FEMA Flood Hazard Boundaries, 2018



3.15 Groundwater Aquifers & Recharge, Contamination Potential, & Water Supply

Groundwater Aquifers and Recharge

Groundwater is water that saturates small spaces between sand, gravel, silt, clay particles, or crevices in underground rocks. Groundwater is found in aquifers or underground formations that provide readily available quantities of water to wells, springs, or streams. Groundwater sources available to southeastern Wisconsin are found in shallow, unconfined aquifer units and deep, semi-confined or confined aquifer units (Figure 48). Both shallow and deep aquifers are tapped and used by private and public users and municipalities.

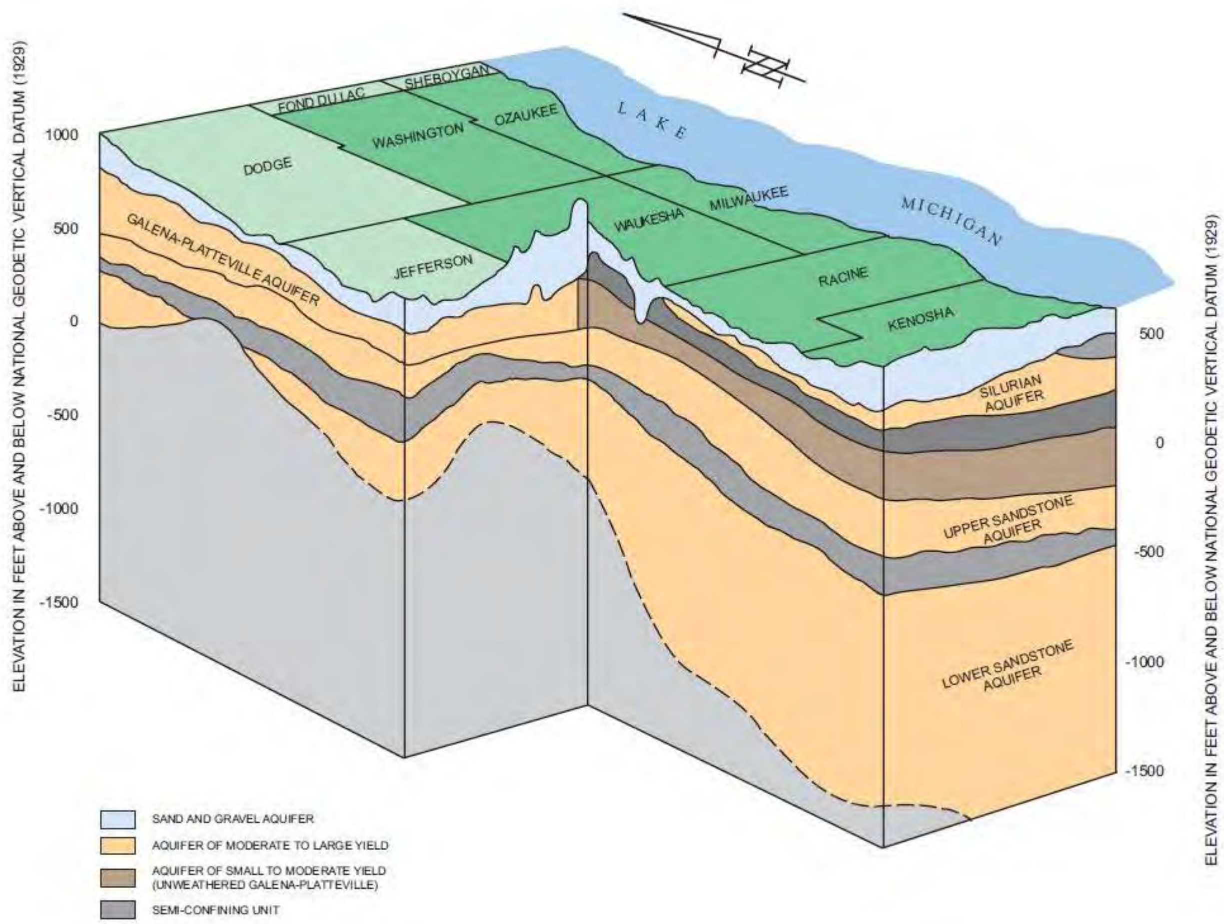


Figure 48. Aquifer Systems in Southeastern Wisconsin. Source: SEWRPC, 2002.

The hydrogeology of the Fredonia-Newburg Area watersheds falls entirely within the Silurian dolomite aquifer. This aquifer, formerly known as the Niagara dolomite aquifer, is the uppermost bedrock aquifer in the area, hydraulically connected to the adjacent sand and gravel aquifer, and generally falls under water table conditions. It is also the primary source of most public water supplies and wells within the watershed. Below the Silurian dolomite aquifer are the upper and lower sandstone aquifers. The upper sandstone aquifer includes sandstone and dolomite of the Ancell and Prairie du Chien Groups, while the lower sandstone aquifer is made up of the thick sedimentary sequences of Cambrian sandstone (SEWRPC 2002).

Groundwater modeling studies conducted by Southeastern Wisconsin Regional Planning Commission (SEWRPC) for the southeastern Wisconsin region in 2010 suggest that deep water aquifers are experiencing excessive drawdown centered on the area of eastern Waukesha County (see Figure 49, left image). Drawdowns in this area exceed 400 feet. This is part of a larger general drawdown occurring in Milwaukee and Chicago and the area around them. Simulated drawdowns within the shallow aquifer (see Figure 49, right image), however, appear much smaller in size and extent. This is because of the unconfined nature of the aquifer and its connection to surface water bodies. "Under natural conditions, most ground water recharge to the shallow aquifer flows through the shallow aquifer and discharges to surface water bodies as baseflow. Pumping the shallow aquifer can reduce the natural ground-water discharge, intercepting it before it reaches surface water bodies and then discharging it to those few rivers that receive wastewater effluent (SEWRPC 2010)." Rather than result in large drawdowns, groundwater deficits in the shallow aquifer effectively reduce groundwater baseflow (SEWRPC 2010).

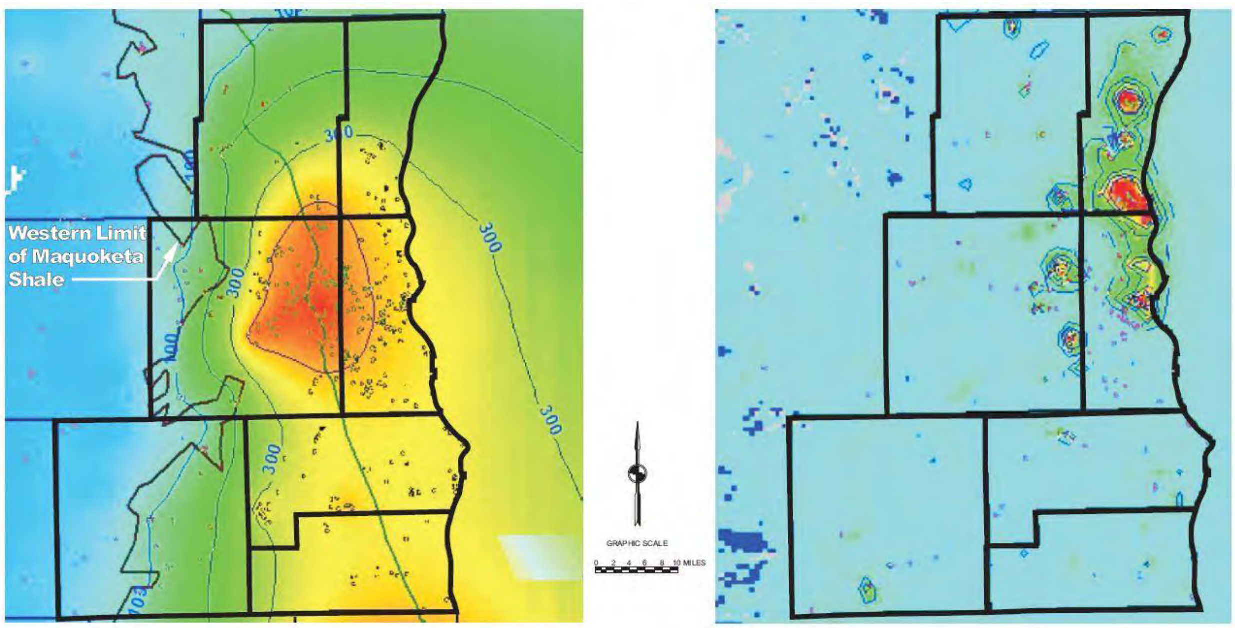


Figure 49. Simulated drawdowns for SEWRPC Region between 1860 and 2000. Left image depicts deep aquifers and right image depicts the shallow aquifer. Source: SEWRPC, 2010.

As the pumping of the deep aquifers and subsequent drawdowns has progressed, water from the shallow aquifer has been diverted downwards toward the deep aquifers. Groundwater recharge of the deep sandstone aquifer does not occur within the watersheds due to the Maquoketa shale formation which underlies the area and serves as an aquitard.

Recharge to the shallow aquifer was estimated using a soil-water balance model. Areas with moderate to high recharge potential are found throughout the entire tri-watershed area, with patches of very high recharge potential occurring east of West Bend, near Newburg, and in scattered places throughout the remainder of the area (Figure 50). Areas with low recharge potential are found in these watersheds mostly in areas of urban development such as in the northern- and southern-most portions of the watershed, while higher recharge potential areas tend to occur where the land is more vegetated such as within parks and open space (SEWRPC 2008).

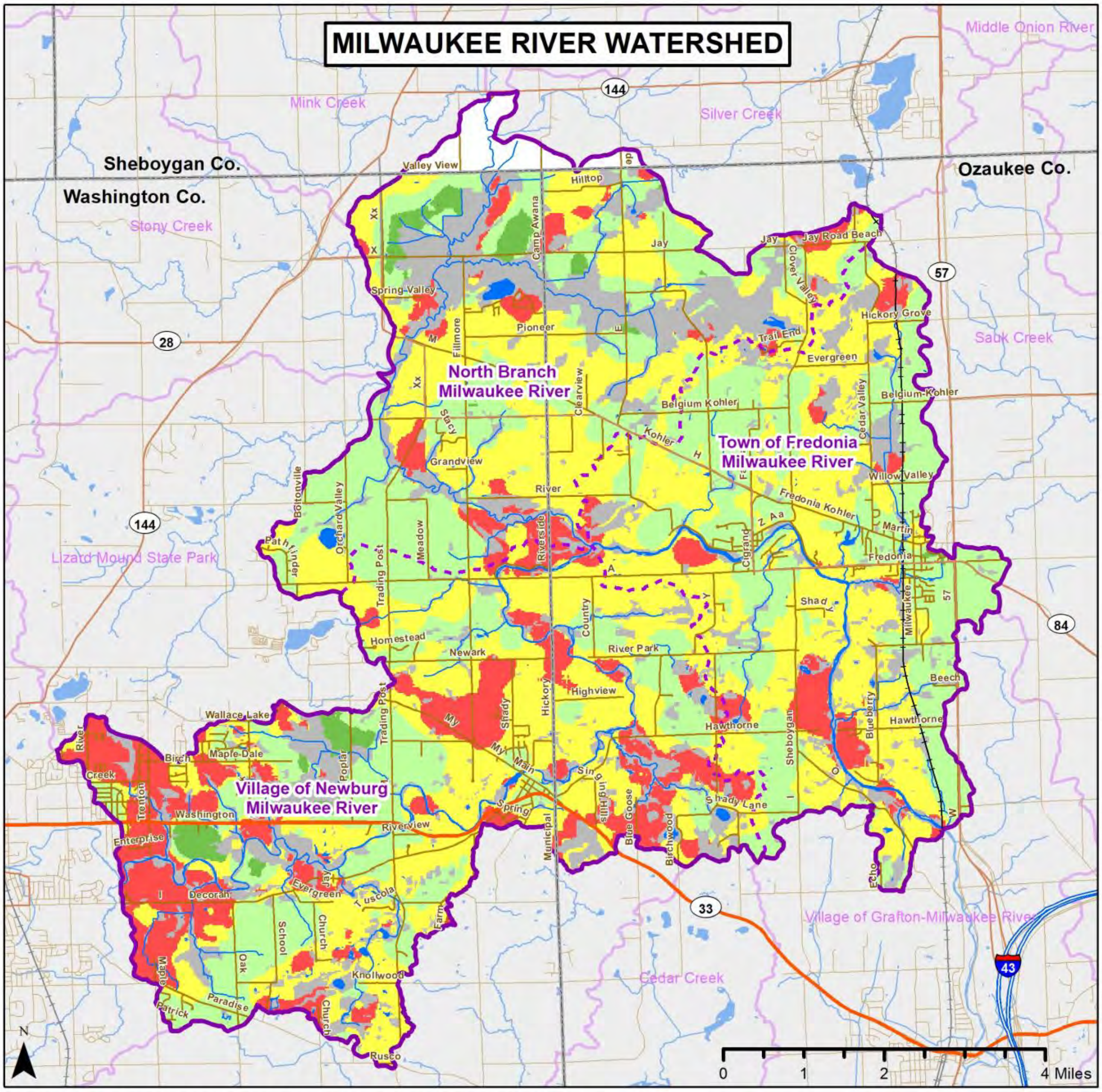
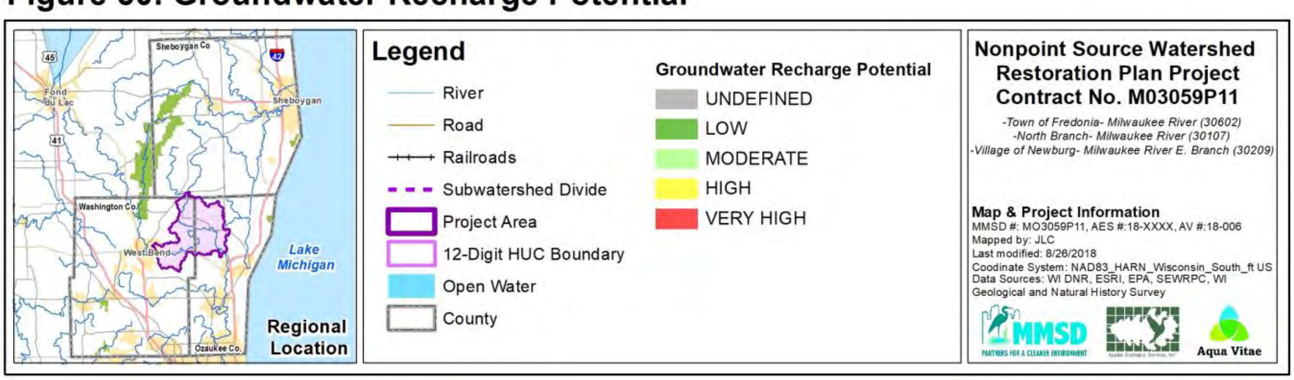


Figure 50. Groundwater Recharge Potential



Groundwater Contamination Potential

In SEWRPC's research into groundwater resources, they determined areas in which shallow groundwater resources were potentially susceptible to contamination. They did this by measuring three parameters: 1) distance from the land surface to the aquifer, 2) properties of materials through which contaminants have to pass to reach the aquifer, and 3) rates at which such contaminants can travel (SEWRPC 2002).

SEWRPC also identifies areas which should be targeted for groundwater protection measures. These areas are also referred to as Special Management Areas and include naturally vulnerable areas, potential problem areas, and wellhead protection areas. Naturally vulnerable areas include those identified as being vulnerable to contamination or critical groundwater recharge areas, either to deep or shallow groundwater aquifers. Areas nearest to West Bend in the as well small locations interspersed throughout the Fredonia-Newburg Area watersheds were determined by the study to include areas that are highly vulnerable to potential contamination (Figure 51), due predominantly to very high rates of groundwater infiltration. Additionally, the remainder of the watershed is determined to be moderately vulnerable where high rates of groundwater infiltration exist.

Potential problem areas are places where naturally vulnerable areas overlap areas where potential contaminant sources are located. Much of the Fredonia-Newburg Area watersheds fall within the category of being naturally vulnerable to contamination.

Finally, wellhead protection areas can be determined in order to protect municipal wells within the shallow aquifer. Wisconsin Administrative Code NR 881 requires a Wellhead Protection Plan for all municipal water supply wells built since 1992, with voluntary compliance for existing wells prior to that date. These plans are meant to delineate and protect the area of land that supplies groundwater to a well, as determined by hydrogeologic analysis (SEWRPC 2002).

Well contamination is a real concern for southeastern Wisconsin as many homes in the region are serviced by private water wells drawing from the local aquifer. Given the overall susceptibility of the watershed to groundwater contamination, sites like underground storage tanks, concentrated animal feeding operations, and landfills can be sources of contamination. Farming activities can also be sources of groundwater contamination with USGS estimating 21% of drinking water wells in the region of Washington and Ozaukee Counties containing detectable amounts of pesticides, herbicides, or metabolites of herbicides (USGS 2008).

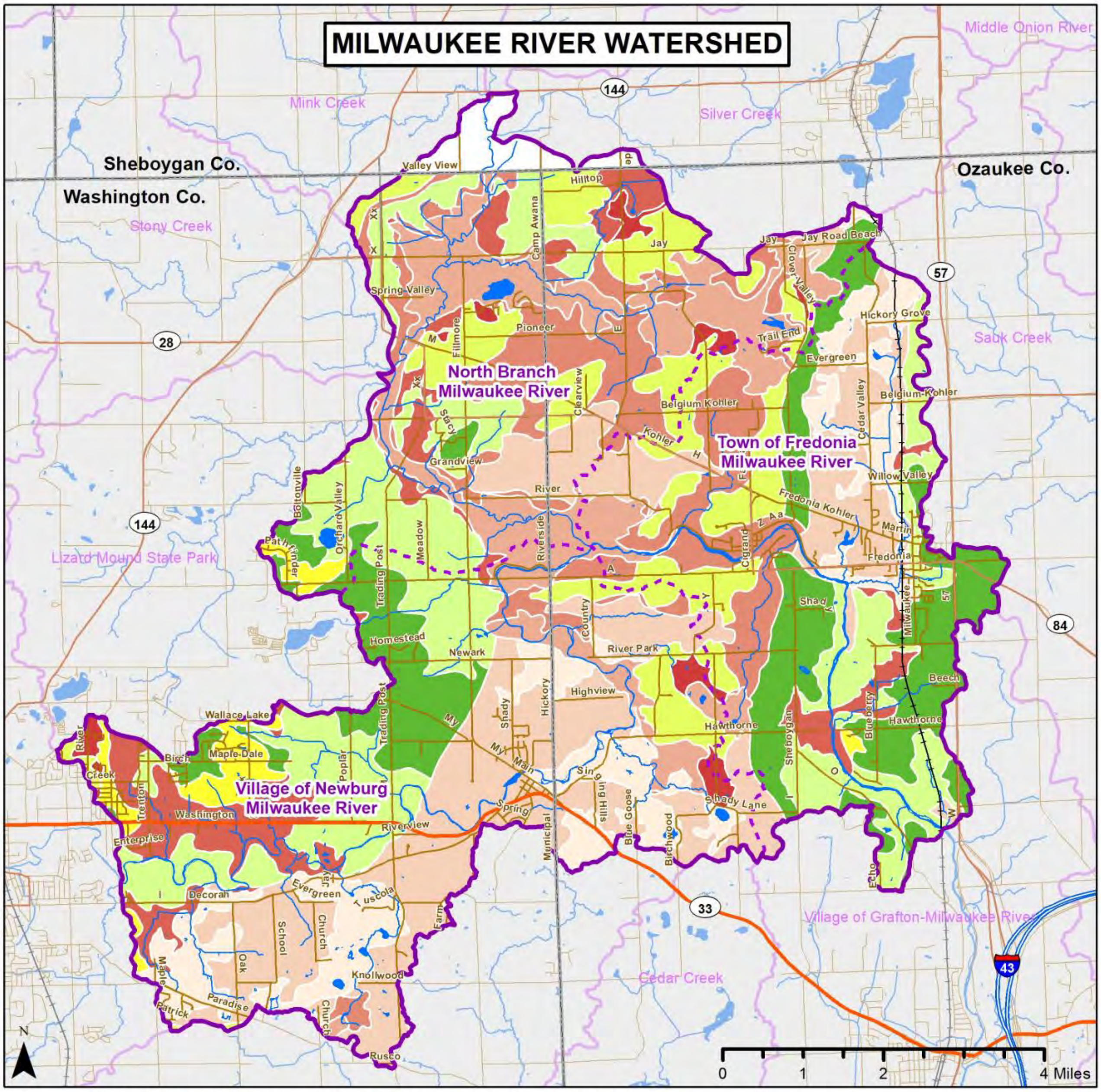
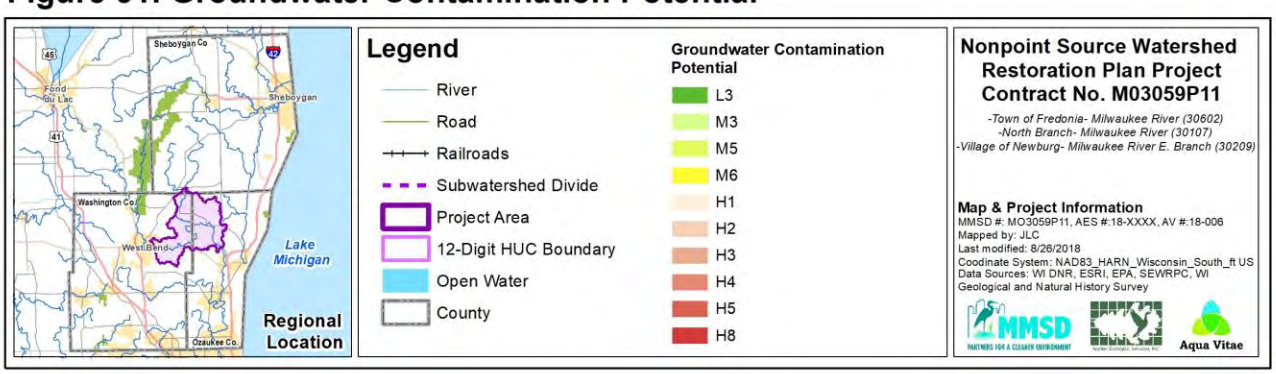


Figure 51. Groundwater Contamination Potential



Community Water Supply

Groundwater is an essential resource to the southeastern Wisconsin region as underlying aquifers provide the drinking water supply for many people. According to a WDNR well inventory within in Fredonia-Newburg Area watersheds, there are 93 public drinking water wells currently active between the municipalities of West Bend, Newburg, Fredonia, and Waubeka. This is likely an overestimation of the actual number of wells in the watersheds, because the data does not include locations, only which municipality each is located in. It is likely that many of the 64 wells listed for West Bend are outside of the boundaries of the watershed, but all of them have been included for the purposes of this report. Of the 93 wells for those municipalities, two are municipal community wells (Fredonia and West Bend); five are non-transient, non-community wells; five are community wells listed as “other than municipal”; and the remaining 81 wells are transient, non-community wells (WDNR 2018). The full list of public wells can be found in Appendix D.

Given the rural nature of the area, the number of private water wells in the watershed is far greater, with Washington county having over 10,000 private wells, and half of Ozaukee county households using private wells. While this watershed plan is focused on surface water quality conditions and restoration, the importance of clean and healthy drinking water is a high priority in the state of Wisconsin. Additional information regarding drinking water conditions and recommendations for improvement in the Fredonia-Newburg Area watersheds can be found through Wisconsin’s Department of Health Services, WDNR, Ozaukee, Washington, and Sheboygan Counties, and SEWRPC.

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4.0 Water Quality Assessment & Pollutant Loading Assessment

4.1 Point and Nonpoint Source Water Quality Pollutants

Water quality can be adversely affected by both point and nonpoint source pollutants. Point sources are identified as any discharge that comes from a pipe or permitted outfall, such as municipal and industrial discharges. Municipal and industrial discharges within the Fredonia-Newburg Area watersheds are regulated through the Wisconsin Pollutant Discharge Elimination System (WPDES). There are two municipal permits located in the Fredonia-Newburg Area watersheds - one in Fredonia and one in Newburg. There are no industrial permit sites located within the watersheds.

Wisconsin WPDES Permit Program

Section 402 of the federal Clean Water Act established the National Pollutant Discharge Elimination System (NPDES). This program regulates point source discharges of pollutants into United States waters and sets specific limits on discharges from point sources, establishes monitoring and reporting requirements, and establishes exceptions. The permitting program is designed to prevent discharges of wastewater and storm water from washing harmful pollutants into local surface waters such as streams, rivers, lakes or coastal waters. It also allows for the USEPA to authorize states to assume many of the permitting, administrative, and enforcement responsibilities of the program (USEPA 2012).

In order to implement the NPDES, the Wisconsin Department of Natural Resources (WDNR) developed the WPDES Permit Program which is administered under the authority of Chapters NR 200 through NR 299 of the Wisconsin Administrative Code. WPDES wastewater discharge permits regulate the discharge of wastewater from municipal and industrial facilities. The WPDES Storm Water Program regulates the discharge of storm water from construction sites, industrial facilities, and municipal separate storm sewer systems (MS4s).

Two types of wastewater discharge permits are issued under the WPDES. General permits are issued for specific categories of industrial, municipal, and other wastewater discharges. Individual WPDES permits are issued to municipal and industrial facilities making discharges to surface water or groundwater that are not covered under general permits. These types of permits may contain numerical effluent limits. Municipal Separate Storm Sewer System (MS4) permits require municipalities to reduce polluted storm water runoff by implementing storm water management programs with best management practices. The MS4 permits usually do not contain numerical effluent limits like other WPDES permits (WDNR 2017).

WPDES Permit Sites

There are two municipal permits located in the Fredonia-Newburg Area watersheds - the Fredonia Municipal Sewer and Water Utility in Fredonia and Newburg Village in Newburg (Table 23). There are no industrial permit sites located within the watersheds.

Fredonia Sewage Treatment Plant (Source: Google Maps)

Table 23. WPDES permitted sites in Fredonia-Newburg Area watersheds.

Permit No.	Facility Name	City	Permit Type
0020800	FREDONIA MUNICIPAL SEWER AND WATER UTILITY	Fredonia	Municipal Permit
0024911	NEWBURG VILLAGE	Newburg	Municipal Permit

Nonpoint Source Pollutants

Nonpoint source pollutants are pollutants that enter a waterway from a source other than a pipe or permitted outfall. Historically these pollutants are the most difficult to control because tracking them back to their source is difficult. Nonpoint source pollutants can include, but are not limited to, illicit discharges into waterways, excess nutrients (such as nitrogen and phosphorus), oils and chemicals washed off of roadways (such as chlorides from deicing agents), and/or excess sediment (from construction sites or streambank destabilization). Most nonpoint source pollutants are monitored via physical-chemical water quality testing.

4.2 Water Quality Report, Designated Use, & Impairments

The Federal Clean Water Act requires Wisconsin and all other states to submit to the United States Environmental Protection Agency (USEPA) a biannual report of the quality of the state's surface and groundwater resources and an updated Section 303 (d) list. The *Wisconsin Water Quality Report to Congress – Year 2018* was compiled by the Wisconsin Department of Natural Resources (WDNR's) Water Division and is the most recent of these reports. These reports must also describe how Wisconsin assessed water quality and whether assessed waters meet or do not meet water quality standards specific to each "Designated Use" of a stream or lake as defined in chs. NR 102, 104, and 105 of the Wisconsin Administrative Code. When a waterbody is determined through biological and/or physical-chemical sampling to be impaired, WDNR must list potential causes and sources for impairment in the 303 (d) impaired waters list.

WDNR developed four general Designated Uses which define the goals for a waterbody for all Wisconsin surface waters: Fish and Aquatic Life, Recreational Use, Public Health and Welfare, and Wildlife. Each designated use is associated with particular water quality criteria that are either numeric or narrative in nature and set the standards a waterbody must meet in order to protect the intended use.

The Fish and Aquatic Life use designation is appropriate for the protection of fish and other aquatic life and is subdivided into further categories – coldwater, warmwater sport fish, warmwater forage fish, limited forage fish, and limited aquatic life. The recreational use designation means a stream is appropriate for recreational use unless a sanitary survey has been completed to show that humans are unlikely to participate in activities requiring full body immersion. The Public Health and Welfare use designation means it is appropriate to protect for incidental contact and ingestion by humans. Finally, the Wildlife use designation means it is appropriate to protect wildlife that relies directly on the water to exist or rely on it to provide food for existence (WDNR 2014).

Wisconsin also utilizes an anti-degradation policy as a component of protecting waters. This policy is aimed at ensuring that high quality waters are prevented from being degraded by identifying them as either Outstanding Resource Waters or Exceptional Resource Waters. No waterbodies within the Fredonia-Newburg Area watersheds have been classified as either Outstanding or Exceptional Resource Waters.

According to WDNR's 2018 303(d) list, the Milwaukee River, North Branch Milwaukee River, and Fredonia Creek within the Fredonia-Newburg Area watersheds are all listed as impaired. This section of the Milwaukee River is 303(d) listed because of unknown pollutant and total phosphorus resulting in elevated water temperatures and an unknown impairment; this section was also 303(d) listed for PCBs at one time but was delisted in 2006. The North Branch Milwaukee River is 303(d) listed because of excessive amounts of phosphorus resulting in a degraded biological community. Finally, Fredonia Creek is 303(d) listed because of excessive amounts of phosphorus resulting in an unknown impairment.

Table 24 includes a summary of Designated Use Impairments for the Milwaukee River, North Branch Milwaukee River, and Fredonia Creek within the Fredonia-Newburg Area watersheds. The Milwaukee River refers to the main stream from the watershed boundary in the easternmost portions of West Bend to the outlet of the watershed at the junction of the Wisconsin and Southern Railroad, while the North Branch Milwaukee River refers to the stream from Route 144 at the northernmost portion of the watershed to the confluence with the Milwaukee River.

Table 24. Designated Use Impairments for the Fredonia-Newburg Area watersheds.

Designated Use	Assessment	Impaired Status	Pollutant	Impairment
Milwaukee River: Warm water sport fish community - Large				
Fish & Aquatic Life	Not Supporting	303(d) listed	Unknown Pollutant, Total Phosphorus, PCBs	Elevated Water Temperature, Impairment Unknown, PCB Contaminated Sediment
Recreational Use	Full Body Contact	-	-	(Delisted in 2006 for PCBs)
Public Health & Welfare	General Advice	-	-	-
Wildlife	NA	-	-	-
North Branch Milwaukee River: Warm water sport fish community - Large				
Fish & Aquatic Life	Not Supporting	303(d) listed	Total Phosphorus	Degraded Biological Community
Recreational Use	Full Body Contact	-	-	-
Public Health & Welfare	General Advice	-	-	-
Wildlife	NA	-	-	-
Fredonia Creek: Not assessed				
Fish & Aquatic Life	Not Assessed	303(d) listed	Total Phosphorus	Impairment Unknown
Recreational Use	Full Body Contact	-	-	-
Public Health & Welfare	General Advice	-	-	-
Wildlife	NA	-	-	-

4.3 Physical, Chemical, and Biological Water Quality Monitoring

In Wisconsin, physical, chemical, biological monitoring, habitat monitoring are all used to assess the health of streams and to determine water quality condition and/or impairment. Chemical and physical characteristics constitute the primary measures of compliance with water quality standards. Fish Indices of Biological Integrity and Macroinvertebrate Indices of Biological Integrity are used to assess the biological health of streams. Physical-chemical sampling results obtained in the field are augmented by the biological data. Many of the nonpoint source pollutants have been tested for via physical-chemical water quality samples conducted at various sites along the streams and tributaries in the Fredonia-Newburg Area watersheds and several fish surveys have been conducted.

All water quality sampling results were downloaded from the EPA's Water Quality Data portal (WQX) from 2008 to 2018 for the Fredonia-Newburg Area watersheds. In general, the most recent data is analyzed and averaged so that recommendations and management strategies are based on the most current depiction of the water quality and biological conditions. This data represents various water quality monitoring programs and sources including WDNR and USGS sampling. In total, there were 26 water quality sampling sites across the Fredonia-Newburg Area watersheds in the last 11 years covering a wide range of water quality and sampling parameters. Table 25 summarizes the locations, types of monitoring that occurred, and date ranges for all known physical-chemical data collected in the watershed while Figure 52 displays the location of each sample site where the data was collected.

Table 25. List of most recent water quality sample sites, locations, dates, and sampling parameters from 2008 to 2018.

Site ID	Organization	WQX Monitoring ID	Monitoring Location/Name	Monitoring Type	Date or Date Range	Water Quality and other Parameters
Fac1	WDNR	WIDNR_WQX-10037650	Fredonia Outfall	Facility Industrial	7/5/2012 - 10/17/2012	*E. coli*, chloride
L01	WDNR	WIDNR_WQX-10014705	ERLER LAKE - LEONARD YAHR PARK BEACH	Lake	5/29/2008 - 8/28/2017	*E. coli*
L02	WDNR	WIDNR_WQX-10037711	Unnamed in Ozaukee Co	Lake	8/7/2012	Ammonia, calcium, calcium carbonate, carbon, chloride, chlorophyll a, secchi depth, DO, NO2+NO3, magnesium, organic carbon, pH, phosphate-phosphorus, potassium, silica, sodium, specific conductance, sulfate, water temp, TSS, turbidity
L03	WDNR	WIDNR_WQX-10037626	Unknown Lake nearshore in Ozaukee Co	Lake	8/7/2012	Chlorophyll a
S01	WDNR	WIDNR_WQX-10029089	North Branch Milwaukee River - Upstream of CTH XX	River/Stream	8/26/2008	TKN, NO2+NO3, TSS, Phosphate-phosphorus, Ammonia, pH, transparency, water temp, air temp, cloud cover, specific conductance, DO
S02	Milwaukee Riverkeeper*	WIDNR_WQX-10029688	North Branch Milwaukee River at Riverside Rd	River/Stream	7/21/2008 - 9/26/2016	DO, DO sat, pH, phosphate-phosphorus, air temp, water temp, transparency
S03	Milwaukee Riverkeeper*	WIDNR_WQX-10014722	MILWAUKEE RIVER-WAUBEKA (RIVER RD.)	River/Stream	5/13/2010 - 8/19/2018	DO, DO sat, pH, water temp, air temp, transparency, phosphate-phosphorus, specific conductance
S04	Milwaukee Riverkeeper*	WIDNR_WQX-10014721	MILWAUKEE RIVER-WAUBEKA (VFW PARK)	River/Stream	5/15/2010 - 9/17/2011	DO, DO sat, pH, water temp, transparency
S05	Milwaukee Riverkeeper*	WIDNR_WQX-10037508	Milwaukee River DS CTH H	River/Stream	8/27/2012 - 4/12/14	Cloud cover, DO, DO sat, flow, pH, phosphate-phosphorus, specific conductance, air temp water temp, transparency, water appearance
S06	Milwaukee Riverkeeper*	WIDNR_WQX-10018035	Milwaukee River -- Fredonia Canoe Launch	River/Stream	5/25/2018 - 9/27/2018	DO, DO sat, pH, specific conductance, air temp, transparency, phosphate-phosphorus
S07	Milwaukee Riverkeeper*	WIDNR_WQX-10031395	Fredonia Creek near intersection with Milwaukee River	River/Stream	5/13/2010 - 7/30/2018	DO, DO sat, pH, water temp, phosphate-phosphorus, transparency
S08	Milwaukee Riverkeeper*	WIDNR_WQX-10039638	Unnamed Trib (Fredonia Creek) at Wenzel Ave	River/Stream	4/6/2011 - 9/27/2018	DO, DO sat, flow, water temp, transparency, phosphate-phosphorus, specific conductance, air temp
S09	Milwaukee Riverkeeper*	WIDNR_WQX-10012524	Riveredge Nature Center Creek at Hawthorne Dr.	River/Stream	6/19/2008 - 10/25/2017	DO, DO sat, pH, water temp, transparency, phosphate-phosphorus
S10	WDNR	WIDNR_WQX-10015988	Milwaukee R. So. - DS of CTH MY Bridge Ca.400 ft 1n Newburg. Subwtsd-West Bend Stm seg-Wb038 Spring	River/Stream	6/7/2010 - 8/19/2010	DO, DO sat, flow, air temp, water temp, transparency
S11	Milwaukee Riverkeeper*	WIDNR_WQX-10012518	Milwaukee River at Streamside Rearing Facility Pump RNC	River/Stream	6/19/2008 - 8/20/2018	DO, DO sat, pH, water temp, transparency, phosphate-phosphorus
S12	Milwaukee Riverkeeper*	WIDNR_WQX-10012525	Riveredge Creek at South Boundary Of Rnc	River/Stream	6/19/2008 - 8/20/2018	DO, DO sat, pH, water temp, transparency, phosphate-phosphorus
S13	WDNR	WIDNR_WQX-10033974	Milwaukee River - East Hawthorne Drive	River/Stream	7/20/2011	Phosphate-phosphorus, DO sat, pH, transparency, water temp, air temp, cloud cover, specific conductance, DO
S14	Milwaukee Riverkeeper*	WIDNR_WQX-10030440	Milwaukee River near Stockhausen Ln upstream from airport	River/Stream	7/16/2008 - 10/26/2013	Transparency, water temp, DO sat, air temp, flow, DO, pH
S15	WDNR	WIDNR_WQX-10040555	Milwaukee River at STH 33 and Oak Rd	River/Stream	7/10/2008 - 9/4/2009	DO, DO sat, flow, air temp, water temp, transparency
S16	USGS	USGS-04086265	MILWAUKEE RIVER @ CNTY TRNK HGHWAY M NR NEWBURG, WI	River/Stream	4/16/2018 - 6/12/2018	Hydrogen ion, oxygen, pH, specific conductance, water temp, turbidity,

Site ID	Organization	WQX Monitoring ID	Monitoring Location/Name	Monitoring Type	Date or Date Range	Water Quality and other Parameters
S17	WDNR	WIDNR_WQX-10031059	Milwaukee River 300ft West CTH M	River/Stream	7/21/2011	Phosphate-phosphorus, DO sat, pH, transparency, water temp, air temp, cloud cover, specific conductance, DO
S18	Milwaukee Riverkeeper*	WIDNR_WQX-673105	Milwaukee River at Cth M (Bi)	River/Stream	5/31/2017 - 9/28/2017	DO, DO sat, pH, air temp, transparency
S19	Milwaukee Riverkeeper*	WIDNR_WQX-10051138	Unnamed (34800) 660ft W of Milwaukee River	River/Stream	5/8/2018 - 9/12/2018	DO, DO sat, air temp, transparency
S20	Milwaukee Riverkeeper*	WIDNR_WQX-10016560	Milwaukee River south of West Bend Airport (near CTH I)	River/Stream	5/19/2015 - 6/8/2018	DO, DO sat, air temp, transparency
S21	Milwaukee Riverkeeper*	WIDNR_WQX-10037509	Unnamed (WBIC=34400) US Tuscola Ln	River/Stream	8/23/2012 - 7/29/2018	Cloud cover, DO, DO sat, flow, pH, phosphate-phosphorus, specific conductance, air temp water temp, transparency
Swr1	WDNR	WIDNR_WQX-10038449	Fredonia Trib - Manhole	Storm Sewer	9/19/2012	Chloride
DO = dissolved oxygen DO Sat = dissolved oxygen saturation pH=acid/base scale NO2+NO3 = nitrate and nitrite nitrogen TSS = total suspended solids TKN = total kjeldahl nitrogen						

* Milwaukee Riverkeeper sampled the site, reported the results to WDNR, and the WDNR SWIMS database reports the sites as WDNR sites.

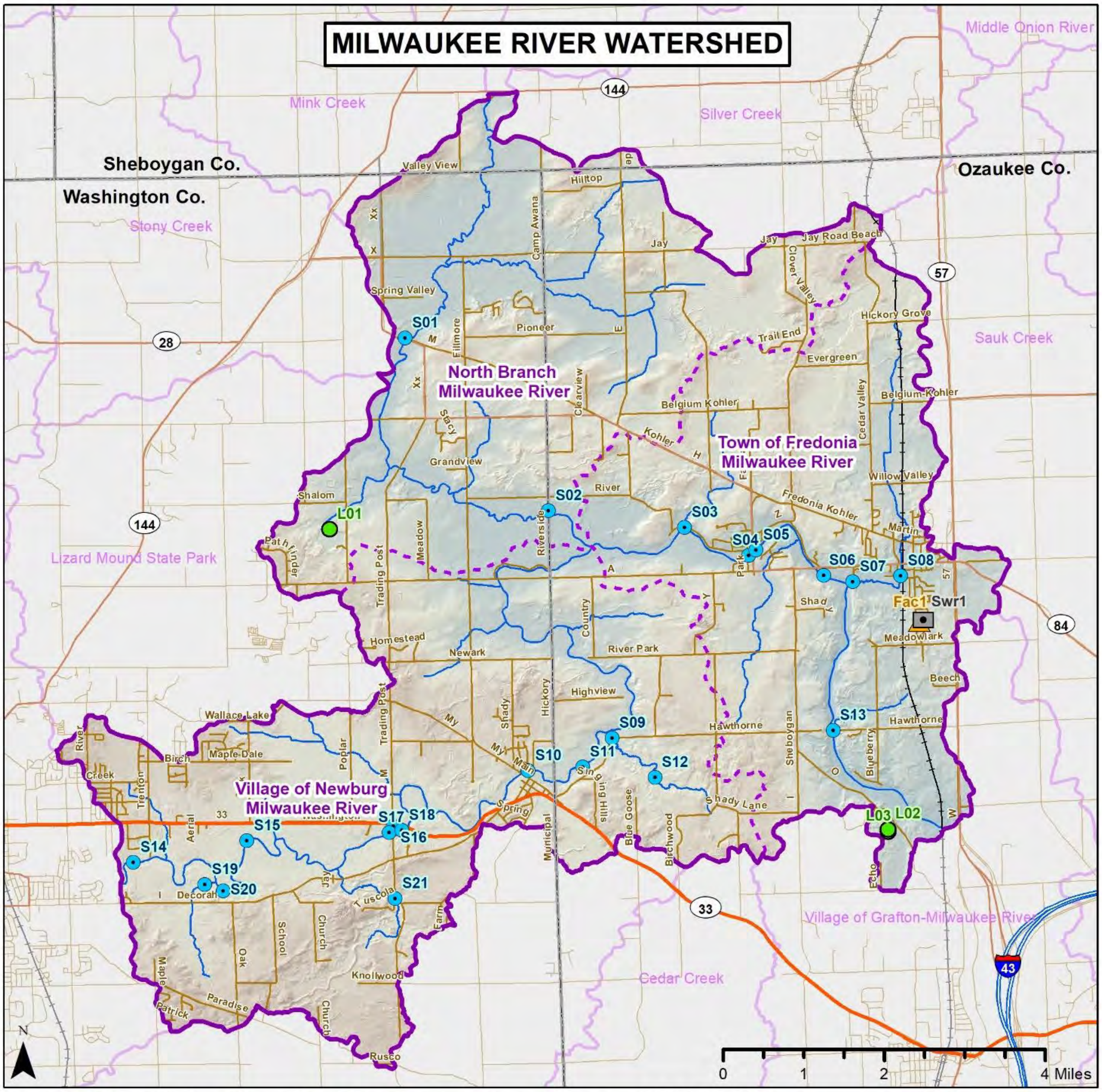
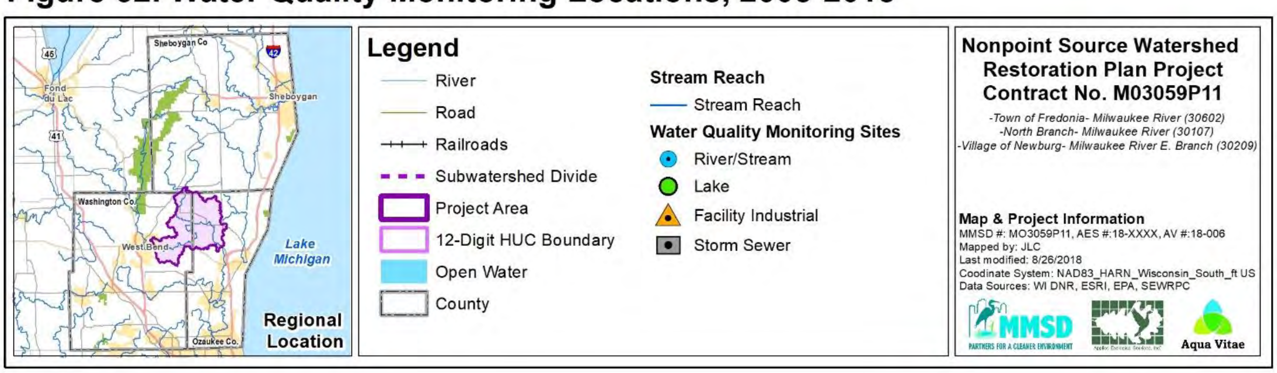


Figure 52. Water Quality Monitoring Locations, 2008-2018



Water Chemistry Monitoring

According to WDNR's 2018 303(d) list, the Milwaukee River, North Branch Milwaukee River, and Fredonia Creek within the Fredonia-Newburg Area watersheds are all listed as impaired. Additionally, the results of the field inventory suggest at least moderate impairment of the tributary streams caused by channelization, streambank erosion, draining of wetlands, and high nutrients and *E. coli* in agricultural and urban stormwater runoff.

Table 26 summarizes the water quality sampling results for the Fredonia-Newburg Area watersheds from 2008 to 2018 and also provides statistical and numerical guidelines for the various criteria. This data meets the data quality guidelines as determined by "WDNR Quality Management Program" and are equivalent to the EPA Quality Assurance Program Plan, including sampling techniques and use of qualified laboratories (WisCalm 2017). Wisconsin provides numeric guidelines within its administrative code for temperature, dissolved oxygen, pH, and phosphorus within NR 102. Wisconsin has not yet derived their own guidelines for the remaining criteria so national standards were utilized. Criteria for specific conductivity, turbidity, and nitrogen reference general guidelines set forth by the USEPA for the nation or relevant ecoregion where applicable. The WDNR's Total Maximum Daily Load (TMDL) for the Milwaukee River Basin (2018) provided the reference criteria for total suspended solids.

All surface water quality sampling results were downloaded from the EPA's Water Quality Data portal (WQX) from 2008 to 2018 for the Fredonia-Newburg Area watersheds. This data represents various water quality monitoring programs and sources including WDNR and USGS sampling. Sampling parameters collected included air temperature, water temperature, dissolved oxygen concentration, dissolved oxygen saturation, pH, total phosphorus, turbidity, conductivity, inorganic nitrogen, total suspended solids, and *E. coli*. The results of this data are displayed in Table 26. Sampling result summaries depicted in Table 26 were chosen based on their location in the watershed and the completeness of the parameters sampled. Typically, the most downstream sampling site for each of the HUC 12 watersheds was chosen as representative of the water quality for that watershed, but additional monitoring locations were included where additional parameters were sampled for.

Noteworthy- Numeric Water Quality Standards

USEPA has tasked states to establish *numeric* water quality standards for nutrients (phosphorus and nitrogen) in lakes and streams. Currently, Wisconsin has a numeric phosphorus standard, but does not have one for nitrogen. To date, Wisconsin has not developed *numeric* standards for specific conductivity, turbidity, total suspended solids, inorganic nitrogen, and kjeldahl nitrogen in streams. *Numeric* criteria have been proposed by USEPA for nutrients based on a reference stream method for the Corn Belt and Northern Great Plains Ecoregion (VI) which includes Wind Point watershed and the USEPA has also established general national guidelines for other criteria.

The USGS has published a document outlining recommended *numeric* criteria for sediment in streams for Ecoregion VI. These reference criteria are used in this report to assess the quality of Wind Point watershed tributaries to develop pollution reduction targets and measure future successes, even though Wisconsin has not adopted these criteria as standards.

Table 26. Surface water quality sample results for Fredonia-Newburg Area watersheds.

Note: Temperature is shown as a maximum value while all other testing results are displayed as an average of all available testing data from 2008 through 2018. Sites S01, S13, and Fac 1 reflect only one sample occurrence.

Parameter	Statistical, Numerical, or General Use Guidelines	Site S01 - North Branch	Site S02 - North Branch	Site S11 - Newburg	Site S13 - Fredonia	Site Fac1 - Fredonia
Temp (F)	<86° F*	MAX 62.3	86.3	92.5	82	N/A
Dissolved Oxygen (DO)	>5.0 mg/l*	AVG 9.2	7.1	9.4	7.6	N/A
DO Saturation	N/A	AVG N/A	74.3	101.3	99	N/A
pH	>6.0 or <9.0*	AVG 8.6	8	8.3	8.1	N/A
Total Phosphorus (TP)	<0.075 mg/L*	AVG 0.084	0.132	0.117	0.155	N/A
Turbidity (converted from cm)	<14 NTU**	AVG <10	14	<10	<10	N/A
Conductivity	<1,500 µS/cm***	AVG 732	N/A	N/A	857	N/A
Inorganic Nitrogen (NO_2+NO_3)	<1.798 mg/L**	AVG 3.4	N/A	N/A	N/A	N/A
Total Suspended Solids (TSS)	<12 mg/L****	AVG 13	N/A	N/A	N/A	N/A
E. coli	<235 MPN/100mL*****	AVG N/A	N/A	N/A	N/A	435

- Cells highlighted in red exceed recommended statistical, numerical, or General Use guidelines
- Temperature listed as the maximum value available for each site.
* Water Quality Standards for WI Surface Waters NR 102 (2012) – Acute criteria for Large Warm Water systems
** Ambient Water Quality Criteria Recommendations: Rivers and Streams in Nutrient Ecoregion VI (USEPA 2000)
*** USEPA, 2012
**** Total Maximum Daily Loads for Total Phosphorus, Total Suspended Solids, and Fecal Coliform Milwaukee River Basin, Wisconsin (WDNR 2018)
***** WI DNR NR 102.12 (1); (Clayton et al. 2012)

Maximum temperature criteria in warmwater streams were exceeded at Site S02 in the North Branch watershed and at Site S11 in the Newburg watershed. As maximums, these values reflect a single testing day and time against the acute criteria, not an average over time. Total phosphorus exceeds the criteria in each of the three watersheds at Sites S02, S11, and S13. Turbidity exceeded the guideline at one location – Site S02 on the North Branch. Inorganic nitrogen was only sampled at one location in the watershed and for only one event at S01 on the North Branch and it exceeded the guideline. Finally, for *E. coli* one monitoring location exceeded the guidelin, but watershed-wide there was only one single stream sample taken for *E. coli* and only at one location which was the Fredonia industrial facility outfall; this made it impossible to draw conclusions regarding *E. coli* conditions watershed-wide. Watershed-wide, there were no criteria exceedances for dissolved oxygen, dissolved oxygen saturation, pH, conductivity, or total suspended solids.

Nutrients such as phosphorus and nitrogen are a necessary component of plant growth and are therefore included in many fertilizers. Unfortunately, both have adverse effects on water quality, with phosphorus being particularly detrimental to aquatic systems in excess quantities. These nutrients are applied as fertilizer, either in an agricultural setting or by applicators or residents and the excess nutrients not absorbed by plants are then washed into waterways. Excess nutrients can cause algal blooms, accelerated plant growth, decreasing oxygen levels, and can lead to fish kills. Currently there is no Wisconsin state standard for nitrogen; however the USEPA recommends a concentration of less than 1.798 mg/l. The Wisconsin state standard for total phosphorus in rivers and streams is less than 0.075 mg/L.

The ability to control erosion and excess sediment, and thereby total suspended solids, in waterways can be linked to the control of how development is handled as well as the condition of streambanks in the watershed. The construction process generally involves significant land disturbance and ecosystem destruction. The grading of sites, removal of vegetation, rerouting of natural drainage systems, and the addition of impervious surfaces, such as roads and parking lots, all interfere with water quality both in the short and long term. Removing vegetation and trees near the stream or floodplain removes the stability of the soil and increases bank erosion and sedimentation to nearby waterways. Alteration of natural drainage patterns can also significantly reduce the ability of the ecosystem to compensate for such increase in contaminants and sedimentation. Eroding streambanks also contribute additional sediments, particularly during and after rain events as peak flows scour away banks. High suspended sediment levels are problematic when light penetration is reduced, oxygen levels decrease, fish and macroinvertebrate gills are clogged, visual needs of aquatic organisms is reduced, and when sediment settles out in streams and lakes. There is no Wisconsin state guideline for total suspended solids, but the Milwaukee River TMDL (WDNR 2018) recommends TSS does not exceed 12 mg/l for streams in the Fredonia-Newburg Area watersheds.

E. coli is used as an indicator that a waterbody is contaminated by sewage which could carry pathogens such as bacteria, viruses, and protozoans. While potential pathogens are too numerous to test for individually, the USEPA recommends *E. coli* testing "as the best indicator of health risk from water contact in recreational waters (USEPA, 2012)." Not only does the presence of excessive *E. coli* counts suggest there is a possible health risk in recreational contact with those waters, but the bacteria "can also cause cloudy water, unpleasant odors, and an increased oxygen demand (USEPA 2012)." The proposed Wisconsin state standard for recreational waters requires that *E. coli* levels do not exceed 235 most probable number per 100 ml of sample (MPN/100 ml).

Typically, watershed-wide water quality reduction targets are calculated based on existing water quality results. For the Fredonia-Newburg Area watersheds, reduction targets for total phosphorus, total suspended solids, and *E. coli* were based on the Milwaukee River Total Maximum Daily Load (TMDL) pollutant load allocations for the corresponding watersheds within the Fredonia-Newburg Area watersheds, under the guidance of WDNR. Allocations for pathogens under the TMDL were measured using fecal coliform as the indicator, not *E. coli* and there was no fecal coliform sampling conducted within the watershed. Furthermore, not enough nitrogen sampling exists to develop a reduction target for nitrogen. Reduction targets are discussed in more detail in Section 5.0.

Biological Monitoring

Biological data can be used alone or in conjunction with physical-chemical data to make a water quality impairment assessment on a waterbody in Wisconsin. An index of biotic integrity is one method of assessing biological health and water quality through several attributes of fish or macroinvertebrate communities found in streams. Macroinvertebrate Index of Biotic Integrity (M-IBI) surveys were conducted by WDNR for the Fredonia-Newburg Area watersheds and the results are available for review via WDNR's Surface Water Data Viewer. Table 27, below, depicts the thresholds for each condition category in WDNR's M-IBI for wadeable streams (WisCALM 2018).

Table 27. Condition category thresholds for wadeable stream M-IBI.

Thresholds	Condition Category
> 7.5	Excellent
5.0 – 7.4	Good
2.5 – 4.9	Fair
< 2.5	Poor

Source: WDNR WisCALM 2018.

WDNR's M-IBI Mean 10 Year Summary Values for the Fredonia-Newburg Area watersheds are summarized in Table 28 below. Watershed-wide, M-IBI Mean 10 Year summary values ranged from Fair to Excellent. North Branch Milwaukee River had one sample site which showed fair stream conditions, Village of Newburg-Milwaukee River had two sample sites with good and excellent stream conditions reported, and Town of Fredonia-Milwaukee River had two sample sites both depicting good stream conditions.

Table 28. M-IBI Mean 10-Year Summary Values for the Fredonia-Newburg Area watersheds.

Sampling Location	10-yr Average M-IBI Score	Condition Category
North Branch Milwaukee River		
North Branch: Site S01	3.07	Fair
Village of Newburg-Milwaukee River		
Newburg: Milwaukee River at Cth A (Bi)	8.38	Excellent
Newburg: Site S17	7.20	Good
Town of Fredonia-Milwaukee River		
Fredonia: Site S05	5.50	Good
Fredonia: Site S13	5.59	Good

4.4 Pollutant Loading Analysis

4.4.1 Watershed-Wide STEPL Modeling

The EPA-approved Spreadsheet Tool for Estimating Pollutant Load (STEPL) model was used to estimate the existing nonpoint source load of nutrients (nitrogen & phosphorus) and sediment for the Fredonia-Newburg Area watersheds by individual subwatershed management unit (SMU) for all categories of land use and streambanks. The model outputs average annual pollutant load for each of the land use/cover types and streambanks. The results of this modeling were used to estimate the total watershed load for nitrogen, phosphorus, and sediment and to identify and map pollutant load "Hot Spot" SMU's. SnapPlus (Soil Nutrient Application Planner), Wisconsin's nutrient management planning software, was used to refine various inputs within the STEPL model to ensure it was reflective of in-field conditions. It is important to note that STEPL is not a calibrated model; it also does not estimate *E. coli* loading which is beyond the scope of this watershed plan.

The baseline results of the STEPL model indicate that existing land use/cover in Fredonia-Newburg Area watershed produces 267,420.9 lbs/yr of nitrogen, 119,568.5 lbs/yr of phosphorus, and 26,573.8 tons/yr of sediment (Table 29; Figure 53). Cropland areas contribute the highest nitrogen load (136,563.5 lbs/yr; 51%), the highest phosphorus load (79,613.0 lbs/yr; 67%) and highest sediment load (18,398.6 tons/yr; 69%) in the watershed. Feedlot areas contribute the second highest nitrogen load (59,839.1lbs/yr: 22%) in the watershed, the third highest phosphorus load (6,321.3lbs/yr: 5%), and do not contribute to sediment loading. Other use areas, such as wetlands and open space, contribute the second highest phosphorus loads (31,352.7 lbs/yr: 12%) and second highest loads of sediment (6,287.6tons/yr: 24%). Urban areas, pastureland, forest, and streambank areas contribute on a smaller scale to overall pollutant loading. All STEPL modeling was done in consultation with and under the guidance of WDNR. The full baseline STEPL Model results can be found in Appendix E.

Table 29. Estimated existing annual pollutant load by source at the watershed scale based on STEPL modeling.

Source	N Load (lbs/yr)	% of Total Load	P Load (lbs/yr)	% of Total Load	Sediment Load (tons/yr)	% of Total Load
Urban	28,762.9	10.8%	4,818.0	4.0%	698.9	2.6%
Cropland	136,563.5	51.1%	79,613.0	66.6%	18,398.6	69.2%
Pastureland	9,593.8	3.6%	2,718.8	2.3%	580.8	2.2%
Forest	553.0	0.2%	381.5	0.3%	52.1	0.2%
Feedlots	59,839.1	22.4%	6,321.3	5.3%	0.0	0.0%
Other Uses	31,352.7	11.7%	24,823.9	20.8%	6,287.6	23.7%
Streambank	755.9	0.3%	892.0	0.7%	555.8	2.1%
Total	267,420.9	100.0%	119,568.5	100.0%	26,573.8	100.0%

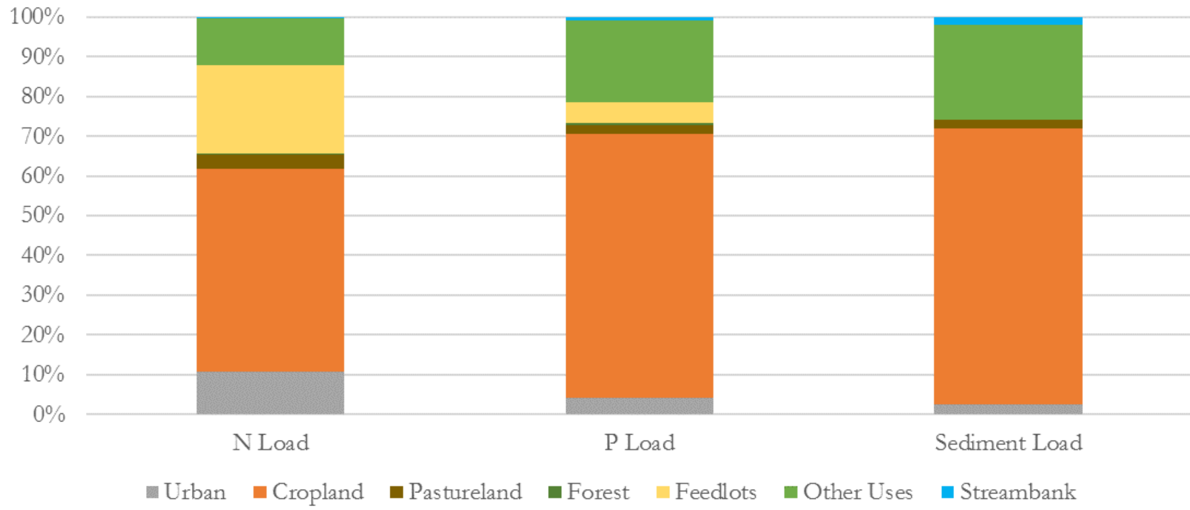


Figure 53. Estimated percent contributions to existing pollutant load by source based on STEPL modeling.

The results of the STEPL model were also analyzed for nonpoint source pollutant loads at the Subwatershed Management Unit (SMU) scale. This allows for a more refined breakdown of nonpoint pollutant sources and leads to the identification of pollutant load "Hot Spots." Hot Spot SMUs were selected by examining pollutant load concentration (load/acre) for nitrogen, phosphorus, and sediment for each SMU. Pollutant load concentrations were then summarized and ranked by SMU from highest to lowest contributors and then subdivided into five categories based on their relative contribution to the overall pollutant loading in the watershed. Table 30 and Figure 54 depict and summarize the results of the SMU scale pollutant loading analysis. Five of the 35 SMUs comprising Fredonia-Newburg Area watershed are considered "High Concentration" pollutant load Hot Spots for nitrogen, phosphorus, and sediment based on STEPL modeling. Four SMUs are considered "High to Moderate Concentration" pollutant load Hot Spots for various combinations of nitrogen, phosphorus, and sediment. Another 6 SMUs are considered "Moderate" and five are "Moderate to Low Concentration" pollutant load Hot Spots. The remaining fifteen SMUs contribute "Low Concentrations" based on modeling.

Table 30. Pollutant load "Hot Spot" SMUs.

SMU	Size (acres)	N Load (lb/yr)	N Load (lb/yr) /acre	P Load (lb/yr)	P Load (lb/yr) /acre	Sediment Load (t/yr)	Sediment Load (t/yr) /acre
High Concentration Hot Spot SMUs							
SMU 15	1,070	77,273.6	72.2	13,699.2	12.8	498	0.5
SMU 01	1,643	66,193.1	40.3	15,725.8	9.6	1,260	0.8
SMU 31	545	6,204.7	11.4	3,737.7	6.9	881	1.6
SMU 21	1,088	11,241.4	10.3	5,820.0	5.3	1,306	1.2
SMU 27	607	5,116.7	8.4	3,517.5	5.8	842	1.4
High to Moderate Concentration Hot Spot SMUs							
SMU 02	536	3,778.2	7.0	2,762.8	5.2	671	1.3
SMU 20	624	4,057.8	6.5	2,810.2	4.5	687	1.1
SMU 28	1,442	8,999.5	6.2	5,133.3	3.6	1,212	0.8
SMU 17	1,542	8,687.4	5.6	5,487.8	3.6	1,269	0.8
Moderate Concentration Hot Spot SMUs							
SMU 08	1,041	5,970.7	5.7	3,422.4	3.3	808	0.8
SMU 10	1,668	7,660.6	4.6	6,116.7	3.7	1,523	0.9
SMU 06	985	4,763.5	4.8	3,359.9	3.4	839	0.9
SMU 05	1,349	6,060.2	4.5	4,879.2	3.6	1,224	0.9
SMU 03	775	3,401.6	4.4	2,653.4	3.4	660	0.9
SMU 11	475	2,886.7	6.1	762.6	1.6	327	0.7
Moderate to Low Concentration Hot Spot SMUs							
SMU 07	486	1,925.3	4.0	1,356.2	2.8	336	0.7
SMU 25	901	3,599.6	4.0	2,380.1	2.6	571	0.6
SMU 09	1,098	4,118.7	3.8	3,085.9	2.8	775	0.7
SMU 33	1,870	9,370.3	5.0	3,460.5	1.9	558	0.3
SMU 14	1,476	5,811.0	3.9	3,486.1	2.4	841	0.6

A brief summary of "High Concentration" pollutant loading Hot Spots follows:

- SMUs 01 (1,643 acres) and 15 (1,050 acres) are both high concentration Hot Spot SMUs due predominantly to feedlot and cropland uses; as such, these are the two highest contributors to pollutant loading in the watershed for nitrogen and phosphorus.
- SMUs 27 (607 acres), 31 (545 acres), and 21 (1,088) are subwatersheds with very high pollutant concentrations originating predominantly from cropland and other uses.

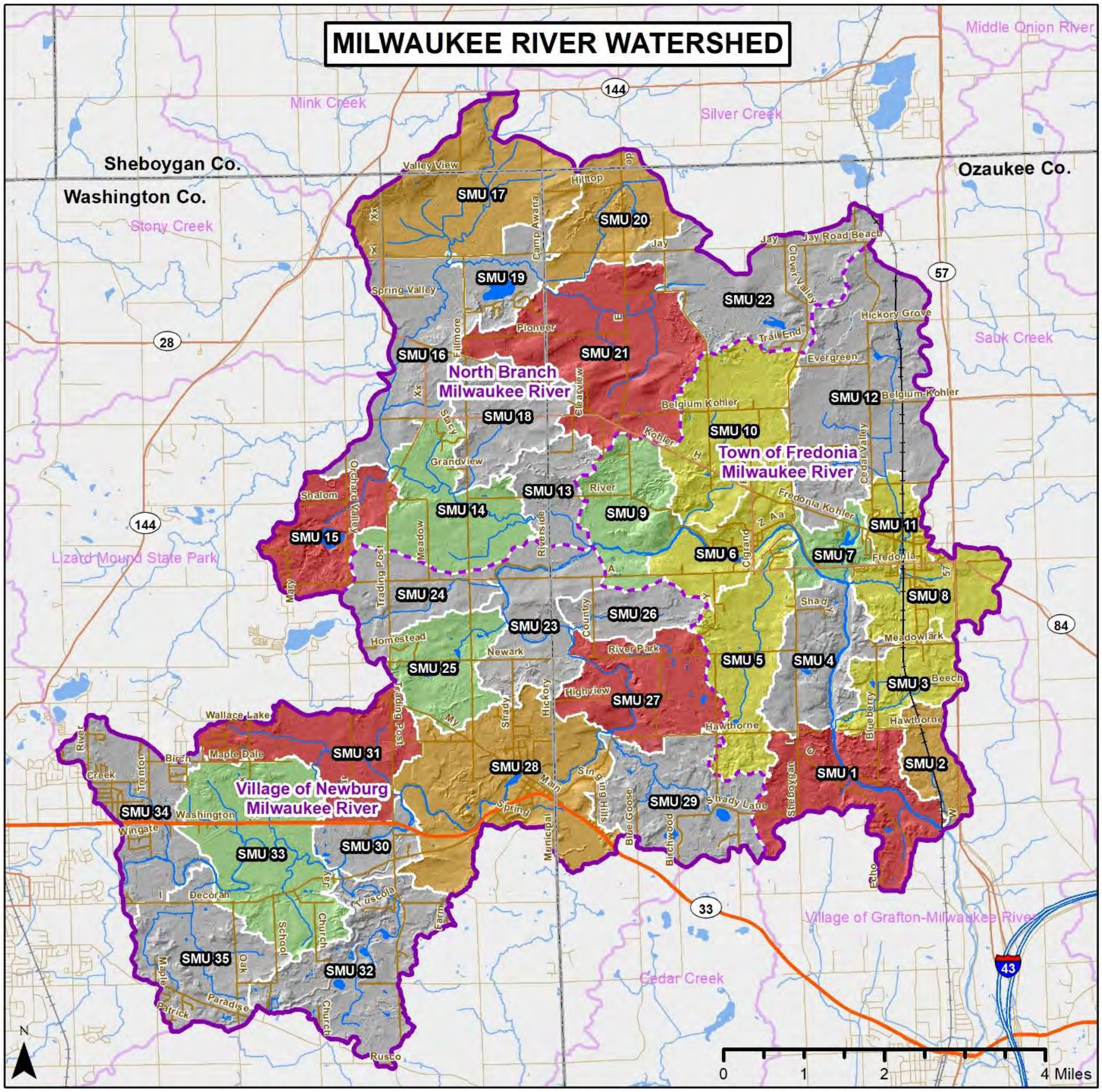
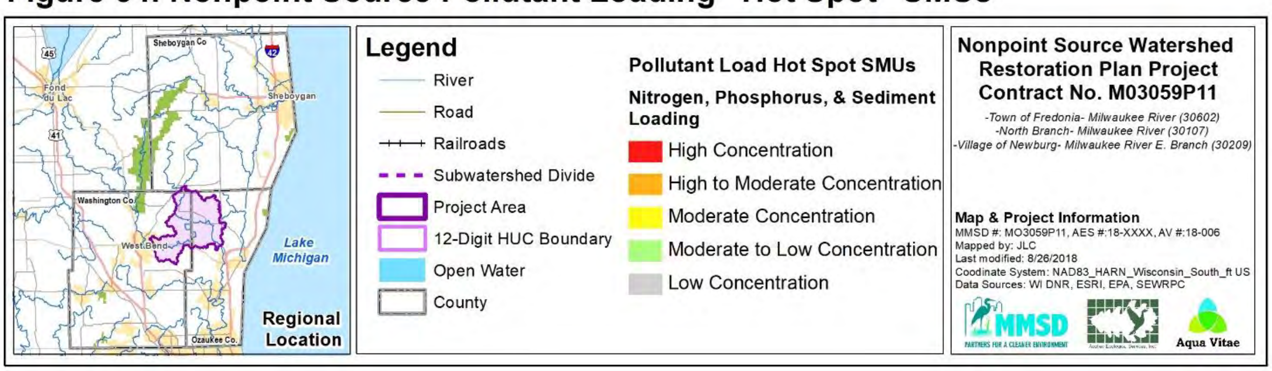


Figure 54. Nonpoint Source Pollutant Loading "Hot Spot" SMUs



4.4.2 Agricultural EVAAL Modeling

Wisconsin Department of Natural Resources (WDNR) created a model called Erosion Vulnerability Assessment for Agricultural Lands (EVAAL). This tool analyzes a number of factors such as topography, soils, rainfall, and land cover to prioritize areas within a watershed that may be vulnerable to soil loss and erosion. Identifying where soils are vulnerable to erosion is important, because erosion contributes sediment and nutrients such as nitrogen and phosphorus to streams. These contributions increase pollutant loading and can result in increased stream turbidity.

EVAAL Version 1.0.1 (December 2015) was used to assess the vulnerability of agricultural lands to erosion. This tool uses the Universal Soil Loss Equation, (USLE) to estimate the risk of sheet and rill erosion and the Stream Power index (SPI) to estimate the risk of gully erosion. The EVAAL model also reduces the influence of those areas that are not hydrologically connected to surface waters, such as internally drained areas, on the final results (WDNR, 2018).

Using the EVAAL model, each parcel was ultimately assigned an average Erosion Vulnerability Score (Figure 55). These scores ranged from -1.550 (these being the least vulnerable to erosion) to 5.203. The higher the mean score, the more vulnerable the parcel is to erosion. The results of the EVAAL modeling are depicted in Figure 55. Ultimately, 3,447 acres were ranked as being highly vulnerable to erosion, with scores on these parcels ranging from 1.450 to 5.203.

The results of the EVAAL modeling will be used to prioritize agricultural projects in the Site-Specific Action Plan (Table 41) if and when additional recommendations are outlined on the highly vulnerable parcels in order to prioritize funding for these projects.

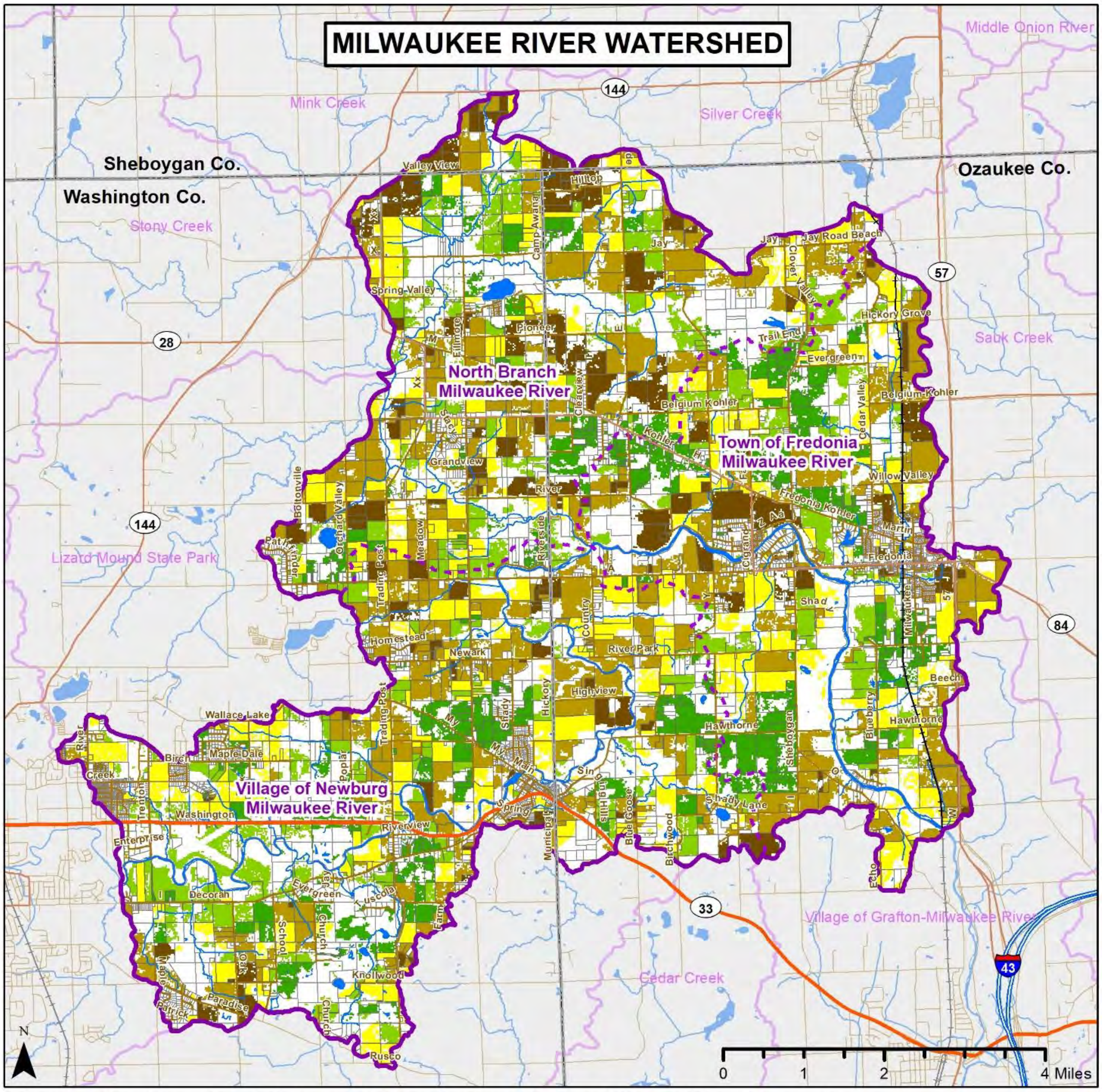
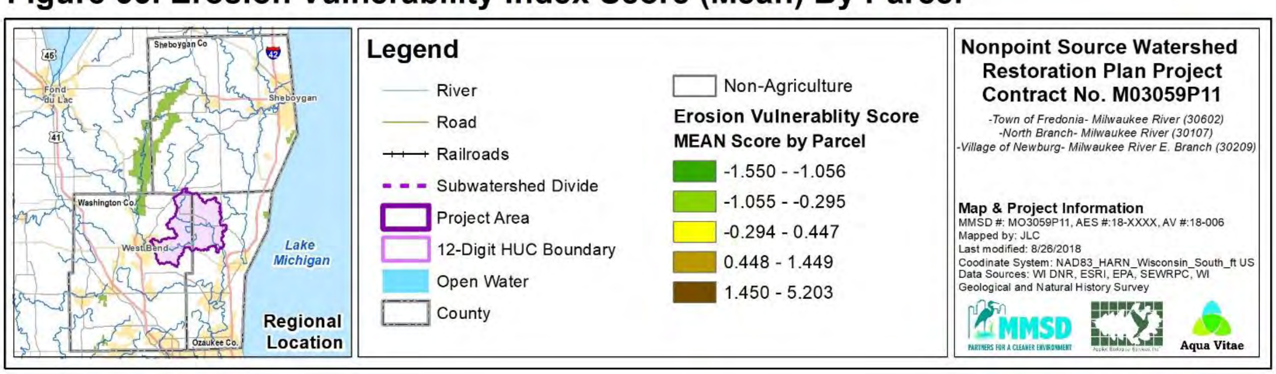


Figure 55. Erosion Vulnerability Index Score (Mean) By Parcel



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5.0 CAUSES & SOURCES OF IMPAIRMENT & REDUCTION TARGETS

5.1 Causes & Sources of Impairment

According to WDNR's 2018 303(d) list, the Milwaukee River, North Branch Milwaukee River, and Fredonia Creek within the Fredonia-Newburg Area watersheds are all listed as impaired. This section of the Milwaukee River is 303(d) listed because of unknown pollutant and total phosphorus resulting in elevated water temperatures and an unknown impairment; this section was also 303(d) listed for PCBs at one time but was delisted in 2006. The North Branch Milwaukee River is 303(d) listed because of excessive amounts of phosphorus resulting in a degraded biological community. Finally, Fredonia Creek is 303(d) listed because of excessive amounts of phosphorus resulting in an unknown impairment.

Causes and sources of water quality impairment are based on WDNR's 303(d) impaired waters information for the Milwaukee River, North Branch Milwaukee River, and Fredonia Creek. It is also important to note that there are also non-water quality related impairments in the watershed such as habitat degradation, loss of open space, hydrologic and flow changes, and reduced groundwater infiltration. Many different causes and sources are related to these impairments. Table 31 summarizes all *known* or *potential* causes and sources of watershed impairments.

Table 31. *Known* and *potential* causes and sources of watershed impairment.

Impairment	Cause of Impairment	Known or Potential Source of Impairment
Water Quality/Fish & Aquatic Life	Nutrients- *known impairment*: (Phosphorus)	Agricultural row crop runoff Residential, Ag, and commercial lawn fertilizer Failing septic systems Livestock operations (manure) Wastewater Treatment Plants Streambank erosion
Water Quality/Fish & Aquatic Life	Sediment- *known impairment* (Total Suspended Solids/turbidity)	Agricultural row crop runoff Urban runoff (roads, parking lots, building, homes, etc.) Discharges from municipal storm sewer systems (MS4) Streambank erosion Construction site runoff
Water Quality: Contact	Bacteria *Known impairment* (*E.coli*)	Septic system failures Illicit sewage discharges Animal/livestock waste Wastewater treatment plants Urban stormwater runoff
Water Quality/Fish & Aquatic Life	Elevated Temperatures- *known impairment*	Lack of appropriate riparian cover Excess channelization Lack of pool/riffles Stormwater discharges Increases in turbidity or nutrient loads
Water Quality/Fish & Aquatic Life	Nutrients- *potential impairment*: (Nitrogen)	Agricultural row crop runoff Residential, Ag, and commercial lawn fertilizer Failing septic systems Livestock operations (manure) Streambank erosion Pet waste

Impairment	Cause of Impairment	Known or Potential Source of Impairment
Habitat Degradation	Invasive/non-native plant species in riparian and other natural areas- *known impairment*	Spread from existing and introduced populations Off road vehicles Hiking off designated trails Loss of wildlife habitat
Habitat Degradation	Loss and fragmentation of open space/natural habitat due to development & groundwater changes- *known impairment*	Inadequate protection policy Traditional development design Streambank, channel, and riparian area modification Lack of needed natural land management Lack of restoration and maintenance funds Wetland loss
Hydrologic and Flow Changes	Impervious surfaces- *known impairment*	Existing & future urban runoff Wetland loss
Aquifer Drawdown	Reduced infiltration & human use- *known impairment*	Groundwater wells Traditional development design Existing and future urban impervious surfaces Inadequate protection policy Wetland loss

5.2 Priority Areas & Management Measures

For this watershed plan a Priority Area is best described as a location in the watershed where future restoration projects are likely to make the most impact on improving water quality or existing or potential causes and sources of an impairment or existing function are significantly worse than other areas of the watershed. Seven Priority Area types were identified in the Fredonia-Newburg Area watershed and include: 1) stream and riparian area restorations; 2) agricultural management recommendations; 3) potential wetland restorations; 4) natural area restorations; 5) bioswale opportunities; 6) golf course naturalizations; and 7) other potential sites, typically geared towards education, but not fitting the categories above. Short descriptions of each Priority Area type are included below. Table 32 includes summaries of the current condition at each Priority Area (by type) and recommended Management. The list of Priority Areas is derived from a comprehensive list of measures found in the Action Plan section of this report. Figure 56 maps the location of each Priority Area.

Priority Stream and Riparian Area Restorations

Priority stream and riparian area restorations are stream reaches with riparian areas that exhibit poor ecological condition or lack buffers but that show excellent potential for ecological restoration and remediation to improve water quality and habitat conditions. Some of these Priority stream reaches would also benefit from using native vegetation and/or bioengineering to stabilize small stretches of bank, while others may need additional instream improvements such as the installation of artificial riffles to improve habitat conditions and increase oxygen levels. Eleven stream reaches, totaling approximately 115,642 linear feet, are categorized as High Priority reaches. Section 3.14.1 includes a full summary of the streams and tributaries in the watershed.

Priority Agricultural Land

It is well documented that agricultural land is a significant contributor of nutrients and sediment to surface waters. According to modeling, agricultural/cropland areas contribute 40% of the nitrogen loading, 58% of the phosphorus load, and 67% of the sediment load to surface waterbodies in these watersheds. In the Fredonia-Newburg Area watersheds this is by far the highest contributor to phosphorus loading, contributing three times more phosphorus than the next highest phosphorus source. There are more than 23,000 acres of cropland (49%) in the Fredonia-Newburg Area watersheds.

During the pollutant loading analysis, all agricultural lands were evaluated according to their Erosion Vulnerability using WDNR's EVAAL model (see Section 4.4.2 for more details). All agricultural parcels that were ranked as being highly vulnerable to erosion, receiving a score ranging from 1.450 to 5.203, are identified as Priority Agricultural Land. Ultimately, 3,447 acres of agricultural land were identified as Priority Areas based on their vulnerability to erosion using the EVAAL model. Practices explored in this plan to reduce pollutant loading from agricultural lands include no-till, reduced tillage, conservation cropping, or injection.

Additionally, 981 acres of agricultural lands were identified during the Aug/Sept 2018 field inventory as needing additional agricultural management measures. Typically, these include the need for cover crops, no-till or reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land.

Feedlots, such as dairy barns or combined animal feedlots (CAFOs) are a significant contributor of nutrient and bacteria loading. According to modeling, feedlots contribute 38% of the nitrogen loading and 15% of the phosphorus load in the watershed. Two feedlots and one smaller dairy operation were found in the Fredonia-Newburg Area watersheds with a combined total of over 5,000 animal units; both of the feedlots are permitted facilities with nutrient management plans in place. These three sites were identified as Priority Areas based on the size of their contribution to nutrient loading in the watersheds. Recommendations in this plan include adjustments to existing nutrient management plans targeted at reducing nutrient loading.

Other Management Measure Sites

For this watershed plan, Other Management Measures include potential wetland restorations, natural area restorations, bioswale opportunities, golf course naturalization, and a few other miscellaneous project types generally targeting educational opportunities.

Priority wetlands restoration sites are generally associated with areas where wetlands that were present prior to European settlement in the 1830s but were drained for agricultural or residential purposes. Many of these historic wetlands can be restored by breaking existing drain tiles and planting with native vegetation. Wetland restorations are excellent projects to improve water quality, reduce flooding, and improve wildlife habitat. Priority Area status was assigned based on location, size, and restoration potential. There are five Priority wetland restoration areas totaling roughly 300 acres. A detailed summary of the extent of drained wetlands and potential wetland restoration opportunities in the watershed is included in Section 3.14.2.

Natural area restorations are large scale natural areas such as woodlands, prairies, and wetlands that are in need of restoration and management plans. These sites would typically benefit from invasive species removal and management, planting of native vegetation, and ongoing maintenance to improve ecological condition, habitat, and water quality. There are four Priority Area natural area restorations.

Potential bioswale opportunities are typically areas along roadways or in older subdivisions that lack detention basins or more formal water quality management. Many of these sites include mown turf grass swales that could be retrofitted as bioinfiltration swales to filter pollutants and are aesthetically pleasing and planted with native plants. There are two Priority Area opportunities to convert such grass swales to bioinfiltration swales.

There are two Priority Area golf course naturalizations in the Fredonia-Newburg Area watersheds. Golf course naturalization includes establishing low stature prairie buffers in rough areas and surrounding pond features and can help cut the maintenance costs of the facilities while improving ecological health and increasing habitat for wildlife.

The remaining Priority Area projects include two educational/rain garden projects, one detention basin retrofit, and one industrial site that needs large scale detention.

Table 32. Summary of Priority Areas, description, & Management Measure recommendations.

Priority Areas	Description	Recommended Priority Area Management Measure
Stream and Riparian Area Restoration		
Tr14	6,600 lf of stream exhibiting low levels of channelization, relatively stable banks, and poor overall riparian area condition	Design and implement a project to improve quality and increase buffers, remove invasives, restore native vegetation and maintain for three years to establish
Tr1b	4,727 lf of stream exhibiting high levels of channelization, moderately stable banks, and good overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish
Tr5	7,413 lf of stream exhibiting high levels of channelization, moderately stable banks, and poor overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish
Tr6	24,441 lf of stream exhibiting high levels of channelization, moderately stable banks, and poor overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish
Tr7	12,031 lf of stream exhibiting low levels of channelization, moderately stable banks, and poor overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish
Tr10	7,845 lf of stream exhibiting low levels of channelization, relatively stable banks, and average overall riparian area condition	Design and implement a project to increase buffers, remove invasives, restore native vegetation and maintain for three years to establish
Tr16	8,474 lf of stream exhibiting moderate channelization, moderately stable banks, and poor overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish
Tr19	14,218 lf of stream exhibiting high levels of channelization, moderately unstable banks, and poor overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish
Tr8	6,746 lf of stream exhibiting no channelization, moderately unstable banks, and average overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish
Tr13	16,208 lf of stream exhibiting low levels of channelization, moderately stable banks, and poor overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish
Tr15	6,939 lf of stream exhibiting high levels of channelization, moderately stable banks, and poor overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish
Agricultural Management Practices		
80B	Agricultural drainage from field and farm yard to stream	Utilize new or additional adjustments to nutrient management plans such as waste management system
30A	Large dairy with narrow grass drainage way adjacent drained hydric soils	Design and implement a project to increase swale width and utilize potential restorable wetland soils for wetland creation; utilize additional nutrient management as appropriate
40C	Existing cattle/dairy farm and pasture with intense grazing immediately adjacent stream	Utilize new or additional adjustments to nutrient management plans such as waste management system
47B	Traditional row crop agricultural field with bare/exposed ground in field - additional infield practice needed	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land
57D	Traditional row crop agricultural field (corn) that could use grass swale and vegetated buffer	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land
20A	Landspreading occurring on row crop disced-under field adjacent mowed ditch with recent runoff and manure evident (runs south)	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land

Priority Areas	Description	Recommended Priority Area Management Measure
24A	Cattle overgrazing in agricultural wetland with no buffer and draining directly to channelized swale	Utilize waste management system and fencing to restrict livestock access on private agricultural land
25A	Land spreading of manure on traditional row crop agricultural field	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land
57C	Traditional row crop agricultural field draining to adjacent wetland	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land
65A	Cattle overgrazing in field with narrow buffer between farm and adjacent stream	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land
69A	Traditional row crop agricultural field that runs down sloped hill; could use contour cropping	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land
Various	Existing agricultural land identified as a Priority Area project in Ozaukee County based on EVAAL Erosion Hazard analysis.	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land
Various	Existing agricultural land identified as a Priority Area project in Sheboygan County based on EVAAL Erosion Hazard analysis.	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land
41B	Traditional row crop agricultural field receiving excessive flows compared to adjacent areas	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land
51A	Buffer needed surrounding wetland, floodplain and hydronic soils; ensure cover crop is establish prior to high flows	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land
52A	Traditional row crop agricultural field with poor cover crop	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land
52B	Animal farm yard with exposed bare soils, obvious and excessive erosion draining to adjacent stream	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land
63B	Marginal agricultural land adjacent heavily eroded right of way area	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land
75B	Animal farm yard immediately adjacent stream; no buffer	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land
84A	Traditional row crop agricultural field with no cover crop	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land
Various	Existing agricultural land identified as a Priority Area project in Washington County based on EVAAL Erosion Hazard analysis.	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land
44A	Cattle overgrazing on agricultural land	Utilize pasture rotation, waste management system, and/or fencing to restrict livestock access on private agricultural land
45A	Cattle overgrazing in agricultural wetland	Utilize pasture rotation, waste management system, and/or fencing to restrict livestock access on private agricultural land
69B	Cattle grazing adjacent stream with no buffer or fencing	Utilize pasture rotation, waste management system, and/or fencing to restrict livestock access on private agricultural land

Priority Areas	Description	Recommended Priority Area Management Measure
40B	Excessive cattle use on agricultural land immediately adjacent stream	Utilize pasture rotation, waste management system, and/or fencing to restrict livestock access on private agricultural land
57B	Traditional row crop agricultural land that could use grass swale; pond and stream with no buffers	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land; install appropriate buffers on waterways
Other Management Measures		
47A	Existing typical mowed turf roadside swales in right-of-way	Design and implement a project to retrofit existing turf swales to bioinfiltraton swales and maintain
72A	Existing typical mowed turf roadside swales in residential development	Design and implement a project to retrofit existing turf swales to bioinfiltraton swales and maintain
47C	Existing typical wet bottom detention basin with mown turf side slopes and large concrete structure at outlet	Design and implement a project to retrofit existing detention basin to remove turf and install natives along slopes and buffer and maintain for three years to establish
68A	Hawthorn Hills Golf Course with typical golf course landscaping	Design and implement a project to naturalize rough areas and install buffers on waterways to improve water quality
87A	Exiting golf course in Washington County with typical landscaping	Design and implement a project to naturalize rough areas and install buffers on waterways to improve water quality
17D	Large industrial gravel and sand operation draining thru wetland to channelized Tributary 3	Design and implement a project to create and install naturalized detention basin to appropriately manage runoff
26A	Exiting gravel dump site that could use silt fence	Install silt fence as appropriate and maintain
18A	Existing woodland in good shape with some invasive spp; EAB has decimated ash canopy; prairie mostly brome with secondary tree growth	Conduct a natural resource inventory and develop a management plan to restore natural area and maintain for three years
72C	Existing ball field at Winggate Park, unused or low-use areas could be naturalized and include educational signage	Design and implement a project to naturalize unused or low-use areas and create signage to educate stakeholders about water quality
97B	Commercial/industrial campus with typical landscaping and parking lot areas	Design and implement a project to naturalize landscaping and install parking lot BMP such as pavement alternatives
17C	Drained and/or farmed hydric soils confirmed in field as good candidate sight for potential wetland restoration	Design and implement a project to restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation; maintain for three to five years until established
27A	Drained and/or farmed hydric soils confirmed in field as good candidate sight for potential wetland restoration	Design and implement a project to restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation; maintain for three to five years until established
57A	Wet depression in front of company building	Design and implement a project to create small wetland or rain garden in front of building
72B	Probably planned development - need to naturalize wet areas to protect headwaters as development occurs	Design and implement a project to protect natural areas from development while maintaining existing density
56A	Waubedonia Park - could create wetland restoration and educational signage in park	Design and implement a project to restore wetlands in low-use areas and create educational signage; maintain for five years until established

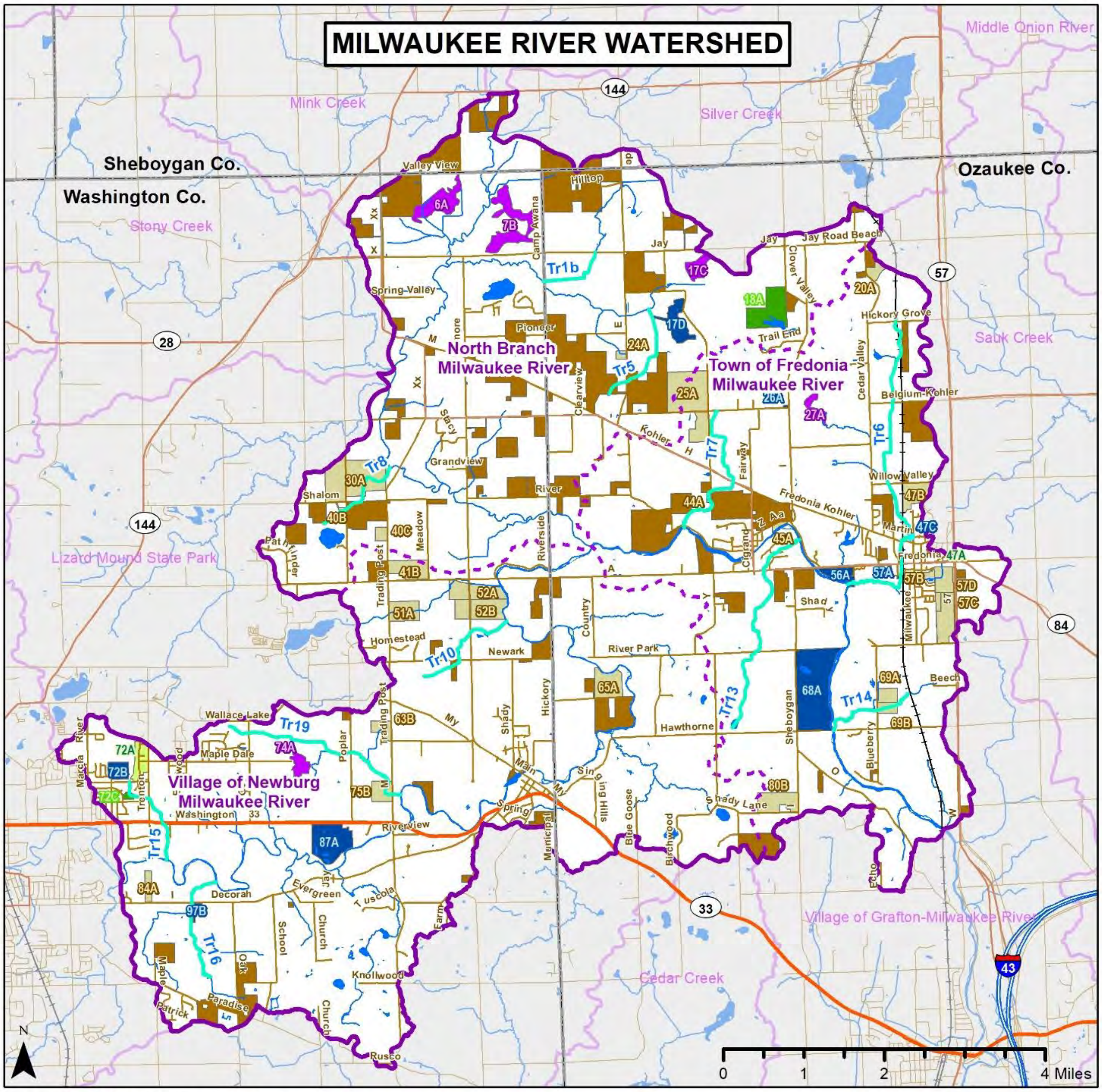
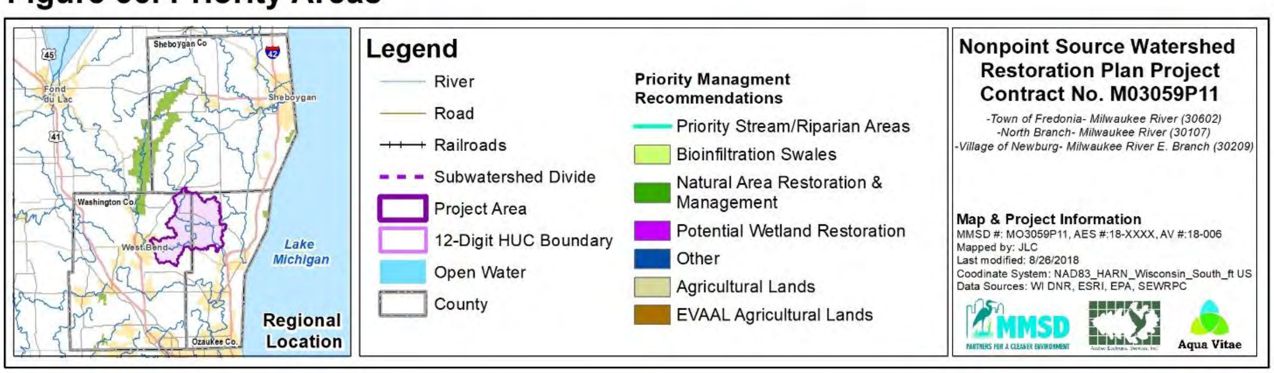


Figure 56. Priority Areas



5.3 Water Quality Impairment Reduction Targets

Establishing water quality impairment reduction targets is important because these targets provide a means to measure how implementation of Management Measures at Priority Areas is expected to reduce watershed pollutants over time. Table 33 summarizes the basis for *known* pollution impairments and reduction targets. Reduction targets listed in Table 33 are based on the percent reduction calculated under the Milwaukee River Total Maximum Daily Load (TMDL) (2018) for the corresponding watersheds within the Fredonia-Newburg Area watersheds, under the guidance of WDNR.

The watershed boundaries that were used for the Milwaukee River TMDL do not match the watershed boundaries of this watershed plan. The watershed boundary for the Newburg watershed is very similar to the Milwaukee River TMDL MI-7 watershed boundary, and likewise the watershed boundary for the Fredonia watershed is very similar to the Milwaukee River TMDL MI-15 watershed boundary. The North Branch watershed consists of roughly half of the Milwaukee River TMDL MI-13 watershed boundary. AES used the required percent reductions calculated under the Milwaukee River TMDL for total phosphorus and total suspended solids. For fecal coliform, no percent reductions were developed and there was not enough data to determine an annual load reduction target.

According to the existing conditions STEPL modeling completed for the Fredonia-Newburg Area watersheds, pollutant loading in the watershed is estimated at 267,420.9 lbs/yr of nitrogen, 119,568.5 lbs/yr of phosphorus, and 26,573.8 tons/yr of sediment. According to the TMDL, the required percent reduction of agricultural total phosphorus is 45% for MI-7 (Newburg), 33% for MI-13 (North Branch), and 51% for MI-15 (Fredonia). The required percent reduction of total suspended solids is 68% for MI-7 (Newburg), 66% for MI-13 (North Branch), and 57% for MI-15 (Fredonia). There was not enough data available to calculate potential bacterial loading using the model, but under the Milwaukee River TMDL the fecal load *allocations* were determined to be 349,556 billion cells/season for MI-7 (Newburg), 283,024 billion cells/season for MI-13 (North Branch), and 339,189 billion cells/season for MI-15 (Fredonia).

Watershed-Wide Reduction Targets for Phosphorus, Suspended Solids & Bacteria

The STEPL modeling was run a second time, including all projects identified in the site-specific action plan table to determine load reductions. Table 33 summarizes the load reduction of phosphorus, nitrogen, and total suspended solids (sediment) expected from addressing all recommended management measures. *E. coli* is also included in Table 33 but there is not enough existing *E. coli* water quality data for the watershed to determine a basis for impairment beyond the Milwaukee River TMDL. There is a gap in science and knowledge on how to cost effectively monitor water quality using *E. coli* as the indicator for bacteria-based surface water impairments. WDNR is currently working with a Bacteria Team to facilitate implementation of best management practice prioritization to address *E. coli* in MS4 stormwater runoff. *E. coli* load duration curves are being developed for portions of the Milwaukee River Watershed based on *E. coli* concentration data collected from September 2017 through November 2019 at sites downstream from the Fredonia Newburg Watershed Plan Area. The Baseline Water Quality Monitoring Phase 1: Cedar, Pigeon, Ulao, and Mole Creeks Final Report deliverable containing load duration curves for *E. coli* will be available through MMSD in summer 2020. Table 34 summarizes the STEPL modeling results (baseline, "with BMP," and reduction) for nitrogen, phosphorus, and sediment by subwatershed management unit.

Watershed-wide phosphorus and sediment reduction targets could not be attained by addressing all Management Measure recommendations (Table 33). It is estimated that my implementing all recommended management measures, 23,193 lbs/yr of phosphorus (19.4%), 19,307 lbs/yr of nitrogen (7.2%), and 4,060 tons/yr of sediment (15.3%) could be removed. It is not known if target bacteria levels can be attained because models do not predict removal efficiency, but many of the recommended restoration projects that address nutrient reductions also reduce bacterial loading.

Both the baseline and "with BMP" STEPL models and all assumptions used in the model were done in consultation with and under the guidance of WDNR and can be found in Appendix E.

Table 33. Basis for *known* water quality impairments, reduction targets, & impairment reduction from all recommended Management Measures.

Impairment: Cause of Impairment	Basis for Impairment	Reduction Target	Reduction from Implementation of all recommended Management Measures
Phosphorus	119,569 lbs/yr of phosphorus loading based on baseline STEPL model	**> 45% for MI-7 (Newburg), 33% for MI-13 (North Branch), and 51% for MI-15 (Fredonia) reduction in phosphorus** loading to achieve Milwaukee River TMDL allocation	23,193 lbs/yr **(19.4%)** of phosphorus reduction based on STEPL model with BMPs
Nitrogen	267,421 lb/yr of total nitrogen loading based on baseline STEPL model	**No reduction target calculated under TMDL**	19,307 lbs/yr **(7.2%)** of nitrogen reduction based on STEPL model with BMPs
Total suspended solids (sediment)	26,574 tons/yr of sediment loading based on baseline STEPL model	**>68% for MI-7 (Newburg), 66% for MI-13 (North Branch), and 57% for MI-15 (Fredonia) reduction in sediment** loading to achieve Milwaukee River TMDL allocation	4,060 tons/yr **(15.3%)** of phosphorus reduction based on STEPL model with BMPs
Bacteria (*E.coli*)	Not enough *E. coli* data to make a determination; no fecal coliform data	Not enough data to determine reduction percent, but based on Milwaukee River TMDL, **fecal coliform load allocations are 349,556 billion cells/season for MI-7 (Newburg), 283,024 billion cells/season for MI-13 (North Branch), and 339,189 billion cells/season for MI-15 (Fredonia).**	N/A – reduction cannot be calculated

Table 34. STEPL baseline and "with BMP" pollutant estimates by subwatershed and calculated reduction for Nitrogen, phosphorus, and sediment.

SMU	Load baseline	Load (with BMP)	Reduced	Load baseline	Load (with BMP)	Reduced	Load baseline	Load (with BMP)	Reduced
	Nitrogen lbs/year			Phosphorus lbs/year			Sediment t/year		
1	5,780	4,533	1,247	6,992	5,851	1,141	1,264	1,043	221
2	3,862	3,827	35	2,779	2,741	37	671	661	9
3	7,262	6,951	310	3,163	2,579	584	659	584	76
4	3,920	3,655	265	3,099	2,819	279	764	693	72
5	6,333	5,888	446	4,931	4,501	430	1,224	1,105	119
6	4,914	4,060	854	3,389	2,517	872	839	622	217
7	2,060	1,835	224	1,382	1,139	243	336	274	62
8	8,777	7,790	988	3,951	2,847	1,103	807	589	218
9	4,345	3,597	748	3,129	2,311	818	775	570	204
10	0,201	8,997	1,204	6,751	5,482	1,269	1,523	1,230	293
11	2,968	2,497	471	778	558	220	327	224	104
12	3,233	2,496	737	3,824	3,547	277	2,401	2,215	186
13	2,425	2,110	315	1,608	1,276	331	394	313	81
14	0,481	0,140	341	4,366	3,959	407	841	793	48
15	1,563	9,870	1,693	3,718	1,925	1,793	503	285	217
16	5,486	4,944	542	3,639	3,079	560	897	763	135
17	9,408	7,699	1,708	5,625	3,995	1,630	1,269	893	377
18	5,904	5,349	555	3,033	2,502	531	662	540	122
19	2,065	1,948	117	1,494	1,372	122	370	331	39
20	4,297	3,840	456	2,856	2,381	475	687	572	115
21	7,955	5,314	2,641	9,439	5,460	3,979	1,305	911	394
22	9,601	9,338	264	4,589	4,180	409	931	873	58
23	7,175	6,671	504	3,561	2,883	678	775	667	108
24	9,679	8,797	882	4,528	2,435	2,093	654	464	190
25	3,783	3,622	161	2,415	2,246	170	571	529	41
26	2,150	2,150	-	1,620	1,620	-	392	392	-
27	4,820	4,241	579	4,791	3,557	1,234	842	720	121
28	9,534	9,359	175	5,235	5,055	180	1,212	1,169	43
29	4,957	4,847	110	3,191	3,076	114	756	728	28
30	2,165	2,040	125	1,300	1,170	130	310	277	33
31	9,637	9,180	457	4,573	4,031	542	881	784	98
32	0,681	0,528	153	3,820	3,281	539	730	699	31
33	0,081	0,042	40	3,596	3,556	39	558	546	12
34	5,040	4,868	172	1,555	1,475	80	307	284	22
35	3,508	3,381	127	1,349	1,272	78	268	251	17
Total	**286,050**	**266,405**	**19,645**	**126,069**	**102,679**	**23,390**	**27,707**	**23,596**	**4,111**

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6.0 MANAGEMENT MEASURES ACTION PLAN

Earlier sections of this plan summarized Fredonia-Newburg Area watersheds' characteristics and identified causes and sources of watershed impairment. This section includes an "Action Plan" developed to provide stakeholders with recommended "Management Measures" (Best Management Practices) to specifically address plan goals at general and site-specific scales. The Action Plan is divided into two subsections:

- *Programmatic Measures*: general remedial, preventive, and policy watershed-wide Management Measures that can be applied across the watershed by various stakeholders.
- *Site Specific Measures:* actual locations where Management Measure projects can be implemented to improve surface and groundwater quality, and green infrastructure.

The recommended programmatic and site-specific Management Measures provide a solid foundation for protecting and improving watershed conditions but should be updated as projects are completed, or other opportunities arise. Key implementation stakeholders are encouraged to organize partnerships and develop various funding arrangements to help delegate and implement the recommended actions. The key stakeholders in the watershed are listed in Table 35.

The unincorporated Towns of Farmington, Fredonia, Saukville, Scott, Sherman, Trenton, and Waubeka, while all key stakeholders and partners, are not specifically called out to coordinate or implement any management recommendations due to their status.

Table 35. Key Fredonia-Newburg Area watershed stakeholders/partners.

Key Watershed Stakeholder/Partner	Acronym/Abbreviation
Milwaukee Metropolitan Sewerage District	MMSD
Village of Fredonia	Fredonia
Village of Newburg	Newburg
City of West Bend	West Bend
Town of Farmington	Farmington
Town of Fredonia	Town of Fredonia
Town of Saukville	Saukville
Town of Scott	Scott
Town of Sherman	Sherman
Town of Trenton	Trenton
Town of Waubeka	Waubeka
United States Environmental Protection Agency (Region 5)	USEPA
Wisconsin Department of Natural Resources	WDNR
Southeastern Wisconsin Regional Planning Commission	SEWRPC
Ozaukee County	Ozaukee
Sheboygan County	Sheboygan
Washington County	Washington
USDA Natural Resource Conservation Service	USDA
Riveredge Nature Center	Riveredge
Milwaukee Riverkeeper	MR
Milwaukee River Watershed Clean Farm Families	Clean Farm
UWM School of Freshwater Sciences	UWM Freshwater

Key Watershed Stakeholder/Partner	Acronym/Abbreviation
UW-Extension	UW-Ext
Community Rivers Program	Comm Rivers
Sweetwater	Sweetwater
Ozaukee Washington Land Trust	OWLT
Developers	Developer
Farming Community	Farm
Private Landowners	Private

6.1 Programmatic Management Measures Action Plan

Numerous types of programmatic Management Measures are recommended to address watershed objectives for each plan goal. The following pages include recommended measures that are applicable throughout the watershed and information needed to facilitate implementation of specific actions. A brief summary of the general programmatic measure types is included below:

Policy: Local, state, and federal government can help prevent watershed impairments in various ways through policy but specifically by adopting the Fredonia-Newburg Area watershed plan, implementing green infrastructure policy, requiring conservation developments, protecting groundwater, reducing road salt usage, requiring natural detention basins, and allowing use of native vegetation/landscaping.

Non-Structural: This includes a broad group of practices that prevent impairment through maintenance and management of Management Measures or programs that are ongoing in nature and designed to control pollutants at their source. Such BMPs include agricultural programs available to farmers and street sweeping.

Structural: This includes a broad group of practices that prevent impairment via installation of in-the-ground measures. This plan focuses on implementation of naturalized stormwater measures/retrofits, permeable paving, vegetated filter strips/buffers, natural area restoration, wetland restoration, and use of rainwater harvesting devices.

Educational: Outreach is important to educate the public related to environmental impacts of daily activities and to build support for watershed planning and projects. Topics typically addressed include land management, pet waste management, good housekeeping, etc.

Noteworthy- *Local Watershed Resource Educational Material*

- "The Water's Edge – Helping fish and wildlife on your waterfront": Produced by WDNR & UWEX
- "Shoreline Plants and Landscaping": Produced by WDNR & UWEX
- "Managing the Water's Edge – Making Natural Connections": Produced by SEWRPC
- "Protecting Your Waterfront Investment": Produced by WDNR, UW Extension Center for Land Use Education, & UWEX
- "Impervious Surfaces – How they Impact Fish, Wildlife, and Waterfront Property Values": Produced by WDNR, UW Extension Center for Land Use Education, & UWEX
- "Managing Leaves and Yard Trimmings": Produced by UWEX, WDNR, and SEWRPC
- "Storm Sewers – The Rivers Beneath our Feet": Produced by WDNR & UWEX
- "Rain Gardens – A how-to manual for homeowners": Produced by WDNR & UWEX

6.1.1 Policy Recommendations

This report makes various recommendations specifying how local governments can use policy to improve the condition of Fredonia-Newburg Area watersheds. Policy recommendations focus on improving watershed conditions by preserving green infrastructure, protecting groundwater, minimizing the use of road salts, encouraging sustainable management of stormwater, and allowing and encouraging the use of native landscaping. To be successful, the Fredonia-Newburg Area Watershed-Based Plan needs to be adopted and local plans and ordinances need to be updated to incorporate the plan's recommendations. The process of creating and implementing policy changes can be complex and time consuming. Although there are numerous possible policy recommendations for the watershed, the following policy recommendations are considered the most important and highest priority for implementation.

Plan Adoption & Implementation Policy Recommendations

- County and municipal governments in the watershed should adopt the Fredonia-Newburg Area Watershed-Based Plan and incorporate plan goals, objectives, and recommended actions into their comprehensive plans and ordinances.

Green Infrastructure Network Policy Recommendations

- Each municipality consider incorporating the identified Green Infrastructure Network into comprehensive plans and development review maps.
- Municipal comprehensive plans and zoning ordinances should utilize tools such as protection overlay districts, setback requirements, open space zoning requirements, conservation easements, and conservation and/or low impact development requirements to protect environmentally sensitive areas located within the identified Green Infrastructure Network parcels.
- Local units of government should utilize tools such as Development Impact Fees, Stormwater Utility Fees, and Special Service Area (SSA) Taxes to help fund future management of green infrastructure components in those areas where new and redevelopment occurs.
- Encourage developers to protect sensitive natural areas, restore degraded natural areas and streams, then donate all natural areas and naturalized stormwater management systems to a public agency or conservation organization for long term management with dedicated funding such as Development Impact Fees, Stormwater Utility Taxes, Special Service Area (SSA) Taxes, etc. In general, it is not recommended that these features be turned over to HOA's to manage.
- Establish incentives for developers who propose sustainable or innovative approaches to preserving green infrastructure and using naturalized stormwater treatment trains.
- Consider limiting mitigation for wetlands lost to development to occur only within the watershed limits.

Groundwater Policy Recommendations

- Encourage stormwater management practices that infiltrate water in any development or redevelopment.
- Limit impervious cover within new and redevelopments occurring within Subwatershed Management Units 3, 8, 11, 12, 25, 33, 34, and 35 which are ranked as highly vulnerable to future impervious cover changes.

- Limit impervious cover and incorporate infiltration practices within new and redevelopments in areas having "High" to "Very High" groundwater recharge potential.

Road Salt Policy Recommendations

- Each municipality consider supplementing existing programs with deicing best management practices such as utilizing alternative deicing chemicals, anti-icing or pretreatment, controlling the amount and rate of spreading, controlling the timing of application, utilizing proper application equipment, and educating/training deicing employees.

Stormwater Management and Facility Policy Recommendations

- Encourage new development and redevelopment to use stormwater management facilities that serve multiple functions including storage, water quality benefits, infiltration, and wildlife habitat.
- Consider incorporating features intended to reduce runoff volume in the design of new and retrofitted detention basins.
- Leverage programs such as the Stormwater Currency Plan from American Rivers to develop community-based programs that leverage public and private sector resources for green infrastructure

Native Landscaping/Natural Area Restoration Policy Recommendations

- Local ordinances should allow the use of native landscaping.
- Ensure local "weed control" ordinances do not discourage or prohibit native landscaping.
- Include requirements for short- and long-term management with performance standards for restored natural areas and stormwater features within new and redevelopment.

6.1.2 Detention Basin Design/Retrofits, Establishment, & Maintenance

Detention basins are best described as human made depressions for the temporary storage of stormwater runoff with controlled release following a rain event. Typical wet bottom and dry bottom basins are planted with turf grass along the slopes and bottoms. These attributes do not promote good infiltration, water quality improvement, or wildlife habitat capabilities. While there are currently few detention basins in these watersheds, they are expected to become more common as development proceeds.

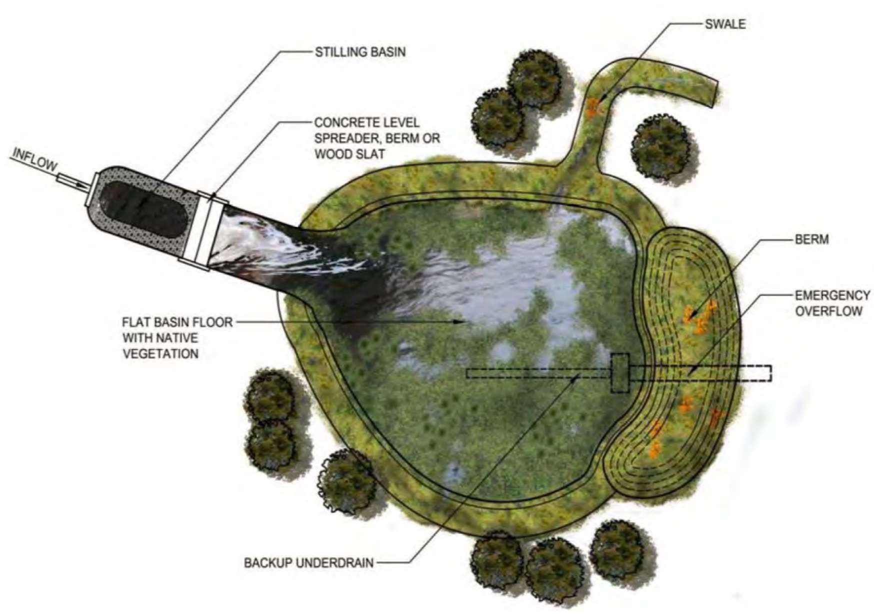


Figure 57. Naturalized dry bottom infiltration basin design.

Studies conducted by several credible entities over the past two decades reveal the benefits of detention basins that serve multiple functions. According to USEPA, properly designed dry bottom infiltration basins can reduce total suspended solids (sediment) by 75%, total phosphorus by 65%, and total nitrogen by 60%. Wet bottom basins designed to have wetland characteristics can reduce total suspended solids (sediment) by 77.5%, total phosphorus by 44% and total nitrogen by 20% (MDEQ, 1999).

Detention Basin Recommendations

Future detention basin design within the watershed should consist of naturalized basins (Figure 58) that serve multiple functions, including appropriate water storage, water quality improvement, natural aesthetics, and wildlife habitat. There is one opportunity to retrofit an existing wet bottom detention basin by incorporating minor changes and naturalizing with native vegetation. Site specific retrofit opportunities are identified in the Site Specific Action Plan. Location, design, establishment, and long term maintenance recommendations for naturalized detention basins are included below.

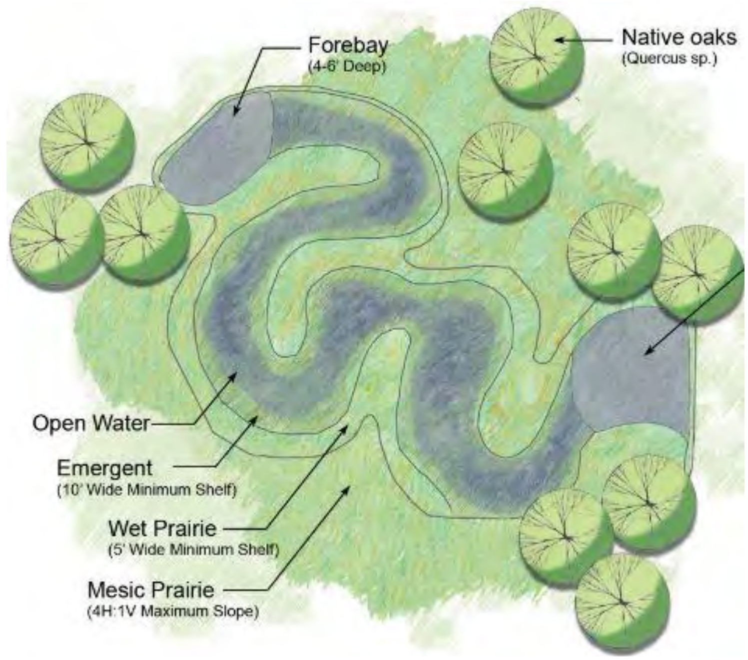


Figure 58. Naturalized wet bottom detention basin design.

<u>Detention Location Recommendations</u>

- Naturalized detention basins should be restricted to natural depressions or drained hydric soil areas and adjacent to other existing green infrastructure where feasible in an attempt to aesthetically fit and blend into the landscape. Use of existing wetlands for detention should be evaluated on a case by case basis.
- Basins should not be constructed in any average to high quality ecological community.
- Outlets from detention basins should not discharge into sensitive ecological areas.

<u>Detention Design Recommendations</u>

- One appropriately sized, large detention basin should be constructed across multiple development sites where feasible rather than constructing several smaller basins.
- Side slopes of basins should be no steeper than 4H: 1V. The slopes should be planted with native prairie vegetation and stabilized with erosion control blanket. Native oak trees (*Quercus sp.*) and other fire-tolerant species should be the only tree species planted on the side slopes for management purposes.
- Dry bottom basins should be planted to mesic, wet-mesic, or wet prairie.
- A minimum 5-foot wide shelf planted to native wet prairie and stabilized with erosion control blanket should be constructed above normal water level in wet and wetland bottom basins. This area should be designed to inundate after every 0.5-inch rain event or greater.

- A minimum 10-foot wide shelf planted with native emergent plugs should extend from normal water level to 2 feet below normal water level in wet and wetland bottom basins.
- Permanent pools in wet and wetland bottom basins should be at least 4 feet deep.
- Irregular islands and peninsulas should be constructed in wet and wetland bottom basins to slow the movement of water through the basin to improve water quality. These features should be planted with native prairie.
- Consideration should be given to constructing 4-6-foot-deep forebays at the inlets of wet and wetland bottom basins to capture sediment and 4-6-foot-deep micropools at the outlets of these basins to continue operation in the event the main outlet becomes clogged.

Short Term (3 Years) Native Vegetation Establishment Recommendations
Developers should generally be responsible for implementing short term management (three years) of detention basins and other natural areas to meet a set of performance standards. Measures needed include mowing during the first two growing seasons to reduce annual and biennial weeds. Spot herbiciding is required to eliminate problematic non-native/invasive species. In addition, the inlet and outlet structures should be checked periodically for erosion and clogging. Table 36 includes a three-year schedule appropriate to establish native plantings around naturalized detention basins.

Table 36. Three-year vegetation establishment schedule for naturalized detention basins.

Year 1 Establishment Recommendations
Mow prairie areas to a height of 6-12 inches in May, July, and September.
Spot herbicide non-native/invasive species throughout site in late May and again in August/September. Target thistle, reed canary grass, common reed, purple loosestrife, bindweed, teasel, Japanese knotweed, burdock, wild parsnip, and all emerging woody saplings.
Check for clogging and erosion control at inlet and outlet structures during site visits.
Year 2 Establishment Recommendations
Mow prairie areas to a height of 12 inches in June and August.
Spot herbicide non-native/invasive species throughout site in May and again in August/September. Target thistle, reed canary grass, common reed, purple loosestrife, bindweed, teasel, Japanese knotweed, burdock, wild parsnip, and all emerging woody saplings. and all emerging woody saplings.
Plant additional emergent plugs if needed and reseed any failed areas in fall.
Check for clogging and erosion control at inlet and outlet structures during site visits.
Year 3 Establishment Recommendations
Spot herbicide non-native/invasive species throughout site in May and again in August/September. Target thistle, reed canary grass, common reed, purple loosestrife, bindweed, teasel, Japanese knotweed, burdock, wild parsnip, and all emerging woody saplings and all emerging woody saplings.
Check for clogging and erosion control at inlet and outlet structures during site visits.

Long Term (4 Years +) Native Vegetation Maintenance Recommendations
HOA's and businesses often lack the knowledge and funding to implement long term management resulting in the decline of these areas over time. Developers should be encouraged to donate naturalized detention basins and other natural areas to a local municipality or conservation organization for long term management who receive funding via a Special Service Area (SSA) tax or other means. Table 37 includes a cyclical long-term schedule appropriate to maintain native vegetation around detention basins.

Table 37. Three-year cyclical long-term maintenance schedule for naturalized detention basins.

Year 1 of 3 Year Maintenance Cycle
Conduct controlled burn in early spring. Mow to height of 12 inches in November if burning is restricted.
Spot herbicide problematic non-native/invasive species throughout site in mid-August. Specifically target thistle, reed canary grass, common reed, and emerging woody saplings such as willow, cottonwood, buckthorn, and box elder.
Check for clogging and erosion control at inlet and outlet structures during site visits.
Year 2 of 3 Year Maintenance Cycle
Spot herbicide problematic non-native/invasive species throughout site in August. Specifically target thistle, reed canary grass, common reed, and emerging woody saplings such as willow, cottonwood, buckthorn, and box elder.
Mow prairie areas to a height of 6-12 inches in November.
Check for clogging and erosion control at inlet and outlet structures during site visits.
Year 3 of 3 Year Maintenance Cycle
Spot herbicide problematic non-native/invasive species in August. Specifically target thistle, reed canary grass, common reed, and emerging woody saplings. Cutting & herbiciding stumps of some woody saplings may also be needed.
Check for clogging and erosion control at inlet and outlet structures during site visits.

6.1.3 Rain Gardens

Rain gardens have become a popular new way of creating a perennial garden that cleans and infiltrates stormwater runoff from rooftops and sump pump discharges. A rain garden is a small shallow depression that is typically planted with deep rooted native wetland vegetation. These small gardens can be installed in a variety of locations but work best when located in existing depressional areas or near gutters and sump pump outlets. It functions by capturing, filtering, and infiltrating stormwater runoff into the ground thereby reducing the flows to nearby streams and other drainageways. Not only do rain gardens clean and infiltrate water, they also provide food and shelter for many birds, butterflies, and insects.

Rain gardens are typically 100-300 square feet in size, should be installed outside of wetlands and floodplains, and planted with native plants to improve water quality and habitat benefits. They should be placed at least 10 feet away from any building or structure and need to be excavated to a depth of 18-24 inches below the exiting grade. Soil amendments are usually required to ensure support of native plants. After installation, rain gardens require ongoing maintenance to ensure they are performing properly.

Rain garden adjacent to single family home

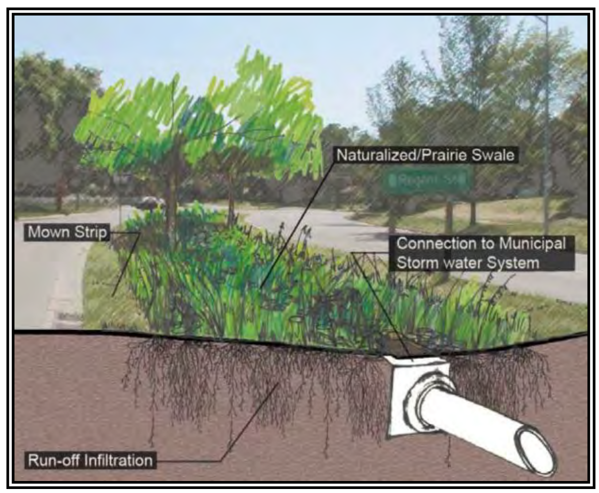
The intent of a rain garden program for residents is to encourage and provide an incentive for applicants to install rain gardens on private property to "micro-manage" stormwater runoff as close to the source (like downspouts, driveways, sump pump discharges) as possible. Typically, this incentive comes in the form of a cost-share program designed to reimburse residents for a portion of the costs incurred by installing a rain garden on their property.

Rain Garden Recommendations
Education programs in the watershed should focus on teaching residents and businesses the beneficial uses of rain gardens. Local governments in the watershed should also install demonstration rain gardens as a way for the general public to better understand their application. The WDNR and UW-Extension have developed a guide to designing and installing rain gardens on residential properties entitled "Rain Gardens- a how-to manual for homeowners" (WDNR, 2003). This document provides details on how a homeowner can design and install a rain garden and can be found at https://hort.extension.wisc.edu/articles/rain-gardens-how-manual-homeowners/. In addition, MMSD's website contains valuable information, guidance, and additional materials that can be downloaded to guide residents on how and where to install a rain garden.

6.1.4 Vegetated Swales (Bioswales)
Vegetated swales, also known as bioswales, are designed to convey water and can be modified slightly to capture and treat stormwater for the watershed. Vegetated swales are designed to remove suspended solids and other pollutants from stormwater running through the length of the swale. The type of vegetation can dramatically affect the functionality of the swale. Turf grass is not recommended because it removes less suspended solids than native plants. In addition, vegetated swales can add aesthetic features along a roadway or trail. They can be planted with wetland plants or a mixture of rocks and plant materials can be used to provide interest.

Swales can be designed as either wet or dry swales. Dry swales include an underdrain system that allows filtered water to move quickly through the stormwater treatment train. Wet swales retain water in small wetland like basins along the swale. Wet swales act as shallow, narrow wetland treatment systems and are often used in areas with poor soil infiltration or high water tables.

Water quality is improved by filtration through engineered soils in dry swales and through sediment accumulation and biological systems in wet swales. According to USEPA, vegetated swales reduce total suspended solids (sediment) by as much as 65%, total phosphorus by 25%, and total nitrogen by 10% (MDEQ, 1999).



Dry vegetated swale rendering

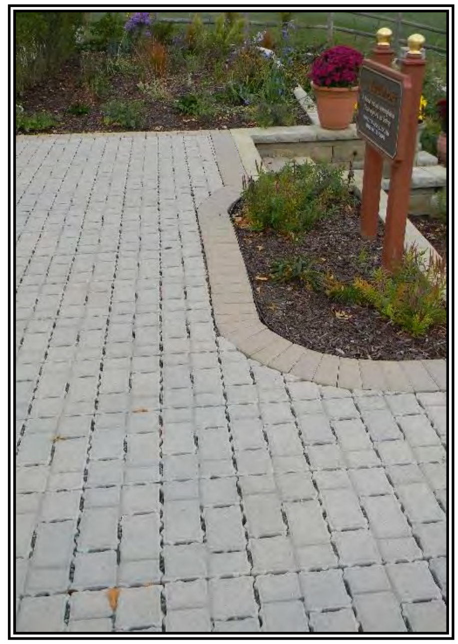
Vegetated Swale Recommendations
Vegetated swales should be used to replace pipes or curbs in new and redevelopment where feasible. Swales can easily be integrated into various urban fabrics with curb cuts for water to access them from roadways, or they can be added between existing lots or in the grassy parkways between roads and sidewalks. Typically, swales are used in lower density settings where infiltration might be maximized. Dry swales should be used for smaller development areas with small drainages. Wet swales should be used along larger roadways, small parking areas, and commercial developments.

6.1.5 Pavement Alternatives
Pervious concrete, permeable asphalt, and paver systems are potential alternatives to conventional asphalt or concrete parking lots and roadways. These alternatives allow for natural infiltration of the

water by allowing water that falls on the surface to flow to a storage gallery through holes in the pavement. Areas that are paved with pervious pavement produce less stormwater runoff than conventionally paved areas.

Traditionally, the quantity and quality of water running off of paved and other impermeable surfaces are the primary reason for stormwater treatment. Pavement alternatives reduce runoff rates and volumes and can be used in almost every capacity in which traditional asphalt, concrete, or pavers are used.

Pavement alternatives capture first flush rainfall events and allow water to percolate into the ground. Pavement alternatives treat stormwater through soil biology and chemistry as the water slowly infiltrates. Groundwater and aquifers are recharged and water that might otherwise go directly to streams will slowly infiltrate, reducing flooding and peak flow rates entering drainage channels. Studies documented by USEPA show that properly designed and maintained pervious pavements reduce total suspended solids (sediment) by 90%, total phosphorus by 65%, and total nitrogen by 85% (MDEQ, 1999).



Pervious pavement adjacent to park

In recent years, concerns have been raised about the environmental effects of the use of coal-tar sealants. Coal-tar sealant is a surface treatment typically applied to protect asphalt on driveways and parking lots which contains polycyclic aromatic hydrocarbons (PAHs). PAHs are a group of chemicals that have been linked to cancer in humans and have been shown to be toxic to aquatic life and damaging to the environment (Needleman, 2015). According to studies, "PAHs are significantly elevated in stormwater flowing from parking lots and other areas where coal-tar sealcoats were used as compared to stormwater flowing from areas not treated with the sealant (USEPA, 2016)." Pervious concrete, permeable asphalt, and paver systems are all potential alternatives to the need for coal-tar sealants. Additionally, several states and municipalities have banned the use and/or sale of coal-tar sealants to further protect their communities.

Pavement Alternatives Recommendations

Future development and redevelopment in the Fredonia-Newburg Area watersheds should consider the use of pavement alternatives, particularly for parking lots that receive high levels of public use. Pavement alternatives can be used in a variety of settings including parking lots, parking aprons, private roads, fire lanes, residential driveways, sidewalks, and bike paths. It is important to note that there are limitations to using pavement alternatives based on subsoil composition and they do require annual maintenance to remain effective over time.

6.1.6 Natural Area Restoration & Native Landscaping

Natural area restoration and native landscaping are essentially one in the same but at different scales. Natural area restoration involves transforming a degraded natural area into one that exhibits better ecological health and is typically done on larger sites such as publicly owned open space. Native landscaping is done at smaller scales around homes or businesses and is often formal in appearance. Both require the use of native plants to create environments that mimic historic landscapes of the Midwest such as prairie, woodland, and wetland. Native plants are defied as indigenous, terrestrial or aquatic plant species that evolved naturally in an ecosystem. The use of native plants in natural areas or native landscaping is well documented. They adapt well to environmental conditions, reduce erosion, improve water quality, promote water infiltration, do not require fertilizer, provide wildlife food and habitat, and have minimal maintenance costs.

Natural Area Restoration/Native Landscaping Recommendations

Large residential lots with existing natural components and sites acquired by local land conservation groups provide many of the best opportunities for natural area restoration and native landscaping at a larger scale. Homeowners interested in restoring natural areas or implementing native landscaping can find guidance through MMSD or by contacting an Ecological Consulting company. Backyard habitats can be certified through the National Wildlife Federation's Certified Wildlife Habitat program.

Native landscaping near residential home

6.1.7 Wetland Restoration

Over 9,730 acres or 54% of the historic wetlands in Fredonia-Newburg Area watershed have been lost to farming and other development practices since European settlement in the 1830s. Wetlands are one of the most important habitat types for harboring plant and animal diversity, as well as for protecting surface water quality, and reducing flooding. These potential benefits make wetland restoration highly beneficial and rewarding.

Approximately 489 acres of drained wetland was discovered in areas of the watershed where wetland restoration might be possible but many of these areas are located on land that is currently in agricultural production. The wetland restoration process involves returning hydrology (water) and vegetation to soils that once supported wetlands. The USEPA estimates that wetland restoration projects can reduce suspended solids (sediment) by 77.5%, total phosphorus by 44%, and total nitrogen by 20% (MDEQ, 1999).

Wetland restoration within Conservation Development

Wetland Restoration Recommendations

Municipalities should strongly consider requiring "Conservation Design" that incorporates wetland restoration on parcels slated for future development. Another potential option is to restore wetlands as part of a wetland mitigation bank where wetlands are restored on private or public land and become "fully certified." Then, developers are able to buy wetland mitigation credits from the wetland bank for wetland impacts occurring elsewhere in the watershed. It may also be possible for owners of wetland mitigation banks to sell "water quality trading credits" to wastewater treatment plants that produce phosphorus in effluent that exceeds state standards. The Site-Specific Action Plan section of this report identifies sites where wetland restoration might be feasible.

6.1.8 Vegetated Filter Strips

Vegetated filter strips are shallowly sloped vegetated surfaces that remove suspended sediment, and nutrients from sheet flow stormwater that runs across the surface. This Management Measure is often referred to as a buffer strip. The type of vegetation can dramatically affect the functionality of the filter strip. Filter strips can either be planted or can be comprised of existing vegetation. Turf grass is not recommended as it removes less total suspended solids than filter strips planted with native vegetation.

Filter strip along municipal building in Algonquin, IL

The wider they are the more effective filter strips are because the amount of time water has for interception/ interaction with the plants and soil within the filter strip is increased. When installed and functioning properly, the USEPA has documented that filter strips can reduce total suspended solids (sediment) by 73%, total phosphorus by 45%, and total nitrogen by 40% (MDEQ, 1999).

Vegetated filter strips work in a variety of locations. Vegetated filter strips in rural and urban areas should be installed along streams, lakes, or ponds. Additionally, they can be used adjacent to buildings and parking lots that sheet drain. The water would then pass through the vegetated filter strip and into a waterway, such as a vegetated swale, stream, lake, pond, or other stormwater feature.

6.1.9 Stormwater Trees/Tree Planting Program

Trees provide extensive evapotranspiration and cooling benefits, improve air quality, provide habitat, increase property values, and improve aesthetics in urban landscapes (see Figure 59). Trees play a valuable role in trapping absorbing stormwater, reducing pollutants, and holding soils in place during rain events and help to recharge groundwater supplies. A 25-foot canopy diameter tree can process the runoff of a 2,400 square foot adjacent impervious surface (EPA, 2016). Depending on the size and species, one tree can store 100 gallons or more of stormwater (Fazio, 2010).

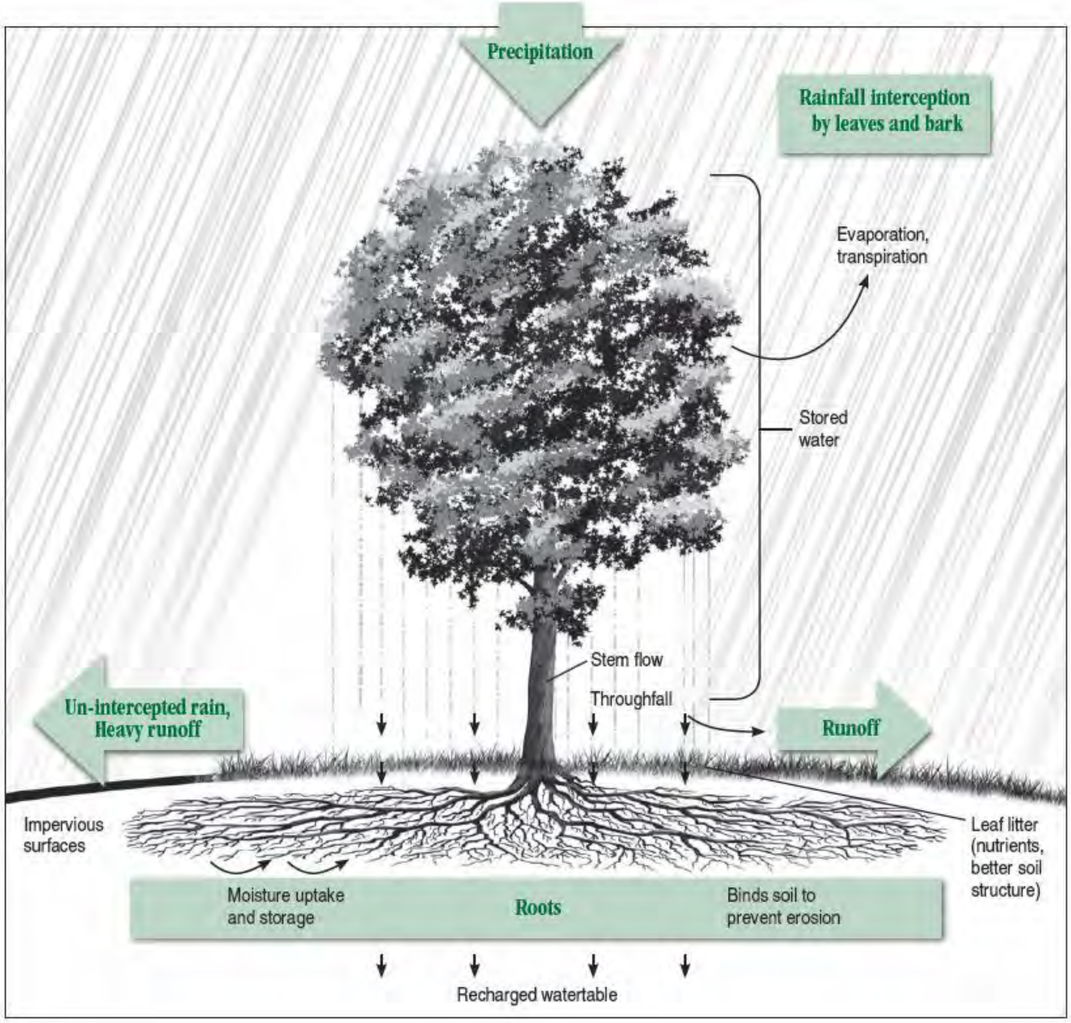


Figure 59. Illustration of how trees help with stormwater management (Source: Fazio, 2010).

Implementing a successful stormwater tree program can be complicated. Space and soil quality constraints can often be the limiting factors on whether a site is appropriate for installing stormwater trees. Other constraints include finding an appropriate species of tree, steep slopes, utility lines, impervious surfaces and pre-existing structures. With a little planning and engineering, many of these constraints can be overcome. In 2016, the USEPA produced a Technical Memorandum on Stormwater Trees that provides detailed information on the benefits and challenges to implementing an effective Stormwater Tree program and maintaining the trees over time. This report is available on the EPA's website at https://www.epa.gov/green-infrastructure/stormwater-trees.

Municipalities in the watersheds should consider adopting a stormwater tree or tree planting program where these are not already in place.

6.1.10 Street Sweeping & Yard Waste Management

Street sweeping is often overlooked as a Management Measure option to reduce pollutant loading in watersheds. Additional municipal street sweeping programs could help reduce non-point source pollutants from urban areas in Fredonia-Newburg Area watershed. Street sweeping works because pollutants such as sediment, trash, road salt, oils, nutrients, and metals that would otherwise wash into stormsewers and streams following rain events are gathered and disposed of properly. The USEPA and Center for Watershed Protection (CWP) report similar pollutant removal efficiencies for street sweeping; weekly street sweeping can remove between 9% and 16% of sediment and between 3% and 6% of nitrogen and phosphorus (MDEQ, 1999; CWP 2007).

Routine street sweeping is an effective Management Measure

Yard waste, such as grass clipping and leaf litter, can also impact water quality when not managed correctly. Composting of yard waste and grasscylying, or leaving grass clippings on a lawn, can keep nutrients such as nitrogen in place. When grasscycling or composting, it is important to keep clippings and waste off of sidewalks or other impervious surfaces where they might otherwise get washed into adjacent drainage systems (Gibb, 2012).

Street Sweeping & Yard Waste Management Recommendations
The frequency of street sweeping is a matter of time and budget and should be determined by each municipality. Weekly street sweeping would provide the best results, but bi-weekly sweeping is cited as being sufficient in most cases. Homeowners should also compost yard waste and practice grasscycling at home.

6.1.11 Stream & Riparian Area Restoration & Maintenance

While the streams in the Fredonia-Newburg Area watershed are in relatively good condition, the leading causes of degraded stream conditions are channel modification and degraded riparian areas. Generally speaking, streambank erosion is not a problem in the watershed. Stream surveys reveal that about 22% (83,320 linear feet) of stream length in the watershed is highly channelized. Another 22% (83,894 linear feet) is moderately channelized. 27% of riparian areas are in poor condition. There is no severe erosion occurring in the watershed, but moderately unstable banks occur along 6% (20,964 linear feet) of stream length. Pollutant modeling indicates that approximately 586 tons/yr of sediment or 2% of sediment loading comes from eroded streambanks and ravines within the watershed.


Stream restoration project example

Stream and riparian area restoration require more data, more paperwork, and more negotiating than most other kinds of restoration projects. Permits are required for even the simplest component such as bank stabilization. After getting through regulatory hurdles, stream restoration is one of the best Management Measures that can be implemented to improve degraded stream and riparian area conditions. This work involves improvements to a stream channel using artificial pool-riffle complexes, streambank stabilization using a combination of bioengineering with native vegetation and adjacent riparian area improvements via removal of non-native vegetation and replacement with native species. These practices are typically done together as a way to improve water quality by reducing sediment transport, increasing oxygen, and improving habitat. The USEPA reports that as much as 90% of sediment, phosphorus, and nitrogen can be reduced following stream restoration. The downside to stream restoration is that it is technical and expensive. Stream restoration projects include detailed construction plans, often complicated permitting, and construction that must be done by a qualified contractor.

With so many individual landowners with parcels intersecting the tributary streams in the watershed, routine maintenance of stream systems is challenging. In many cases, landowners simply do not have the knowledge or are not physically capable of maintaining streams on their property. Stream maintenance includes an ongoing program to remove blockages caused by accumulated sediment, fallen trees, etc. and is a cost-effective way to prevent flooding and streambank erosion.

Riparian buffers are defined as land adjoining any water body including ponds, lakes, streams, and wetlands. In 2010 the Southeastern Wisconsin Regional Planning Commission (SEWRPC) produced a document entitled "Managing the Water's Edge: Making Natural Connections" (SEWRPC 2010). The research presented in this document was conducted to determine if an optimal riparian buffer design or width could be determined that effectively reduces pollutants, provides water quality protection, helps prevent channel erosion, provides adequate fish and wildlife habitat, enhances environmental corridors, augments baseflow, and moderates water temperature.

Interestingly, no consensus of optimal buffer width could be determined but what is apparent is that many riparian corridors no longer fulfill their potential due to encroachment by agricultural and urban development. SEWRPC's document summarizes how to maximize both water quality protection and conservation of aquatic and terrestrial wildlife populations using buffers as shown in Figures 60 and 61.

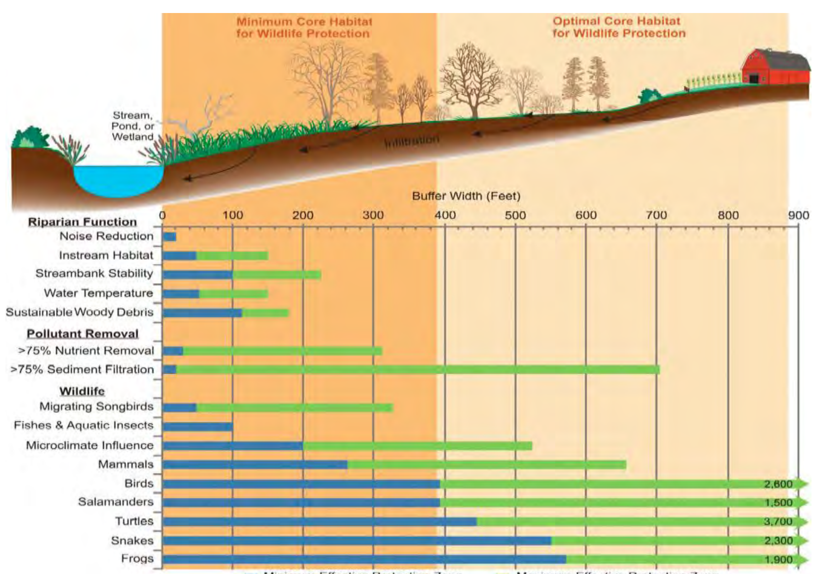


Figure 60. Riparian function, pollutant removal, and wildlife benefits for various buffer widths (Source: SEWRPC) 2010).

As described in SERWPC's document, the use of "Environmental Corridors" or what is also known as green infrastructure to connect open space and other natural area features should be embraced and the minimum goal of 75 feet should be achieved where feasible whereby 75% minimum of the total stream length should be naturally vegetated to protect the functional integrity of the water resource and 75 foot wide minimum riparian buffers are recommended from the top edge of each stream bank that are naturally vegetated to protect water quality. SEWRPC also recommends that new development should incorporate water quality and wildlife enhancement or improvement objectives by creating green infrastructure and buffer linkages. This can be achieved by maintaining a minimum 150-foot protection area around isolated riparian features. This protection area consists of optimal core habitat that is protected with minimized edge effects (Figure 61).

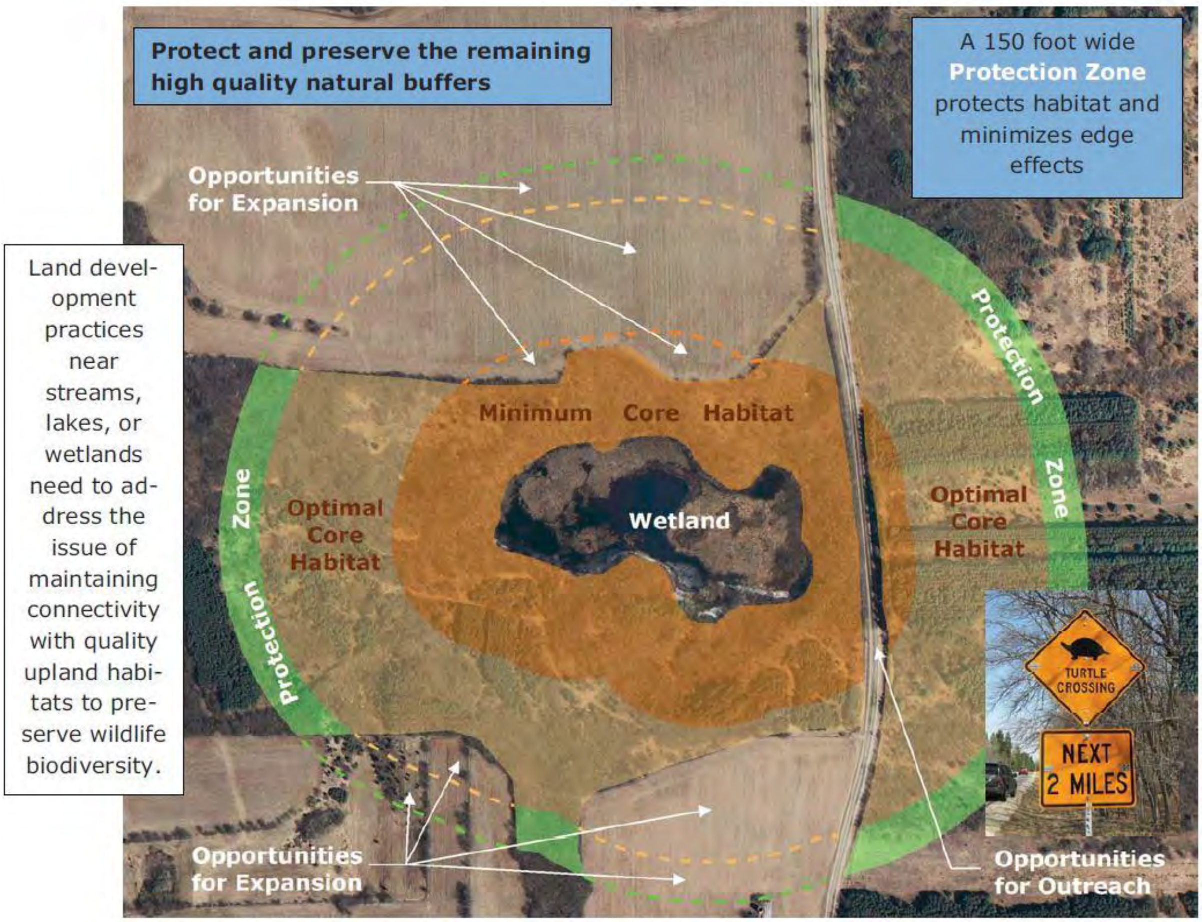


Figure 61. Riparian area core habitat and protection zones (Source SEWRPC 2010).

Stream & Riparian Area Recommendations

While most of the stream and riparian area recommendations in this plan focus on restoration or improvement of riparian buffers, some spot stabilization of banks is recommended where appropriate. Where existing buffers are less than 75 feet, recommendations have been made to extend buffers where possible; that said, extending a riparian buffer to 75 feet where no buffer exists in not always achievable. In these cases, typically recommendations included increasing the buffer to

20-30 feet along each bank. All stream and riparian area opportunities are identified in the Site-Specific Action Plan. As far as stream maintenance goes, agencies such as the Wisconsin Department of Natural Resources (WDNR), Washington and Ozaukee Counties, SEWRPC, and MMSD can help guide land management for riparian owners. In addition, the American Fisheries Society has created a short document called "Stream Obstruction Removal Guidelines" which is meant to clarify the appropriate ways to maintain obstructions in streams to preserve fish habitat.

6.1.12 Septic System Maintenance

Municipalities within the watershed regulate against the construction and usage of private onsite wastewater treatment systems (POWTS) for residents who have access to municipal sewer lines. According to §455-27 of the Village of Fredonia's Code of Ordinances, "the maintenance and use of septic tanks, holding tanks, and private sewage disposal systems within the area of the Village serviced by its sewer system are hereby declared a public nuisance and a health hazard," and as such their usage is prohibited. In the Village of Newburg Code §51.06, "all buildings used for human habitation and located adjacent to a sewer main, or in a block through which such a system extends, shall be connected to the village sanitary sewer system within 30 days…". West Bend Code Chapter 11.05 also requires the connection of sewer to buildings for which it is made available.

On a statewide level, the regulation of POWTS (also colloquially known as septic systems) is handled by the Department of Safety and Professional Services. Ordinances defining installation, operation, and maintenance are defined in Washington County Sanitary Code (Ch. 25) and Ozaukee County Sanitation and Health (Ch. 9.) While it is important that municipalities provide and enforce the connection to municipal wastewater treatment; it is in areas where this service is not available that the proper installation, permitting, and maintenance of POWTS is a necessity. When septic systems are not maintained and fail they can contribute high levels of nutrients and bacteria to the surrounding environment. Literature sources from USEPA indicate a general septic system failure rate of between 2% and 5% (USEPA, 2005).

Ozaukee County identified a number of non-pressurized in ground systems as potentially failing POWTS in the Fredonia-Newburg Area watersheds. Ozaukee County identified a total of 984 POWTS within the Fredonia-Newburg Area watersheds. Of these, 556 are non-pressurized in-ground systems, 193 of which predate any official records. These systems are typically ones that predate any official record keeping or tracking of septic systems and therefore have the potential to be leaking, failing, or in need of maintenance. Maps identifying POWTS in Ozaukee County can be found in Appendix F. Washington and Sheboygan Counties should be contacted for more information regarding potentially failing POWTS within their jurisdictions.

Septic System Recommendations

Septic owners should become compliant with sewage treatment and disposal ordinances and have routine inspections and sampling completed at least every three years. The Counties should require additional soil testing when inspections are conducted to ensure that POWTS have not already leached into the soils or groundwater. The Counties should work with partner agencies and other funders to leverage additional funds toward repairing or replacing the potentially failing POWTS sites identified in Appendix F; these sites are also Priority Areas recommended for repair or replacement.

Wisconsin's private onsite wastewater treatment system grant program can provide financial assistance to homeowners and small business who need to replace a failing system in participating counties. All three of the counties in which the Fredonia-Newburg Area watersheds participate in the program. The program is administered by the Wisconsin Department of Safety and Professional Services (DSPS) and a brochure that describes the program to homeowners can be found at: https://dsps.wi.gov/Documents/Programs/WisconsinFund/Brochure.pdf

The USEPA also provides an excellent guide for septic system owners called "A Homeowner's Guide to Septic Systems (USEPA, 2005)." The guide explains how septic systems work, why and how they should be maintained, and what makes a system fail.

6.1.13 Agricultural Management Practices

Significant portions of the Fredonia-Newburg Area watershed have been developed and are anticipated to continue developing to residential, commercial, and industrial uses. However, the most prevalent land use is the combined 23,044.5 acres of agricultural land observed in 2018. This accounts for 49% of the watershed area. Pollutant loading estimates using USEPA's STEPL model point to agricultural land as a significant contributor of nutrients and sediment in runoff. In fact, agricultural areas are estimated to contribute about 11,197 lbs/yr (37.5%) of nitrogen, 2,689 lbs/yr (15.7%) of phosphorus, and 1,432.4 tons/yr (15%) sediment. Fortunately, there are numerous agricultural measures and funding sources that can be used by farmers to protect water quality. Many recommended programs are offered through the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS).

The following is a summary of USDA 2018 Farm Bill and Wisconsin NRCS agricultural programs that have environmental benefits: (www.usda.gov/wps/portal/usda/usdahome). Many of the farm and nutrition policies defined in the 2018 Farm Bill are continuations of those laid out in the 2014 Farm Bill.

2018 Farm Bill Financial Assistance Programs

NRCS offers financial and technical assistance to help agricultural producers make and maintain conservation improvements on their land:

Environmental Quality Incentives Program (EQIP)

The NRCS's Environmental Quality Incentive Program (EQIP) is a voluntary conservation program that provides financial assistance to individuals/entities to address soil, water, air, plant, animal and other related natural resource concerns on their land. EQIP offers financial and technical help to assist participants to install or implement structural and management practices on eligible agricultural land. Grassed waterways, stream fencing, critical area planting, terraces, manure management systems including storage structures and barnyard runoff protection, and many other conservation practices are eligible for EQIP. Projects are selected based on environmental value.
Contracts run for 1-10 years and may be eligible for financial assistance, up to $300,000 for the life of the Farm Bill. Public Access is not required.

Conservation Stewardship Program (CSP)

The Conservation Stewardship Program helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resources concerns. Participants earn CSP payments for conservation performance - the higher the performance, the higher the payment. The benefit is an improved resource condition including soil quality, water quality and quantity air quality, and habitat quality. CSP provides two types of payments through five-year contracts: annual payments for installing new conservation activities and maintaining existing practices; and supplemental payments for adopting a resource-conserving crop rotation.

2018 Farm Bill Easement Programs

NRCS offers easement programs to eligible landowners to conserve working agricultural lands, wetlands, grasslands and forestlands:

Agricultural Conservation Easement Program (ACEP)

The Agricultural Conservation Easement Program (ACEP) provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits.

Agricultural Land Easements NRCS provides financial assistance to eligible partners for purchasing Agricultural Land Easements that protect the agricultural use and conservation values of eligible land. The program protects grazing uses and related conservation values by conserving grassland, including rangeland, pastureland and shrubland. Under the Agricultural Land component, NRCS may contribute up to 50 percent of the fair market value of the agricultural land easement. Where NRCS determines that grasslands of special environmental significance will be protected, NRCS may contribute up to 75 percent of the fair market value of the agricultural land easement.

Wetland Reserve Easements provide habitat for fish and wildlife, including threatened and endangered species, improve water quality by filtering sediments and chemicals, reduce flooding, recharge groundwater, protect biological diversity and provide opportunities for educational, scientific and limited recreational activities.

NRCS provides technical and financial assistance directly to private landowners and Indian tribes to restore, protect, and enhance wetlands through the purchase of a wetland reserve easement. Through the wetland reserve enrollment options, NRCS may enroll eligible land through:

- **Permanent Easements** – conservation easements in perpetuity. NRCS pays 100 percent of the easement value for the purchase of the easement. Additionally, NRCS pays between 75 to 100 percent of the restoration costs.
- **30-year Easements** – 30-year easements expire after 30 years. NRCS pays 50 to 75 percent of the easement value for the purchase of the easement. Additionally, NRCS pays between 50 to 75 percent of the restoration costs.
- **Term Easements -** easements that are for the maximum duration allowed under applicable State laws. NRCS pays 50 to 75 percent of the easement value for the purchase of the term easement. Additionally, NRCS pays between 50 to 75 percent of the restoration costs.

Healthy Forests Reserve Program (HFRP)

The Healthy Forests Reserve Program (HFRP) helps landowners restore, enhance and protect forestland resources on private lands through easements and financial assistance. Through HRFP, landowners promote the recovery of endangered or threatened species, improve plant and animal biodiversity and enhance carbon sequestration.

HFRP provides landowners with 10-year restoration agreements and 30-year or permanent easements for specific conservation actions. For acreage owned by an Indian tribe, there is an additional enrollment option of a 30-year contract. Some landowners may avoid regulatory restrictions under the Endangered Species Act by restoring or improving habitat on their land for a specified period of time.

2018 Farm Bill Partnership Programs

NRCS works with partners to leverage additional conservation assistance for agricultural producers and landowners in priority conservation areas:

Regional Conservation Partnership Program (RCPP)

The Regional Conservation Partnership Program (RCPP) promotes coordination between NRCS and its partners to deliver conservation assistance to producers and landowners. NRCS provides assistance to producers through partnership agreements and through program contracts or easement agreements. RCPP encourages partners to join in efforts with producers to increase the restoration and sustainable use of soil, water, wildlife and related natural resources on regional or watershed scales.

Other 2018 Farm Bill Programs

Experienced Services Program

Through the Experienced Services Program (renamed from the 2014 Agriculture Conservation Experienced Services (ACES), experienced workers, age 55 and over, help NRCS employees provide technical services in support of conservation. NRCS enters into agreements with nonprofit organizations that provide ES workers on a part-time or full-time basis. NRCS provides funds, office space, position descriptions, work assignments and oversight for the ES positions, while the nonprofit organization handles advertising, recruiting, hiring and payroll for each position.

Conservation Innovation Grants (CIG)

Conservation Innovation Grants (CIG) are competitive grants that stimulate the development and adoption of innovative approaches and technologies for conservation on agricultural lands. CIG accelerates technology development and transfer, and the adoption of promising technologies and approaches to address some of the nation's most pressing natural resource concerns. NRCS identifies successful projects for potential integration of technologies and approaches into NRCS' toolkit of conservation practices.

Emergency Watershed Protection Program (EWP)

The purpose of the Emergency Watershed Protection Program (EWP) was established by Congress to respond to emergencies created by natural disasters. The EWP Program is designed to help people and conserve natural resources by relieving imminent hazards to life and property caused by floods, fires, drought, windstorms, and other natural occurrences.

Wisconsin NRCS Programs

Cooperative Conservation Partnership Initiative (CCPI)

The CCPI provides funding for eligible partner organizations through grant agreements focusing on the priorities of the Environmental Quality Incentives Program or the Wildlife Habitat Incentives Program.

Conservation Stewardship Program (CSP)
The CSP will help owners and operators of agricultural lands maintain conservation stewardship and implement and maintain additional needed conservation practices. The conservation benefits gained will keep farms and ranches more sustainable and profitable and increase the benefits through improved natural resources.

Conservation Technical Assistance (CTA)
Through Conservation Technical Assistance, NRCS assists landowners and land users, communities, units of state and local government, Tribes, and other Federal agencies in planning and implementing conservation systems.

Conservation Reserve Program (CRP)
CRP can reduce erosion, increase wildlife habitat, improve water quality, and increase forestland. Landowners set aside cropland with annual rental payments based on amount bid. Tree planting, wildlife ponds, grass cover, and other environmental practices are eligible practices. Land is accepted into the program if bid qualifies. Continuous signup is open for buffers, waterways and environmental practices. Periodic signups are announced throughout the year for other practices. The contract period is 10 years, 15 years if planting hardwood trees. It is transferable with change in ownership and public access is not required.

Conservation Tillage (no till) farming

Grassland Reserve Program
The Grassland Reserve Program (GRP) is a voluntary program for landowners and operators to protect grazing uses and other related conservation values by restoring and conserving eligible grassland and certain other lands through rental contracts and easements. When properly managed, grasslands can result in cleaner, healthier streams, and reduced sediment loads in water bodies. These lands are vital for the production of livestock forage and provide forage and habitat for maintaining healthy wildlife populations. They also add to the beauty of the landscape, provide scenic vistas and open space, provide for recreational activities and protect the soil from water and wind erosion.

Grazing Lands Conservation Initiative
The Grazing Lands Conservation Initiative is intended to provide technical, educational and other help to conserve and improve privately owned grazing and pasture lands. Intended practices include prescribed grazing, animal trails and walkways, and fencing.

Great Lakes Restoration Initiative

To improve the health of the Great Lakes, NRCS is providing financial and technical resources to 8 states to improve water quality in the region. Through this Initiative, NRCS focuses on helping farmers implement conservation practices that reduce erosion, improve water quality, and maintain agricultural productivity in selected watersheds.

For more information about agricultural management practices and programs, please contact:

Ozaukee County - Andy Holschbach
Land & Water Management Department
121 W. Main St, P.O. Boz 994, Port Washington, WI 53074
262-284-8271

Washington County - Paul Sebo
Land & Water Conservation Division
333 E. Washington St, Ste. 2300
P.O. Box 2003, West Bend WI 53095
262-335-4805

Michael Patin, District Conservationist:
Plymouth & West Bend Service Centers
Natural Resources Conservation Service
United States Department of Agriculture
Office Phone: 262-335-4860 Ext. 2359
www.wi.nrcs.usda.gov

Other Agricultural Recommendations

Principles of Soil Health

Improving water quality in runoff from agricultural lands can often be achieved by maintaining soil health and following soil health principles. There are five principles of soil health; they include soil armor, minimizing soil disturbance, plant diversity, continual live plant/root, and livestock integration. Armoring the soil refers to cover for the soil and controls erosion and evaporation rates, maintains soil temperatures, reduces compaction, suppresses weed growth and provides habitats for species. Minimizing soil disturbance reduces erosion, increases infiltration, and helps keep organic matter in the soil. Diversifying crop rotations can improve biodiversity, improves infiltration and nutrient cycling, and reduces pests. Providing some type of live plant root on a year-round basis is important for building soil health, ensuring that there is food for the soil web continuously throughout the year. Finally, integrating animals or livestock in the form of grazing can help balance the carbon to nitrogen ration, manage crop rotation, and help suppress weeds by fulfilling the natural symbiotic relationships between plants, animals, and the soil web (Fuhrer, 2018). Landowners should work with their local USDA-NRCS representative and cropping consultant to implement a system that will work for them.

Subsurface (Tile) Drainage Best Management Practices

Subsurface drain tiles are a commonly used practice by farmers to help lower the water table of poorly drained fields and/or wet areas within fields. Unfortunately, nitrogen and phosphorus often find their way into tiles through cracks and macropores in the soil. The tiles then carry these nutrients to local streams. Management of the water table through control structures at drain tile outlets is a promising approach to reduce the amount of nutrients that exit the tile lines (Figure 62). This is accomplished by adjusting the control structure so that the water table rises after harvest to limit drainage during the off-season. The water table can then be lowered a few weeks prior to planting in spring. The water table can also be raised in midsummer to store water for crops.

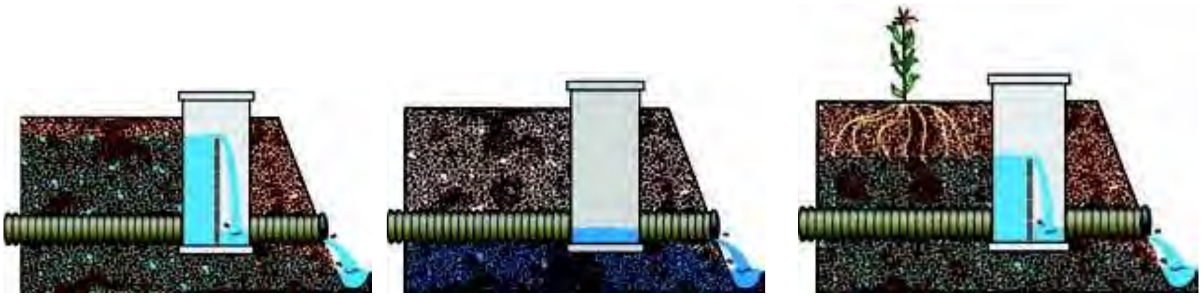


Figure 62. Use of tile control to raise water table after harvest (left), drawdown prior to seeding (middle), and raised again in midsummer (right) (Source: Purdue University)

Waste (Manure) Management

Livestock production within the agricultural industry is a producer of waste materials that need management. These wastes include primarily manure from livestock. The NRCS has produced the "Agricultural Waste Management Field Handbook (AWMFH)" to provide specific guidance for planning, designing, and managing systems where agricultural wastes are involved. It can help assist agricultural producers in organizing a comprehensive plan that results in the integration of waste management into overall farm operations. Material in this handbook covers a wide range of activities from incorporating available manure nutrients into crop nutrient budgets to proper disposal of waste materials that do not lend themselves to resource recycling.

6.1.14 Downspout Disconnection/Rainwater Harvesting & Re-use

Downspout disconnection and rain barrel programs help reduce the amount of clean water that is used as well as reduce the amount of wastewater discharged to streams. Water harvesting and re-use via rain barrels and cisterns are important options to decrease the amount of stormwater runoff in a watershed. It is a simple, economical solution that can be done by any homeowner or business. On most homes and buildings, the water from roofs flows into downspouts and then onto streets, parking areas, or into storm sewers. Disconnecting downspouts and using either rain barrels or cisterns for re-use later can reduce the flood levels in local streams.

Rain barrel adjacent to residential home

Water re-use differs based on the type of storage and water treatment. A rain barrel is typically attached to a downspout and collects water for irrigation purposes. In many areas, residential irrigation can account for almost 50 percent of residential water consumption. Re-using water is a great way of minimizing water use and lowering water bills.

A cistern also stores water from rooftop runoff to be used later. However, a cistern is often larger, sealed, and the water can be filtered for a wider variety of uses. With appropriate sanitation treatments, water from cisterns can even be reused for toilets, housecleaning, showers, hand washing, and dish washing. Cistern water, without any sanitation, can be used for lawn and garden watering, irrigation, car washing, and window cleaning.

The primary purpose of rain barrels and cisterns is water storage. Rain barrels typically store 55 gallons each. Cisterns can store greater amounts. Rain barrels and cisterns also reduce water demand in the summer months by reducing the potable water used for irrigation or other household uses.

Rainwater Harvesting & Reuse Recommendations
Education programs in the watershed should focus on teaching residents and businesses the beneficial uses of rain barrels and cisterns. Local governments in the watershed should aim to install demonstration rain barrels as a way for the public to better engage in their use around residential homes. Local governments and organizations such as the Counties, Milwaukee Riverkeeper, or Riveredge Nature Center should begin to or continue sponsoring programs where residents and businesses can purchase rain barrels.

6.1.15 Conservation Design & Low Impact Development

The negative effects of "Traditional Development" are well documented. As additional residential and other development occurs within Fredonia-Newburg Area watershed, it will be extremely important to consider development alternatives such as Conservation or Low Impact development.

Conservation Design

Conservation design facilitates development density needs while preserving the most valuable natural features and ecological functions of a site. It does this by reducing lot size, especially lot width, while increasing the available land area to allow for open space and natural resources (Figures 63 - 65). The open space is typically preserved or restored as natural areas that are integrated with newer natural Stormwater Treatment Train features and recreational trails and serve as an amenity to the entire development. The open space allows the residents to feel like they have larger or more private lots because most of the lots adjoin the open space system.

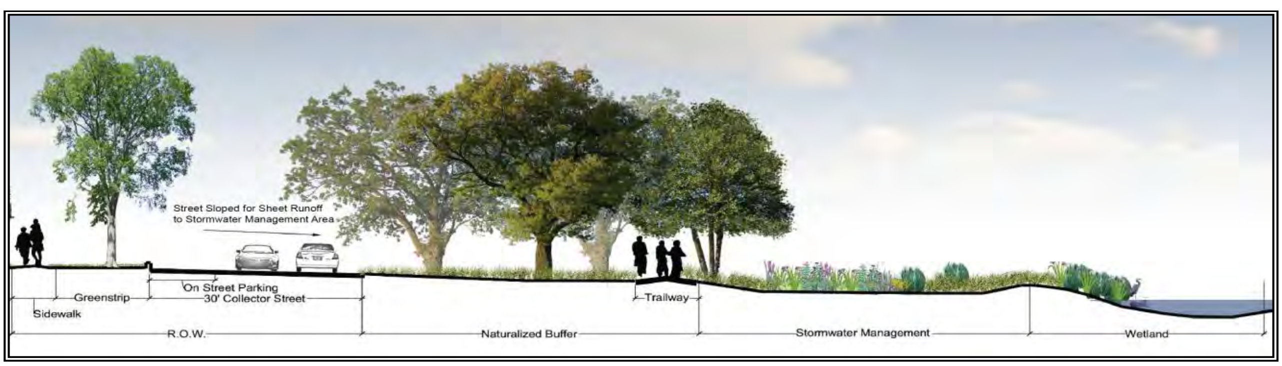


Figure 63. Stormwater Treatment Train within Conservation Development.

Figure 64. Traditional vs. Conservation Development Design (Elkhorn, WI)

Figure 65. Conservation/Low Impact development design

Such flexibility is intended to retain or increase the development rights of the property owner and the number of occupancy units permitted by the underlying zoning designation, while encouraging environmentally responsible development. Conservation design is most appropriate in areas having natural and open space resources to be protected and preserved such as floodplains, groundwater recharge areas, wetlands, woodlands, streams, wildlife habitat, etc. It can also be used to preserve and integrate agricultural uses into the land pattern. The approach first considers the natural landscape and ecology of a development site rather than determining design features on the basis of pre-established density criteria. The general steps included below are generally followed when designing the layout of a development site:

<u>Step 1</u>: Identify all natural resources, conservation areas, open space areas, physical features, and scenic areas and preserve and protect these areas from any negative impacts generated as a result of the development.

<u>Step 2</u>: Locate building sites to take advantage of open space and scenic views by requiring smaller lot sizes or cluster housing as well as to protect the development rights of the property owner and the number of occupancy units permitted by the underlying zoning of the property.

<u>Step 3</u>: Design the transportation system to provide access to building sites and to allow movement throughout the site and onto adjoining lands; roads should not traverse sensitive natural areas.

Step 4: Prepare engineering plans which indicate how each building site can be served by essential public utilities

Low Impact Development (LID)

Low impact development (LID) focuses on the hydrologic impact of development and tries to maintain pre-development hydrologic systems, treating water as close to the source as possible (see Figure 66). LID principles can be incorporated into development or stormwater ordinances and used in new development or retrofitting existing developments. Green infrastructure systems are created to mimic natural processes that promote water infiltration, native plant evapotranspiration, and stormwater reuse.

Figure 66: Greener Streetscape using LID practices. *"Greening the Code"* Washington County, OR

Low impact development seeks to keep stormwater out of pipes and instead keep the entire infrastructure more natural and above ground. Solutions start at the lot scale such as rain gardens and overflows to swales adjacent to roads. Larger impervious areas, such as a commercial development may utilize constructed wetlands for stormwater storage while adding value to the area by enhancing aesthetics, site interest and the ecology. Milwaukee Metropolitan Sewerage District (MMSD) has been influential in determining pollutant reductions for various LID methodologies. The following Noteworthy section includes a list of possible Management Measure practices, as described by MMSD in, "Evaluation of Stormwater Reduction Practices (MMSD, 2003)."

Noteworthy- MMSD Recommended Management Measure Practices

Downspout Disconnection: Disconnection of roof downspouts from sewers or from direct runoff to other impervious land surfaces.

Rain Barrels: Collection of roof runoff in barrels, later used as irrigation.

Cisterns: Roof runoff collection systems that store water in a tank: water may be reused for toilet, laundry, and lawn watering purposes.

Rain Gardens: Small vegetated depressions used to capture water and promote infiltration and evapotranspiration.

Green Roofs: Soil and vegetation installed on top of a conventional flat or slightly sloped roof. A complete green roof system may include a watertight membrane, protective layer, insulation, irrigation system, drainage system, filter layer, soil, and plants.

Rooftop Storage: Temporary storage of rain on a flat roof and the gradual release of this volume using restricted roof drain inlets.

Green Parking Lots: Various measures used to reduce the impervious area of a parking lot and promote infiltration and/or evapotranspiration.

Stormwater Trees: Increasing tree canopies to provide stormwater interception and evapotranspiration.

Porous Pavement: The use of porous asphalt or concrete, modular block systems, grass pavers, or gravel pavers to allow stormwater infiltrate and not runoff.

Inlet Restrictors/Pavement storage: Grading and flow restrictors that allow the temporary storage of stormwater on streets and parking lots.

Bioretention: Landscaped depressions planted with grass, shrubs, and/or trees. Typically built with a sand/gravel underdrain, mulch, and soil amendments to maximize storage, infiltration and water cleansing.

Onsite Filtering Practices: Practices such as sand filters, bioretention cells, swales, and filter strips that use a filter media (sand, soil, gravel, peat, or compost) to reduce runoff and promote water cleansing.

Pocket Wetlands: Small constructed wetlands that can reduce peak flows and runoff volumes and remove pollutants via settling and bio-uptake.

French Drains and Dry Wells: Gravel-filled trenches used to capture roof runoff and allow it to percolate into the soil.

Infiltration Sumps: Below ground, perforated, cylindrical, concrete structures used to collect stormwater and allow it to percolate into the soil.

Compost Amendments: Incorporating decomposed organic material into the soil to improve infiltration and vegetation performance.

Stormwater Policies: Land development and stormwater management criteria and requirements

Economics of Conservation Developments and Low Impact Development

Both conservation developments and low impact development (LID) are not only environmentally sound choices, but economical ones for both developers and municipalities. Conservation design can produce some of its biggest cost savings in infrastructure costs such as site preparation, stormwater management, site paving, and sidewalks (Conservation Research Institute, 2005).

According to a study conducted by Applied Ecological Services, Inc., the average savings created by choosing conservation development over more traditional footprints is 24% (Table 38) (AES, 2007). Not only do lots in conservation developments typically cost less to install, but they also "carry a price premium … and sell more quickly than lots in conventional subdivisions (Mohamed, 2006)." Another study conducted in Concord, Massachusetts found that over an eight-year period, a cluster development with protected open space had a 2.6% higher annual appreciation rate over "residential properties with significantly larger private yards, but without the associated open-space (Lacy, 1990)."

Table 38. Savings of Conservation Development over Traditional Subdivision Design for ten Midwestern conservation development projects.

Positive numbers are savings of Conservation Development over Traditional.
Negative numbers are costs of Conservation Development over Traditional.

Project:	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	Average
ITEM											
Grading	-$214,740	$257,832	$1,813,726	$2,215,025	$1,856,206	$1,862,988	$796,705	$291,957	$302,497	$2,852,312	51.00%
Roadway	$84,702	$18,754	-$16,477	-$130,230	$1,464,599	$1,187,386	$205,168	$9,231	-$9,963	$801,484	18.00%
Storm Sewer	$181,611	$31,220	$6,648	$89,676	$974,689	$547,184	$210,289	$65,501	$110,021	$678,302	40.00%
Sanitary Sewer	$41,614	-$4,365	$0	-$203,064	$850,962	$224,776	$72,436	-$15,502	$5,960	$423,458	6.00%
Water	$44,483	-$4,671	-$63,680	-$215,881	$905,157	$240,064	$76,815	-$16,257	$5,973	$451,084	5.00%
Ecological	-$56,500	-$74,857	-$277,472	-$400,321	-$407,131	-$625,084	-$160,341	-$93,954	-$264,513	-$380,992	-154.00%
Amenities	$17,572	-$16,202	-$94,399	-$226,216	$552,667	$221,666	$7,825	-$15,749	-$39,274	$266,982	6.00%
Contingencies	$132,055	$51,928	$342,087	$282,247	$1,549,287	$914,745	$302,225	$56,307	$27,675	$1,273,157	24.00%
Total Savings	$660,277	$259,639	$1,710,433	$1,411,235	$7,746,436	$4,573,725	$1,511,124	$281,534	$138,377	$6,365,787	
Total Percent Savings	19.00%	20.00%	33.00%	15.00%	43.00%	32.00%	25.00%	15.00%	4.00%	37.00%	24.30%*
Cost Savings Per Lot	$8,725.00	$6,978.00	$147,012.00	$29,012.00	$7,904.00	$20,077.00	$7,346.00	$4,078.00	$4,959.00	$67,676.00	$30,376.70

* Total Savings Percentage is *not* the percentage savings of all individual Items added together, because dollar-values of Items are different.
Visit www.appliedeco.com for more detailed info.

While low impact development covers a range of stormwater practices, it has some of the same cost benefits as conservation design. Typically LID practices "can cost less to install, have lower operations and maintenance costs, and provide more cost-effective stormwater management and water-quality services than conventional stormwater controls (ECONorthwest, 2007)." Similar to conservation design, cost savings from utilizing LID practices can be found as a reduction in the amount of drainage infrastructure and land disturbance required; additionally, property values can be increased by 12 - 16% (UNH Stormwater Center, 2011).

There is also evidence that combining both conservation and low impact development practices through holistic site design can create deeper cost savings for developers as well as increased ecosystem benefits – particularly by combining clustered site designing and naturalized stormwater management systems (Conservation Research Institute, 2005). Not only do conservation and low impact development practices provide a more economical possibility for developers and municipalities, but they can improve water quality, habitat, and property values in the watershed.

6.1.16 Green Infrastructure Planning

A green infrastructure network provides communities with a tool to identify and prioritize land use or conservation opportunities and plan development that benefits both people and nature by providing a framework for future growth. It identifies areas not suitable for development, areas suitable for development but that should incorporate conservation or low impact design standards, and potential development areas that do not affect green infrastructure. Watershed stakeholders can use green infrastructure plans for trail routing, open space linkages, and natural area restoration decisions. Residents can use green infrastructure recommendations to reduce runoff from their properties and to see how their properties fit into the larger network. A Green Infrastructure Network for the watershed was developed in Section 3.11.

Green Infrastructure Network *implementation* has several actions:

- Protect specific unprotected green infrastructure parcels through acquisition, regulation, and/or incentives.
- Incorporate conservation or low impact design standards on green infrastructure parcels where development is planned.
- Limit future subdivision of green infrastructure parcels.
- Implement long term management of green infrastructure.

Green Infrastructure Recommendations
A Green Infrastructure Network can only be realized by coordinated planning efforts of local municipalities, park districts, developers, and private land owners. Stakeholders should follow the recommended process below to initiate and implement the Green Infrastructure Network for the Fredonia-Newburg Area watersheds.

1) Include all green infrastructure parcels in updated community comprehensive plans and development review maps.
2) Utilize tools such as protection overlays, setbacks, open space zoning, conservation easements, conservation and/or low impact development, etc. on all green infrastructure parcels.
3) Utilize tools such as Development Impact Fees, Stormwater Utility Fees, Special Service Area (SSA) Taxes, etc. to help fund future management of green infrastructure components where new and redevelopment occurs.
4) Identify important unprotected green infrastructure parcels not suited for development then protect and implement long term management.
5) Work with private land owners along stream/tributary corridors to manage their land for green infrastructure benefits.
6) Use the Green Infrastructure Network to identify new trails and trail connections.

6.1.17 Water Quality Trading & Adaptive Management

The following information is cited directly from a Wisconsin Department of Natural Resource's (WDNR) document entitled "A Water Quality Trading How To Manual" (WDNR 2013). Water Quality Trading (WQT or "trading") presents a way for municipal and industrial Wisconsin Pollutant Discharge Elimination System (WPDES) permit holders to demonstrate compliance with water quality-based effluent limitations (WQBELs). Generally, trading involves a point source facing relatively high pollutant reduction costs compensating another party to achieve less costly pollutant reduction with the same or greater water quality benefit. In other words, trading provides point sources with the flexibility to acquire pollutant reductions from other sources in the watershed to offset their point source load so that they will comply with their own permit requirements, while simultaneously helping to fund water quality improvements nearby. Trading is not a mandatory program or regulatory requirement, but rather a market-based option that may enable some industrial and municipal facilities within Fredonia-Newburg Area watershed to meet regulatory requirements more cost-effectively. Now that more restrictive water quality standards are effective in Wisconsin, such as those for phosphorus, trading may be economically preferable to other compliance options.

There are many benefits to trading:

1. Permit compliance through trading may be economically preferable to other compliance options.
2. New and expanding point source discharges can utilize trading to develop new economic opportunities in a region, while still meeting water quality goals.
3. Permittees, and the point and nonpoint sources that work cooperatively with them, can demonstrate their commitment to the community and to the environment by working together to protect and restore local water resources.

Adaptive management is often confused with trading, as both options allow permittees to work with nonpoint or other point sources of phosphorus in a watershed to reduce the overall phosphorus load to a given waterbody. Adaptive management is solely focused on phosphorus compliance and improving water quality so that the applicable phosphorus criterion is met. Trading is not limited to phosphorus and may be used to meet limits for various compounds. Trading focuses on compliance with a discharge *limit* while adaptive management focuses on compliance with phosphorus *criteria*.

Water quality trading has seven components: pollutant, trading participants, pollution reduction credit, credit threshold, trade ratio, location, and timing (Figure 67). Each of these components must be adequately addressed in a trading strategy. The "pollutant" is simply the contaminant being traded. The "trading participants" are entities involved in the trade. "Credit" is the amount of a given pollutant that is available for trading. "Credit Threshold" is the amount of pollutant reduction that needs to be achieved before credits are generated. "Trade ratios" are put in place due to uncertainty margins. "Location" refers to the fact that the credit user and generator must discharge to the same waterbody. "Timing" is important because credits must be generated before they can be used to offsite the pollution.

Figure 67. Water quality trading components (source: WDNR).

6.2 Site Specific Management Measures Action Plan

Site Specific Management Measure (Best Management Practice [BMP]) recommendations made in this section of the report are backed by findings from the watershed field inventory, overall watershed resource inventory, and input from stakeholders. In general, the recommendations address sites where watershed problems and opportunities can best be addressed to achieve watershed goals and objectives. The Site-Specific Management Measures Action Plan is organized by the jurisdiction in which recommendations are located making it easy for users to identify the location of project sites and corresponding project details. It is important to note that project implementation is voluntary and there is no penalty or reduction in future grant opportunities for not following recommendations. Site Specific Management Measures were identified within the following jurisdictional boundaries and are included in the Site-Specific Action Plan:

- *Village of Fredonia*
- *Newburg*
- *West Bend*
- *Ozaukee County*
- *Sheboygan County*
- *Washington County*

Management Measure categories in the Site-Specific Action Plan include:

- *Stream & Riparian Area Restoration*
- *Agricultural Management Practices*
- *Potential Wetland Restoration*
- *Natural Area Restorations*
- *Bioinfiltration Swales*
- *Other Management Measures*

Descriptions and location maps for each Management Measure category follow. Table 41 includes useful project details such as site ID#, Location, Units (size/length), Owner, Existing Condition, Management Measure Recommendation, Priority, Responsible Entity, Sources of Technical Assistance, Cost Estimate, and Implementation Schedule.

Project importance, technical and financial needs, cost, feasibility, and ownership type were taken into consideration when prioritizing and scheduling Management Measures for implementation. High, Medium, or Low Priority was assigned to each recommendation. Priority Areas as discussed in Section 5.2 are all High Priority and highlighted in red on project category maps and the Action Plan table. For this watershed plan a Priority Area is best described as a location in the watershed where existing or potential future causes and sources of an impairment or existing function are significantly worse than other areas of the watershed or where additional management measures can produce a significant reduction in pollutant loading. Implementation schedule varies greatly with each project but is generally based on the short term (1-10 years) for High Priority projects and 10-20+ years for medium and low priority projects. Maintenance projects are ongoing.

The Site Specific Management Measures Action Plan is designed to be used in one of two ways.

Method 1: The user should find the respective jurisdictional boundary (listed alphabetically in Table 41) then identify the Management Measure category of interest within that boundary. A Site ID# can be found in the first column under each recommendation that corresponds to the Site ID# on a map (Figures 68-70) associated with each category.

Method 2: The user should go to the page(s) summarizing the Management Measure category of interest then locate the corresponding map and Site ID# of the site-specific recommendations for that category. Next, the user should go to Table 41 and locate the jurisdiction where the project is located, then go to the project category and Site ID# for details about the project.

Pollutant Load Reduction Estimates

Pollutant load reductions were estimated using STEPL by subwatershed management unit and by the three watersheds (see Section 5.3). Estimated *percent* removal of total suspended solids, nitrogen, and phosphorus are included below. These percent removal efficiencies were based on either USEPA's Region 5 Model or the STEPL model (Table 39) and serve as a general guide to pollutant reduction as reference. This model uses "Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual" (MDEQ, 1999) to provide estimates of sediment and nutrient load reductions of potential projects. Percent removal efficiencies for total bacteria such as *E. coli* were derived from the National Pollutant Removal Performance Database that was developed by the Center for Watershed Protection (CWP 2007).

Table 39. Percent pollutant removal efficiencies for various Management Measures.

Management Measures	TSS	TN	TP	Bacteria
Vegetated Filter Strips	73%	40%	45%	37%
Extended Wet Detention, Wetland Restoration	60%	35%	45%	70%
Wetland Detention	78%	20%	44%	78%
Dry Detention	58%	30%	26%	88%
Infiltration Basin	75%	60%	65%	90%
Streambank Stabilization	90%	90%	90%	N/A
Conservation Tillage*	77%	25%	69%	N/A
Nutrient Management*	0%	25%	56%	N/A
Fencing and Streambank Stabilization*	75%	75%	75%	37-45%
Injection	N/A	N/A	94%	N/A
Weekly Street Sweeping	16%	6%	6%	N/A
Porous Pavement	90%	85%	65%	90%

Note: All bacteria reduction estimates were derived from the Center for Watershed Protection or other relevant studies.
* Reductions derived from STEPL.

Watershed-Wide Summary of Action Recommendations

All Site-Specific Management Measures, Education Plan (Section 7.0), and Monitoring Plan (Section 9.1) recommendation information is condensed by Category in Table 40. This information provides a watershed-wide summary of the "Total Units" (size/length), "Total Cost," and "Total Estimate of Pollutant Load Reduction" if all the recommendations in the Site-Specific Management Measures Action Plan, Education Plan, and Monitoring Plan are implemented. Key points include:

- 378,341 linear feet of stream & riparian area restoration costing $16,960,000.
- 5,052 acres of agricultural management practice recommendations.
- 1,590 acres of other ecological restoration costing $4,854,000.
- 19,307 pounds/year of nitrogen (TN) would potentially be reduced each year.
- 23,193 pounds/year of phosphorus (TP) would potentially be reduced each year, representing a 19.4% reduction, short of the reduction target identified in Section 5.0.
- 4,060 tons/year of total suspended solids (TSS) would potentially be reduced each year, representing a 15.3% reduction, short of the reduction target identified in Section 5.0.
- Education programs will cost $1.5-2.5 million over 10 years to implement (see Section 7.0).

- A water quality monitoring plan will cost at least $1 million over 10 years to implement (see Section 9.0).

Table 40. Watershed-wide summary of Management Measures recommended for implementation.

Management Measure Category	Total Units (size/ length)	Total Cost	Estimated Load Reduction		
			TN (lbs/yr)	TP (lbs/yr)	TSS (t/yr)
Stream & Riparian Area Restoration	378,341 lf	$16,960,000	137	163	101
Agricultural Management Practice Recommendations	5,052 ac	N/A	17,587	21,775	3,654
Other Management Measures					
Wetland Restoration	489 ac	$2,325,000	1,204	1,166	289
All Urban Measures	1,101 ac	$2,529,000	380	90	16
Information & Education Plan	Entire Plan	$1.5-2.5 million over 10 years	N/A	N/A	N/A
Water Quality Monitoring Plan	Entire Plan	> $1 million over 10 years	N/A	N/A	N/A
TOTALS		**$21,814,000**	**19,307**	**23,193**	**4,060**

6.2.1 Streambank and Riparian Area Restoration Recommendations

Applied Ecological Services, Inc. (AES) completed a general inventory of the streams in the Fredonia-Newburg Area watershed in late summer of 2018. All streams and tributaries were assessed based on divisions into "Stream Reaches". Thirty (30) stream reaches were assessed accounting for 378,341 linear feet or 71.6 miles. Detailed notes were recorded for each stream reach related to potential Management Measure recommendations such as improving streambank and channel conditions, improving riparian area health, and maintaining these reaches long term. The results of the stream inventory are summarized in Section 3.14.1; the results of the inventory can be found in Appendix C and in the Fredonia-Newburg Area watersheds GIS dataset.

The conditions of streams and tributaries in the watersheds vary. Within the North Branch, Town of Fredonia, and Village of Newburg watersheds respectively, approximately 33%, 32%, and 7% of the riparian areas are in "Good" ecological condition, 41%, 11%, and 71% are in "Average" ecological condition, and 7%, 58%, and 22% are in "Poor" condition. Channelization is seen most commonly along the tributaries within the watershed, but not on the main branches of the Milwaukee River and North Branch Milwaukee River. Generally, there is little erosion seen in the streams across the watershed.

Stream and riparian area recommendations for this watershed plan generally focus on restoring and improving the riparian corridor, with some spot stabilization of banks recommended where appropriate. Where existing buffers are less than 75 feet, recommendations have been made to extend buffers where possible; that said, extending a riparian buffer to 75 feet where no buffer exists in not always achievable. In these cases, typically recommendations included increasing the buffer to 20-30 feet along each bank.

Most stream restoration projects include at least one of the following three water quality and habitat improvement components; 1) removal of existing invasive vegetation including trees and shrubs from the banks and extending buffers where none currently exists followed by; 2) spot stabilization of banks using bioengineering, regrading of banks, and installation of native vegetation where necessary; and 3) restored riffles/grade controls in the stream channel to simulate conditions found in naturally meandering streams and to improve in-stream habitat. Short- and long-term maintenance then follows and is critically important in the development process and to maintain restored conditions.

Figure 68 shows the location of all potential stream and riparian area restoration projects by reach ID# and priority while Table 41 lists project details about each recommendation within the appropriate jurisdictional boundary. High Priority projects were generally assigned to streams with either heavily degraded or where no riparian areas existed or in cases that showed relatively higher rates of erosion than other streams. Medium and Low priority was generally assigned to stream reaches exhibiting only minor problems. In many cases, only riparian area restoration and maintenance are needed with little to no streambank or in-stream restoration. It is also important to note that implementation costs listed in Table 41 are estimates only. Actual costs will need to be developed via a conceptual plan prior to applying for grants and installing the project.

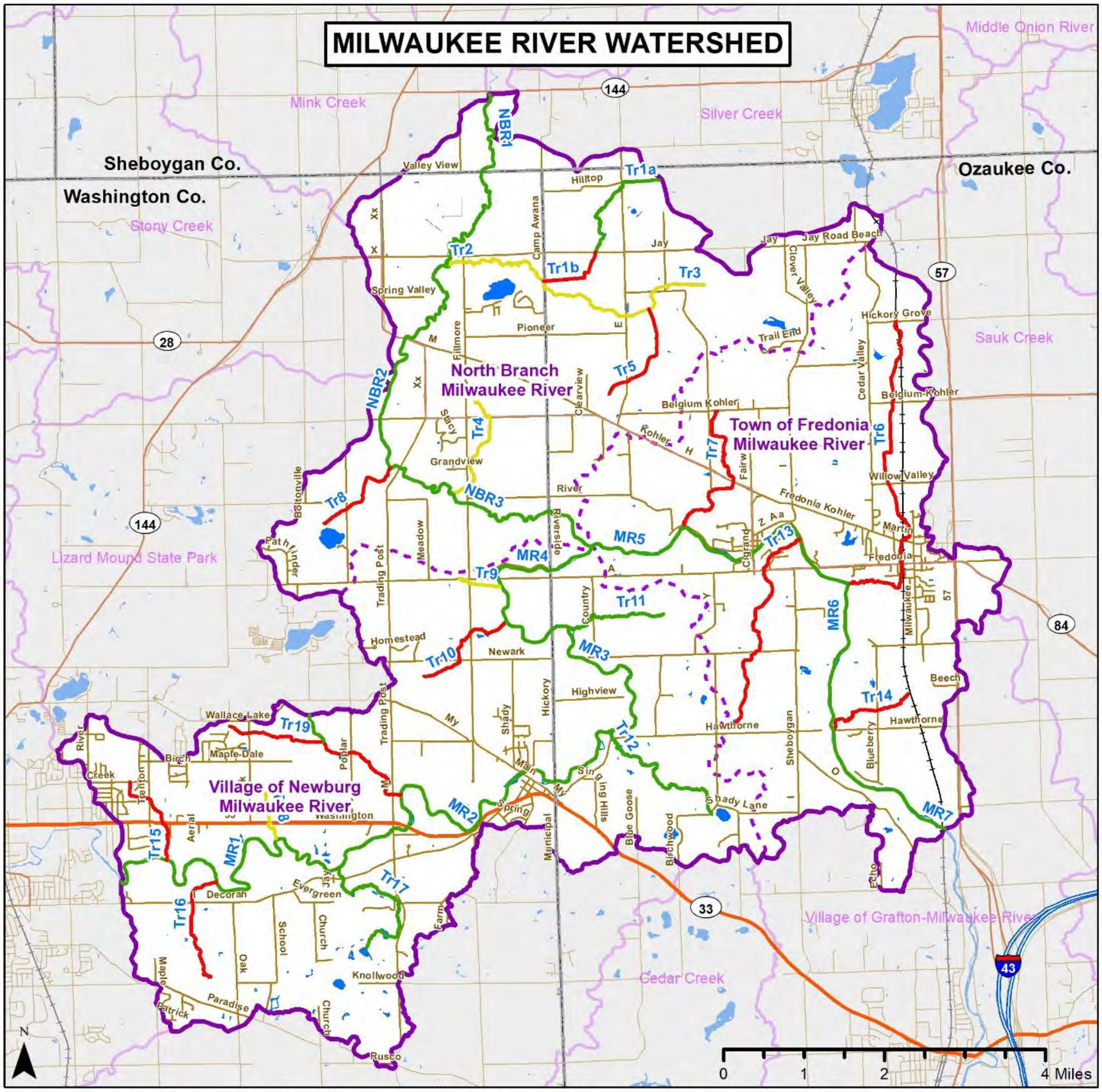
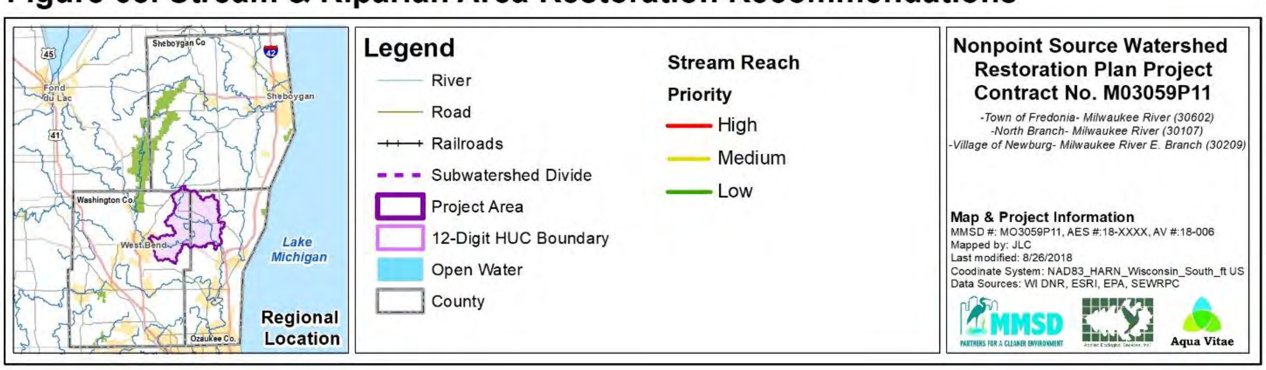


Figure 68. Stream & Riparian Area Restoration Recommendations



6.2.2 Agricultural Management Practice Recommendations

Agricultural land is the single largest land use in the Fredonia-Newburg Area watersheds (49% of the total area) and includes row crops, hay, pasture, and livestock uses. While Wisconsin is known for its food production, how this land is managed can have a significant effect on water quality. According to the Environmental Protection Agency's (EPA's) National Water Quality Inventory for 2000, "agricultural nonpoint source (NPS) pollution was the leading source of water quality impacts on surveyed rivers and lakes… Agricultural activities that cause NPS pollution include poorly located or managed animal feeding operations; overgrazing; plowing too often or at the wrong time; and improper, excessive or poorly timed application of pesticides, irrigation water and fertilizer. (EPA, 2013)"


Example of conservation tillage (no till) farming

Agricultural land can be a significant contributor of nutrients and sediment to local streams when practices such as cover crops, filter strips, grass swales, no or reduced tillage, waste (manure) management, prescribed grazing, and fencing to restrict livestock access to streams are not in place. In September 2018, Applied Ecological Services, Inc. (AES) completed a windshield survey of the watershed, including an assessment of agricultural land practices. This included map notations of existing conservation practices (such as no-till farming, vegetated swales, contour cropping, etc.), general agricultural land cover types (such as row crop, hay, or pasture), and cattle access to streams. Areas where additional conservation practices could be implemented were also noted. Additional modeling was done using EVAAL to determine the location of agricultural lands that are more vulnerable to erosion. In total, over 5,000 acres of agricultural lands were identified that potentially could benefit from some type of additional conservation practices. Results of the agricultural land inventory can be found in Appendix C and the GIS dataset and the results of the EVAAL model are discussed in more detail in Section 4.4.2.

Pollutant load modeling estimates show that agricultural lands, including both cropland and feedlots, are the single largest contributor to nutrient and sediment loading in the Fredonia-Newburg Area watersheds. Cropland areas contribute the highest nitrogen load (126,848.6 lbs/yr; 40%), the highest phosphorus load (76,961.4 lbs/yr; 58%) and highest sediment load (18,536.0 tons/yr; 67%) in the watershed. Feedlot areas contribute the second highest nitrogen load (119,185.1 lbs/yr: 38%) in the watershed, the third highest phosphorus load (19,336.9 lbs/yr: 15%), and do not contribute to sediment loading. If additional agricultural management practices are utilized in these areas pollutant loading could be reduced significantly.

Some agricultural parcels within the watershed are already utilizing appropriate conservation practices, including no-till farming, vegetated swales, or cattle fencing in order to reduce nutrient and sediment loading to streams. Most farmers understand the inherent value in reducing soil and nutrient losses on their farms and consider it good business practice to do so. For those parcels where conservation practices appeared to be lacking, potential recommendations were noted. These recommendations most commonly included the need for additional in-field practices such as cover crops, no-till, reduced tillage, conservation cropping, vegetated filter strips, manure injection, low disturbance injection, or other targeted agricultural best management practices.

7A – example of livestock access to wetland area

The watershed also includes a number of dairy and other livestock operations. In some cases it was apparent that livestock were allowed free access to streams, streambanks, and wetlands and instances of eroded and muddy banks were not uncommon in these areas. Unmanaged cattle access to streams can lead to large increases in total kjeldahl nitrogen, total phosphorus, ammonium, total suspended solids, turbidity, and *E. coli*. over summer and fall months (Vidon, 2008). Recommendations for these types of operations typically included installing fencing to restrict livestock access to waterbodies, injecting liquid manure into fields rather than spreading it on top of fields, implementing other manure management practices on livestock operations, installing vegetated swales along the edges of pastures, and making adjustments to existing nutrient management plans. Fencing has also been shown to reduce *E. coli* loading 37-46% (Texas, 2011); vegetated swales reduce fecal coliform by 74% (Wolfson, 2010); and manure management systems reduce varying amounts of pathogens between 90-99% depending on the type of system/treatment utilized (Sobsey, 2001). Soil injection of manure (as opposed to surface application) resulted in total phosphorus load decreases of 94% (Deverede, 2004).

52B – bare soils adjacent tributary – opportunity for additional practices

Over 5,000 acres of agricultural management recommendations were identified, 4,733 acres of which are High Priority for potential nutrient and sediment reduction based on their size, location, and/or EVAAL modeling. Figure 69 shows the location and priority of all agricultural management practice recommendations by ID# while Table 41 includes action recommendations for each. Note: cost estimates for implementing conservation tillage are not included because the costs are largely dependent on a farmer's available equipment and other factors.

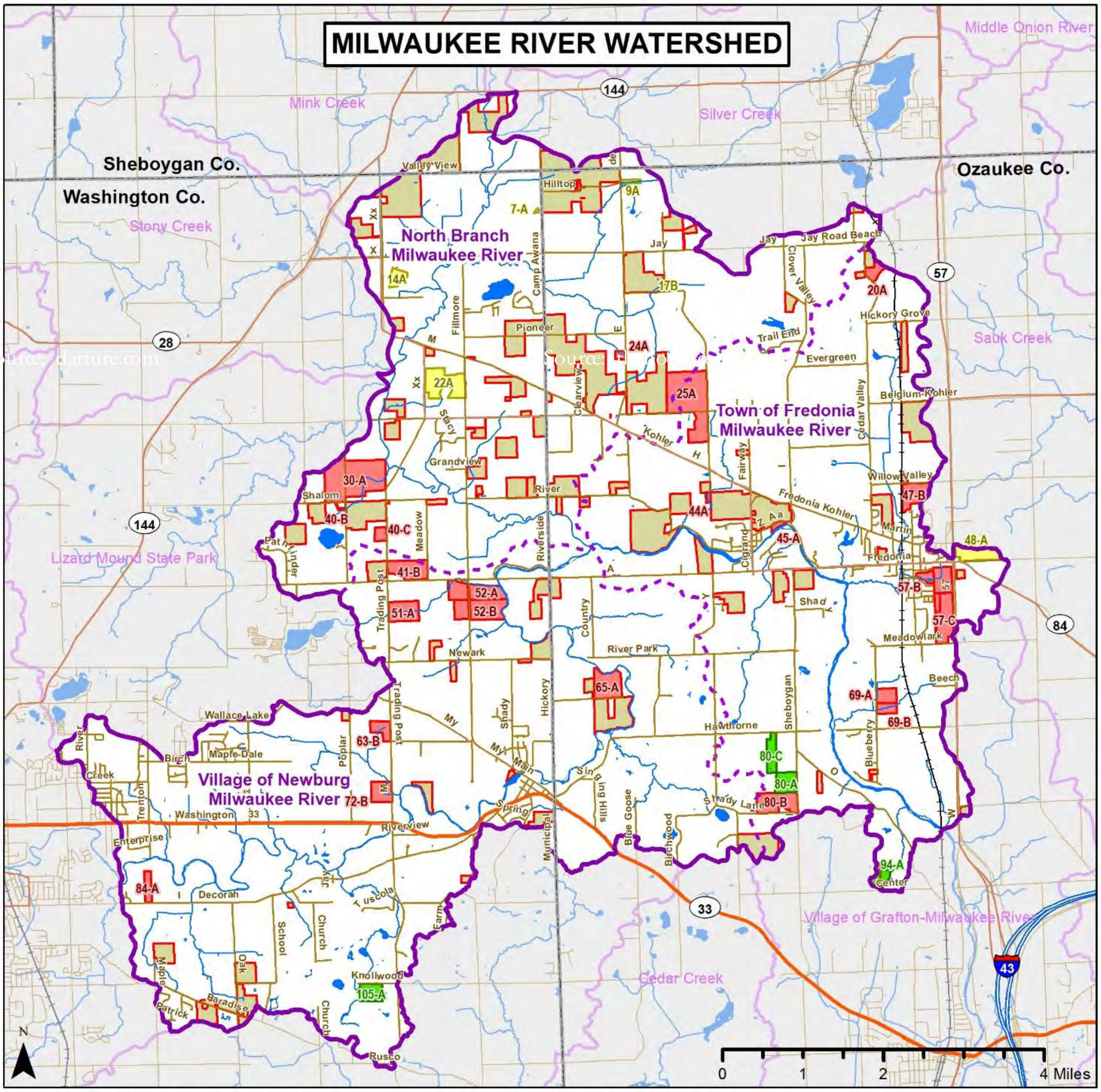
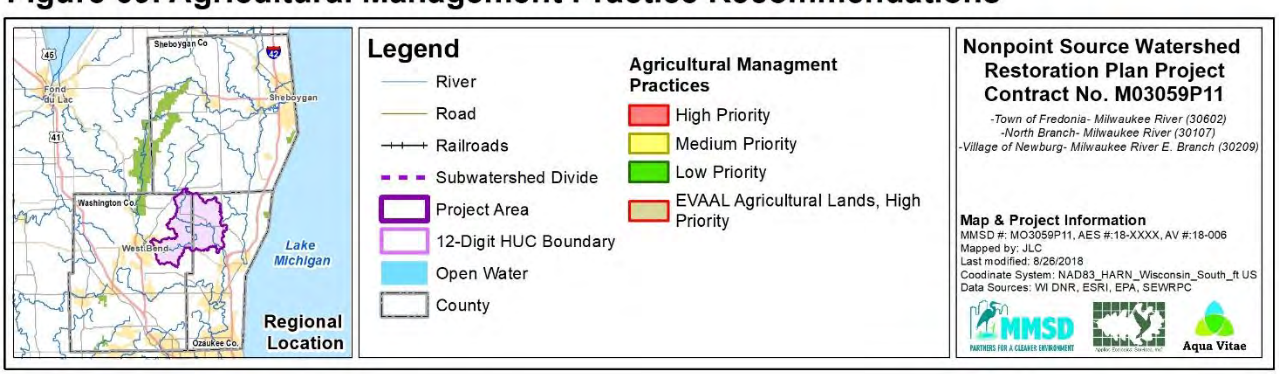


Figure 69. Agricultural Management Practice Recommendations



6.2.3 Other Management Measure Recommendations

While completing the inventory of Fredonia-Newburg Area watershed, Applied Ecological Services, Inc. (AES) noted potential Management Measures that fit under miscellaneous other categories. Detailed field investigation information for these projects can be found in Appendix C and the GIS dataset. Figure 70 shows the location of all "Other Management Measure" recommendations by ID# while Table 41 lists details about each recommendation within the appropriate jurisdictional boundary. Potential projects include:

- 15 potential wetland restorations
- 9 natural area restorations
- 5 bioswale opportunities
- Naturalization of rough areas at two golf courses
- 3 other education projects
- 1 detention basin retrofit

Wetland restoration is the process of bringing back historic wetlands in areas where they have been drained. This section does not include enhancement and maintenance for existing wetlands. Restoration can be important for mitigation purposes or done simply to benefit basic environmental functions that historic wetlands once served. Improvement in water quality is the greatest benefit provided by wetland restoration. Other benefits include reducing flood volumes/rates and improved habitat to increase plant and wildlife biodiversity. The wetland restoration process is generally the same for all sites. First a study must be completed to determine if restoration at the site is actually feasible. If it is, a design plan is developed, permits obtained, then the project is implemented by breaking existing drain tiles and/or regrading soils to attain proper hydrology to support wetland vegetation. Planting with native wetland species is the next step followed by short- and long-term maintenance and monitoring to ensure establishment.

Wetland restoration sites were identified in Section 3.14.3 using a GIS exercise and specific criteria determined to be essential for restoration of a functional and beneficial wetland. The initial analysis resulted in 29 sites meeting these criteria. However, only 15 of these sites were determined to be "potentially feasible" based on careful review of each site using recent aerial photography, open space inventory results, existing land use, and field inspections during the inventory.

Potential wetland restoration - 42A on private land in Washington County

All other management measure recommendations, including natural area restorations, bioswale opportunities, naturalization of golf courses, potential rain gardens, and other educational projects, were opportunities that were identified during the fall 2018 field inventory. Examples of some of these project types are depicted below.

Potential Parking Lot BMP - 40A, Leonard J Yahr County Park

Golf Course Naturalization - 68A, Hawthorn Hills Golf Course

Potential rain garden opportunity - 57A in front of Milwaukee NC Machining Company commercial building

Natural Area Restoration – 75A, management plan and restoration needed

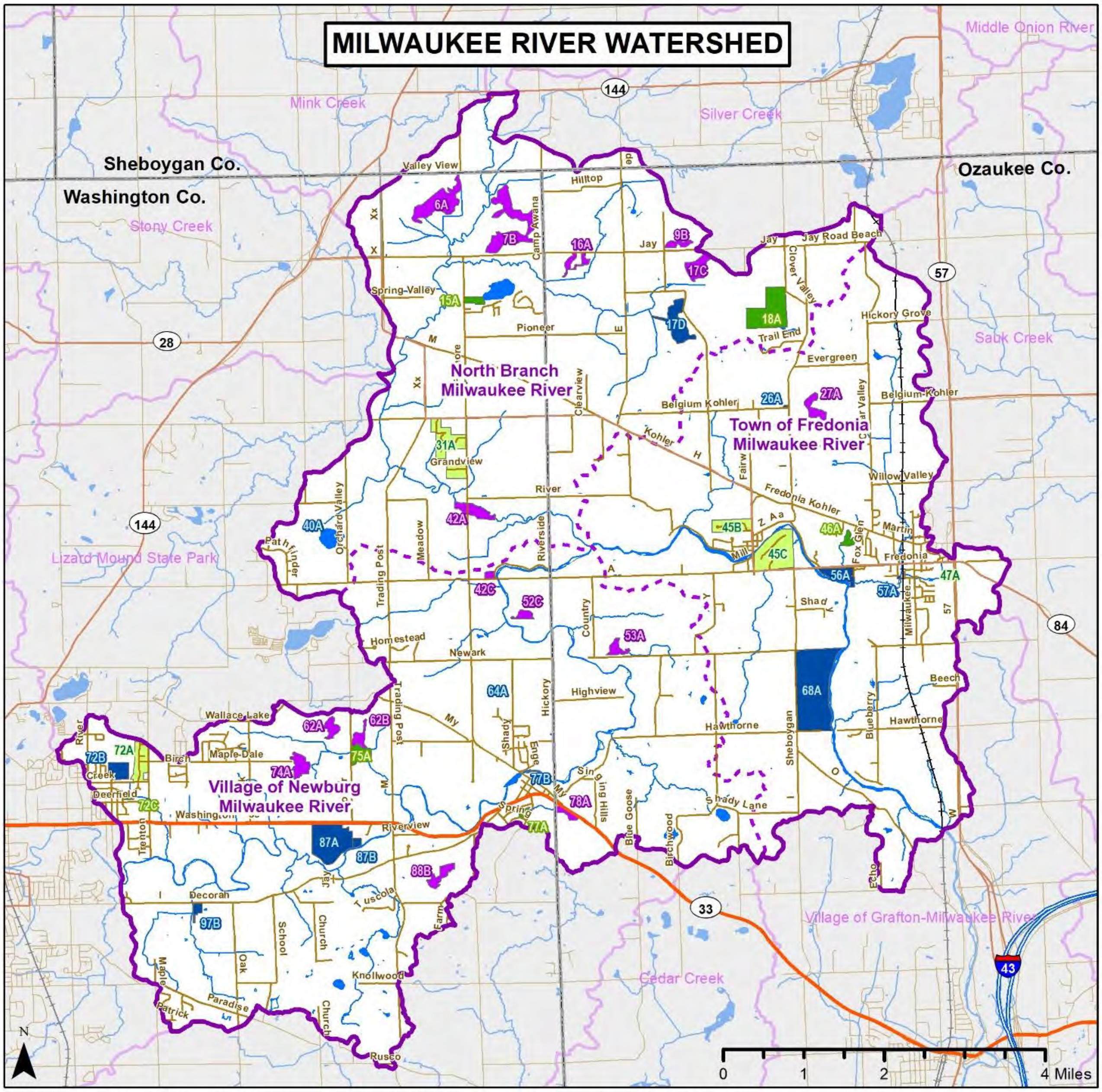
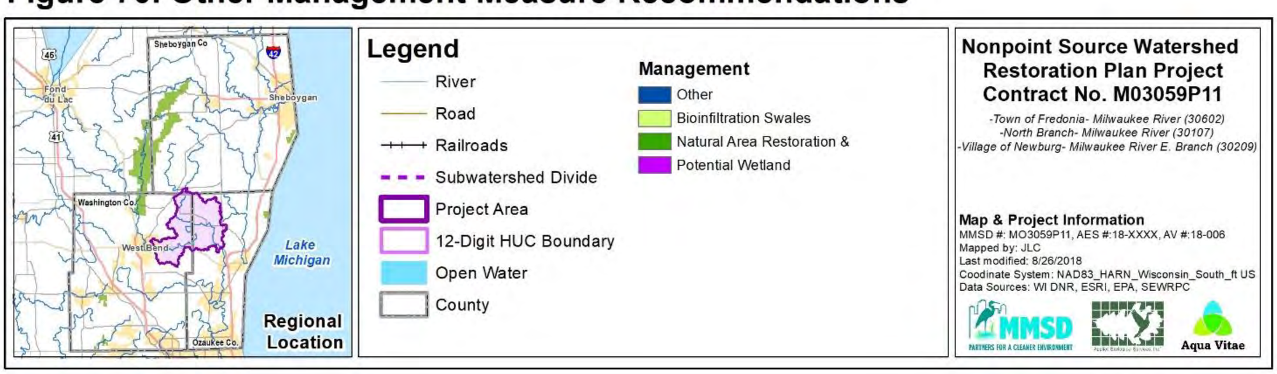


Figure 70. Other Management Measure Recommendations



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6.2.4 Site-Specific Management Measures Action Plan Table

Table 41. Site Specific Management Measures Action Plan Table.

THE VILLAGE OF FREDONIA									
ID#	**Location**	**Units (acres or linear feet)**	**Existing Condition**	**Management Measure Recommendation**	**Priority**	**Owner & Responsible Entity**	**Sources of Technical Assistance**	**Cost Estimate**	**Implementation Schedule (Years)**
AGRICULTURAL MANAGEMENT PRACTICES (SEE FIGURE 69)									
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement farm management practices is relatively low because of programs offered by agencies such as USDA/NRCS. Note: Cost estimates for agricultural management practice recommendations cannot be estimated due to the varying needs of individual farms, farm equipment, and other resources.									
47B	See Figure 69 for project location	57.5	Traditional row crop agricultural field with bare/exposed ground in field - additional infield practice needed	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	High	Owner/Farmer (private)	NRCS, Ozaukee County	Not applicable	1-10 Years
48A	See Figure 69 for project location	54.5	Traditional row crop agricultural field planted in soy beans on sloping land	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	Medium	Owner/Farmer (private)	NRCS, Ozaukee County	Not applicable	10-20 Years
57D	See Figure 69 for project location	46.3	Traditional row crop agricultural field (corn) that could use grass swale and vegetated buffer	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	High	Owner/Farmer (private)	NRCS, Ozaukee County	Not applicable	1-10 Years
57B	See Figure 69 for project location	14.6	Traditional row crop agricultural land that could use grass swale; pond and stream with no buffers	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land; install appropriate buffers on waterways	High	Owner/Farmer (private)	NRCS, Ozaukee County	Not applicable	1-10 Years
OTHER MANAGEMENT MEASURES (SEE FIGURE 70)									
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement these projects varies depending on complexity.									
47A	See Figure 70 for project location	2.4	Existing typical mowed turf roadside swales in right-of-way	Design and implement a project to retrofit existing turf swales to bioinfiltraton swales and maintain	High	Fredonia	Environmental Consultant/ Contractor	$45K to design, construct, and maintain for three years	1-10 Years
47C	See Figure 70 for project location	0.7	Existing typical wet bottom detention basin with mown turf side slopes and large concrete structure at outlet	Design and implement a project to retrofit existing detention basin to remove turf and install natives along slopes and buffer and maintain for three years to establish	High	Private Owner	Ozaukee County, Environmental Consultant/ Contractor	$20K to design, construct, maintain for three years	1-10 Years
57A	See Figure 70 for project location	1.2	Wet depression in front of company building	Design and implement a project to create small wetland or rain garden in front of building	High	Private Owner	MMSD Fresh Coast Resource Center and online resources, Ozaukee County	$25K to design, consturct, maintain for three years and create signage	1-10 Years
56A	See Figure 70 for project location	37.6	Waubedonia Park - could create wetland restoration and educational signage in park	Design and implement a project to restore wetlands in low-use areas and create educational signage; maintain for five years until established	High	Ozaukee County	MMSD Fresh Coast Resource Center and online resources, WDNR	$250K to design, consturct, maintain for five years and create signage	1-10 Years

NEWBURG

ID#	Location	Units (acres or linear feet)	Existing Condition	Management Measure Recommendation	Priority	Owner & Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
OTHER MANAGEMENT MEASURES (SEE FIGURE 70)									
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement these projects varies depending on complexity.									
77A	See Figure 70 for project location	5.4	Existing pond in average condition with minimal buffer; buffer contributing ag runoff	Design and implement a project to increase native buffer around pond and utilize as green infrastructure connection	Low	Village of Newburg	Environmental Consultant/ Contractor	$50K to design, construct, and maintain for three years	10-20 Years
77B	See Figure 70 for project location	2.6	Existing grass, gravel, ball diamond at Fireman's Park; could naturalize low use areas and create bioswales as educational project	Design and implement a project to naturalize unused or low-use areas, install bioswales, and create signage to educate stakeholders about water quality	Low	Newburg Fire Department	WDNR, Environmental Consultant/ Contractor	$50K to design, construct, maintain for three years and create signage	10-20 Years

OZAUKEE COUNTY									
ID#	Location	Units (acres or linear feet)	Existing Condition	Management Measure Recommendation	Priority	Owner & Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
AGRICULTURAL MANAGEMENT PRACTICES (SEE FIGURE 69)									
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement farm management practices is relatively low because of programs offered by agencies such as USDA/NRCS. Note: Cost estimates for agricultural management practice recommendations cannot be estimated due to the varying needs of individual farms, farm equipment, and other resources.									
80B	See Figure 69 for project location	74.1	Agricultural drainage from field and farm yard to stream	Utilize new or additional adjustments to nutrient management plans such as waste management system	High	Owner/Farmer (private)	WDNR, NRCS	Not applicable	1-10 Years
20A	See Figure 69 for project location	21.4	Landspreading occurring on row crop disced-under field adjacent mowed ditch with recent runoff and manure evident (runs south)	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	High	Owner/Farmer (private)	NRCS, Ozaukee County	Not applicable	1-10 Years
24A	See Figure 69 for project location	8.0	Cattle overgrazing in agricultural wetland with no buffer and draining directly to channelized swale	Utilize waste management system and fencing to restrict livestock access on private agricultural land	High	Owner/Farmer (private)	NRCS, Ozaukee County	Not applicable	1-10 Years
25A	See Figure 69 for project location	211.1	Land spreading of manure on traditional row crop agricultural field	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	High	Owner/Farmer (private)	NRCS, Ozaukee County	Not applicable	1-10 Years
57C	See Figure 69 for project location	87.6	Traditional row crop agricultural field draining to adjacent wetland	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	High	Owner/Farmer (private)	NRCS, Ozaukee County	Not applicable	1-10 Years
65A	See Figure 69 for project location	71.0	Cattle overgrazing in field with narrow buffer between farm and adjacent stream	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	High	Owner/Farmer (private)	NRCS, Ozaukee County	Not applicable	1-10 Years
69A	See Figure 69 for project location	29.2	Traditional row crop agricultural field that runs down sloped hill; could use contour cropping	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	High	Owner/Farmer (private)	NRCS, Ozaukee County	Not applicable	1-10 Years
80A	See Figure 69 for project location	42.2	Traditional row crop agricultural field with bare/exposed ground in field - additional infield practice needed	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	Low	Owner/Farmer (private)	NRCS, Ozaukee County	Not applicable	10-20 Years
80C	See Figure 69 for project location	35.5	Traditional row crop agricultural field with bare/exposed ground in field - additional infield practice needed	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	Low	Owner/Farmer (private)	NRCS, Ozaukee County	Not applicable	10-20 Years
94A	See Figure 69 for project location	23.5	Traditional row crop agricultural field with bare/exposed ground in field - additional infield practice needed	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	Low	Owner/Farmer (private)	NRCS, Ozaukee County	Not applicable	10-20 Years
9A	See Figure 69 for project location	6.9	Traditional row crop (soybeans) agricultural field draining to drainage ditch without buffer	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	Medium	Owner/Farmer (private)	NRCS, Ozaukee County	Not applicable	10-20 Years
Various	See Figure 69 for project location	2,032.8	Existing agricultural land identified as a Priority Area project based on EVAAL Erosion Hazard analysis.	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	High	Owner/Farmer (private)	NRCS, Ozaukee County	Not applicable	1-10 Years
17B	See Figure 69 for project location	2.7	Cattle with open access to eroded riparian banks and heavily grazed woodlands	Utilize pasture rotation, waste management system, and/or fencing to restrict livestock access on private agricultural land	Medium	Owner/Farmer (private)	NRCS, Ozaukee County	Not applicable	10-20 Years
44A	See Figure 69 for project location	4.7	Cattle overgrazing on agricultural land	Utilize pasture rotation, waste management system, and/or fencing to restrict livestock access on private agricultural land	High	Owner/Farmer (private)	NRCS, Ozaukee County	Not applicable	1-10 Years
45A	See Figure 69 for project location	7.0	Cattle overgrazing in agricultural wetland	Utilize seasonal pasture rotation, waste management system, and/or fencing to restrict livestock access on private agricultural land	Medium	Owner/Farmer (private)	NRCS, Ozaukee County	Not applicable	1-10 Years
69B	See Figure 69 for project location	21.1	Cattle grazing adjacent stream with no buffer or fencing	Utilize pasture rotation, waste management system, and/or fencing to restrict livestock access on private agricultural land	High	Owner/Farmer (private)	NRCS, Ozaukee County	Not applicable	1-10 Years

ID#	Location	Units (acres or linear feet)	Existing Condition	Management Measure Recommendation	Priority	Owner & Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
OTHER MANAGEMENT MEASURES (SEE FIGURE 70)									
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement these projects varies depending on complexity.									
45B	See Figure 70 for project location	49.6	Existing typical mowed turf roadside swales	Design and implement a project to retrofit existing turf swales to bioinfiltraton swales and maintain	Medium	HOA, Ozaukee County	WDNR, Environmental Consultant/ Contractor	$15K to design, construct, maintain for three years	10-20 Years
45C	See Figure 70 for project location	125.2	Existing typical mowed turf roadside swales	Design and implement a project to retrofit existing turf swales to bioinfiltraton swales and maintain	Medium	HOA, Ozaukee County	WDNR, Environmental Consultant/ Contractor	$20K to design, construct, maintain for three years	10-20 Years
68A	See Figure 70 for project location	284.9	Hawthorne Hills Golf Course with typical golf course landscaping	Design and implement a project to naturalize rough areas and install buffers on waterways to improve water quality	High	Ozaukee County	WDNR, Environmental Consultant/ Contractor	$350K to design, construct and maintain for three years	1-10 Years
17D	See Figure 70 for project location	65.0	Large industrial gravel and sand operation draining thru wetland to channelized Tributary 3	Design and implement a project to create and install naturalized detention basin to appropriately manage runoff	High	Hartmann Sand & Gravel Co.	Ozaukee County, WDNR	$80K to design, permit, & construct basin and maintain for three years	1-10 Years
26A	See Figure 70 for project location	0.9	Exiting gravel dump site that could use silt fence	Install silt fence as appropriate and maintain	High	Private Owner	Ozaukee County, WDNR	$5K to install silt fence	1-10 Years
18A	See Figure 70 for project location	120.5	Existing woodland in good shape with some invasive spp; EAB has decimated ash canopy; prairie mostly brome with secondary tree growth	Conduct a natural resource inventory and develop a management plan to restore natural area and maintain for three years	High	OWLT	Environmental Consultant/ Contractor, WDNR	$12K to develop NRI/Management Plan	1-10 Years
46A	See Figure 70 for project location	12.8	Large residential pond with multiple owners along shoreline, heavily used; predominantly mowed turf to edge; appears to be algae forming in lake	Design and implement a project to remove turf from slopes and install native buffer along shoreline	Low	Crystal Springs Park Association	Environmental Consultant/ Contractor	$130K to design, construct, maintain for three years	10-20 Years
16A	See Figure 70 for project location	18.9	Drained and/or farmed hydric soils confirmed in field as good candidate sight for potential wetland restoration	Design and implement a project to restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation; maintain for three to five years until established	Medium	Owner/Farmer (private)	WDNR, Environmental Consultant/ Contractor	$95K to design, construct, maintain for three years	10-20 Years
17C	See Figure 70 for project location	38.4	Drained and/or farmed hydric soils confirmed in field as good candidate sight for potential wetland restoration	Design and implement a project to restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation; maintain for three to five years until established	High	Private Owner	WDNR, Environmental Consultant/ Contractor	$190K to design, construct, maintain for three years	1-10 Years
27A	See Figure 70 for project location	28.2	Drained and/or farmed hydric soils confirmed in field as good candidate sight for potential wetland restoration	Design and implement a project to restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation; maintain for three to five years until established	High	Private Owner	WDNR, Environmental Consultant/ Contractor	$140K to design, construct, maintain for three years	1-10 Years
53A	See Figure 70 for project location	18.1	Drained and/or farmed hydric soils confirmed in field as good candidate sight for potential wetland restoration	Design and implement a project to restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation; maintain for three to five years until established	Medium	Private Owner	WDNR, Environmental Consultant/ Contractor	$95K to design, construct, maintain for three years	10-20 Years
78A	See Figure 70 for project location	14.5	Drained and/or farmed hydric soils confirmed in field as good candidate sight for potential wetland restoration	Design and implement a project to restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation; maintain for three to five years until established	Medium	Private Owner	WDNR, Environmental Consultant/ Contractor	$90K to design, construct, maintain for three years	10-20 Years
9B	See Figure 70 for project location	14.1	Row crop in drained hydric soils, driveway splits former wetland	Design and implement a project to restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation; maintain for three to five years until established	Medium	Private Owner	WDNR, Environmental Consultant/ Contractor	$90K to design, construct, maintain for three years	10-20 Years

ID#	Location	Units (acres or linear feet)	Existing Condition	Management Measure Recommendation	Priority	Owner & Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
STREAM & RIPARIAN AREA RESTORATION (SEE FIGURE 68)									
Technical and Financial Assistance Needs: Stream restorations are complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration. The project becomes more complex in areas that flow through several governing bodies or multiple private residences. Technical and financial assistance associated with stream maintenance is generally low for minor tasks such as removing debris.									
MR3	See Figure 68 for project locations	19,693	19,693 lf of stream exhibiting no channelization, moderately stable banks, and average overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	Low	Ozaukee County, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$1.2M to design, permit, construct, maintain buffer & bank stabilization for three years	10-20 Years
MR5	See Figure 68 for project locations	13,137	13,137 lf of stream exhibiting moderate channelization, moderately stable banks, and good overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	Low	Ozaukee County, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$850K to design, permit, construct, maintain buffer & bank stabilization for three years	10-20 Years
MR6	See Figure 68 for project locations	19,309	19,309 lf of stream exhibiting no channelization, relatively stable banks, and good overall riparian area condition	Design and implement a project to increase buffers, remove invasives, restore native vegetation and maintain for three years to establish	Low	Ozaukee County, Fredonia, private owners	WDNR, Environmental Consultant/ Contractor	$245K to design, construct, maintain for three years	10-20 Years
MR7	See Figure 68 for project locations	10,766	10,766 lf of stream exhibiting low levels of channelization, relatively stable banks, and average overall riparian area condition	Design and implement a project to increase buffers, remove invasives, restore native vegetation and maintain for three years to establish	Low	Ozaukee County, private owners	WDNR, Environmental Consultant/ Contractor	$150K to design, construct, maintain for three years	10-20 Years
Tr11	See Figure 68 for project locations	7,605	7,605 lf of stream exhibiting no channelization, relatively stable banks, and average overall riparian area condition	Design and implement a project to increase buffers, remove invasives, restore native vegetation and maintain for three years to establish	Low	Ozaukee County, private owners	WDNR, Environmental Consultant/ Contractor	$125K to design, construct, maintain for three years	10-20 Years
Tr12	See Figure 68 for project locations	12,056	12,056 lf of stream exhibiting no channelization, relatively stable banks, and average overall riparian area condition	Design and implement a project to increase buffers, remove invasives, restore native vegetation and maintain for three years to establish	Low	Ozaukee County, private owners	WDNR, Environmental Consultant/ Contractor	$190K to design, construct, maintain for three years	10-20 Years
Tr14	See Figure 68 for project locations	6,600	6,600 lf of stream exhibiting low levels of channelization, relatively stable banks, and poor overall riparian area condition	Design and implement a project to increase buffers, remove invasives, restore native vegetation and maintain for three years to establish	High	Ozaukee County, private owners	WDNR, Environmental Consultant/ Contractor	$100K to design, construct, maintain for three years	1-10 Years
Tr1a	See Figure 68 for project locations	8,513	8,513 lf of stream exhibiting no channelization, relatively stable banks, and average overall riparian area condition	Design and implement a project to increase buffers, remove invasives, restore native vegetation and maintain for three years to establish	Low	Ozaukee County, Fredonia. private owners	WDNR, Environmental Consultant/ Contractor	$135K to design, construct, maintain for three years	10-20 Years
Tr1b	See Figure 68 for project locations	4,727	4,727 lf of stream exhibiting high levels of channelization, moderately stable banks, and good overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	High	Ozaukee County, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$320K to design, permit, construct, maintain buffer & bank stabilization for three years	1-10 Years
Tr3	See Figure 68 for project locations	13,542	13,542 lf of stream exhibiting high levels of channelization, moderately stable banks, and average overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	Medium	Ozaukee County, Fredonia. Washington County, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$700K to design, permit, construct, maintain buffer & bank stabilization for three years	10-20 Years
Tr5	See Figure 68 for project locations	7,413	7,413 lf of stream exhibiting high levels of channelization, moderately stable banks, and poor overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	High	Ozaukee County, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$500K to design, permit, construct, maintain buffer & bank stabilization for three years	1-10 Years

ID#	Location	Units (acres or linear feet)	Existing Condition	Management Measure Recommendation	Priority	Owner & Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
Tr6	See Figure 68 for project locations	24,441	24,441 lf of stream exhibiting high levels of channelization, moderately stable banks, and poor overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	High	Ozaukee County, Fredonia, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$1.9M to design, permit, construct, maintain buffer & bank stabilization for three years	1-10 Years
Tr7	See Figure 68 for project locations	12,031	12,031 lf of stream exhibiting low levels of channelization, moderately stable banks, and poor overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	High	Ozaukee County, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$765K to design, permit, construct, maintain buffer & bank stabilization for three years	1-10 Years
Tr13	See Figure 68 for project locations	16,208	16,208 lf of stream exhibiting low levels of channelization, moderately stable banks, and poor overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	High	Ozaukee County, Waubeka, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$1.1M to design, permit, construct, maintain buffer & bank stabilization for three years	1-10 Years

SHEBOYGAN COUNTY

ID#	Location	Units (acres or linear feet)	Existing Condition	Management Measure Recommendation	Priority	Owner & Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
AGRICULTURAL MANAGEMENT PRACTICES (SEE FIGURE 69)									
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement farm management practices is relatively low because of programs offered by agencies such as USDA/NRCS. Note: Cost estimates for agricultural management practice recommendations cannot be estimated due to the varying needs of individual farms, farm equipment, and other resources.									
Various	See Figure 69 for project location	252.2	Existing agricultural land identified as a Priority Area project based on EVAAL Erosion Hazard analysis.	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	High	Owner/Farmer (private)	NRCS, Sheboygan County	Not applicable	1-10 Years

WASHINGTON COUNTY

ID#	Location	Units (acres or linear feet)	Existing Condition	Management Measure Recommendation	Priority	Owner & Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
AGRICULTURAL MANAGEMENT PRACTICES (SEE FIGURE 69)									
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement farm management practices is relatively low because of programs offered by agencies such as USDA/NRCS. Note: Cost estimates for agricultural management practice recommendations cannot be estimated due to the varying needs of individual farms, farm equipment, and other resources.									
30A	See Figure 69 for project location	215.4	Large dairy with narrow grass drainage way adjacent drained hydric soils	Design and implement a project to increase swale width and utilize potential restorable wetland soils for wetland creation; utilize additional nutrient management as appropriate	High	Owner/Farmer (private)	WDNR, NRCS	Not applicable	1-10 Years
40C	See Figure 69 for project location	15.9	Existing cattle/dairy farm and pasture with intense grazing immediately adjacent stream	Utilize new or additional adjustments to nutrient management plans such as waste management system	High	Owner/Farmer (private)	WDNR, NRCS	Not applicable	1-10 Years
14A	See Figure 69 for project location	20.9	Existing agricultural field with soybeans planted in marginal land (drained hydric soils)	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	Medium	Owner/Farmer (private)	NRCS, Washington County	Not applicable	10-20 Years
22A	See Figure 69 for project location	93.0	Land spreading of manure on traditional row crop agricultural field	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	Medium	Owner/Farmer (private)	NRCS, Washington County	Not applicable	10-20 Years
41B	See Figure 69 for project location	68.0	Traditional row crop agricultural field receiving excessive flows compared to adjacent areas	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	High	Owner/Farmer (private)	NRCS, Washington County	Not applicable	1-10 Years
51A	See Figure 69 for project location	59.5	Buffer needed surrounding wetland, floodplain and hydronic soils; ensure cover crop is establish prior to high flows	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	High	Owner/Farmer (private)	NRCS, Washington County	Not applicable	1-10 Years
52A	See Figure 69 for project location	84.1	Traditional row crop agricultural field with poor cover crop	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	High	Owner/Farmer (private)	NRCS, Washington County	Not applicable	1-10 Years
52B	See Figure 69 for project location	95.6	Animal farm yard with exposed bare soils, obvious and excessive erosion draining to adjacent stream	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	High	Owner/Farmer (private)	NRCS, Washington County	Not applicable	1-10 Years
63B	See Figure 69 for project location	30.1	Marginal agricultural land adjacent heavily eroded right of way area	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	High	Owner/Farmer (private)	NRCS, Washington County	Not applicable	1-10 Years
75B	See Figure 69 for project location	40.5	Animal farm yard immediately adjacent stream; no buffer	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	High	Owner/Farmer (private)	NRCS, Washington County	Not applicable	1-10 Years
7A	See Figure 69 for project location	1.3	Grazing black angus cows in wetland; fence off wetland from grazing	Utilize pasture rotation and fencing to restrict livestock access on private agricultural land	Medium	Owner/Farmer (private)	NRCS, Washington County	Not applicable	10-20 Years
84A	See Figure 69 for project location	21.5	Traditional row crop agricultural field with no cover crop	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	High	Owner/Farmer (private)	NRCS, Washington County	Not applicable	1-10 Years
Various	See Figure 69 for project location	1,161.7	Existing agricultural land identified as a Priority Area project based on EVAAL Erosion Hazard analysis.	Utilize additional conservation practices such as no-till, reduced tillage, conservation cropping, vegetated filter strips, or injection on private agricultural land	High	Owner/Farmer (private)	NRCS, Washington County	Not applicable	1-10 Years
105A	See Figure 69 for project location	38.3	Cattle overgrazing on agricultural land	Utilize pasture rotation, waste management system, and/or fencing to restrict livestock access on private agricultural land	Low	Owner/Farmer (private)	NRCS, Washington County	Not applicable	10-20 Years
40B	See Figure 69 for project location	2.1	Excessive cattle use on agricultural land immediately adjacent stream	Utilize pasture rotation, waste management system, and/or fencing to restrict livestock access on private agricultural land	High	Owner/Farmer (private)	WDNR, NRCS	Not applicable	1-10 Years

ID#	Location	Units (acres or linear feet)	Existing Condition	Management Measure Recommendation	Priority	Owner & Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
OTHER MANAGEMENT MEASURES (SEE FIGURE 70)									
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement these projects varies depending on complexity.									
31A	See Figure 70 for project location	101.9	Existing swales/ditches with some natives but mostly turf and rocks	Design and implement a project to retrofit existing turf swales to bioinfiltraton swales and maintain	Medium	HOA, Washington County	WDNR, Environmental Consultant/ Contractor	$18K to design, construct, maintain for three years	10-20 Years
72A	See Figure 70 for project location	53.5	Existing typical mowed turf roadside swales in residential development	Design and implement a project to retrofit existing turf swales to bioinfiltraton swales and maintain	High	HOA/ Owner/ Developer	WDNR, Environmental Consultant/ Contractor	$15K to design, construct, maintain for three years	1-10 Years
87A	See Figure 70 for project location	133.1	Exiting golf course in Washington County with typical landscaping	Design and implement a project to naturalize rough areas and install buffers on waterways to improve water quality	High	Foursome Management/ Owner	Environmental Consultant/ Contractor	$175K to design, construct and maintain for three years	1-10 Years
15A	See Figure 70 for project location	13.9	Degraded oak woodland with tamarack, birch, ironwood, oaks, maple; fallow old field has Canada goldenrod	Conduct a natural resource inventory and develop a management plan to restore natural area and maintain for three years	Medium	OWLT	Environmental Consultant/ Contractor, WDNR	$8K to develop NRI/Management Plan	10-20 Years
75A	See Figure 70 for project location	29.0	Existing degraded wetland with dead ash population being replaced by buckthorn.	Design and implement a natural area management plan to manage buckthorn that is replacing Ash and impacting flow; maintain for three to five years	Low	Private Owner	Environmental Consultant/ Contractor	$6K to develop NRI/Management Plan	10-20 Years
87B	See Figure 70 for project location	7.2	Large ball diamond and football field providing stormwater storage	Design and implement a project to naturalize unused or low-use areas, install bioswales, and create signage to educate stakeholders about water quality	Medium	Town Trenton	Environmental Consultant/ Contractor	$75K to design, construct, maintain for three years and create signage	10-20 Years
40A	See Figure 70 for project location	0.9	Typical landscaping and parking lot areas	Design and implement a project to naturalize landscaping and install parking lot BMP such as pavement alternatives	Low	Washington County	WDNR, Private Contractor	$350K to replace existing asphalt with permeable pavers, naturalize landscaped areas, and install educational signage	10-20 Years
42A	See Figure 70 for project location	36.2	Drained and/or farmed hydric soils confirmed in field as good candidate sight for potential wetland restoration	Design and implement a project to restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation; maintain for three to five years until established	Medium	Private Owner	WDNR, Environmental Consultant/ Contractor	$180K to design, construct, maintain for three years	10-20 Years
42C	See Figure 70 for project location	7.0	Drained and/or farmed hydric soils confirmed in field as good candidate sight for potential wetland restoration	Design and implement a project to restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation; maintain for three to five years until established	Low	Private Owner	WDNR, Environmental Consultant/ Contractor	$60K to design, construct, maintain for three years	10-20 Years
52C	See Figure 70 for project location	13.0	Drained and/or farmed hydric soils confirmed in field as good candidate sight for potential wetland restoration	Design and implement a project to restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation; maintain for three to five years until established	Medium	Private Owner	WDNR, Environmental Consultant/ Contractor	$80K to design, construct, maintain for three years	10-20 Years
62A	See Figure 70 for project location	20.6	Drained and/or farmed hydric soils confirmed in field as good candidate sight for potential wetland restoration	Design and implement a project to restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation; maintain for three to five years until established	Medium	Private Owner	WDNR, Environmental Consultant/ Contractor	$105K to design, construct, maintain for three years	10-20 Years
62B	See Figure 70 for project location	19.3	Drained and/or farmed hydric soils confirmed in field as good candidate sight for potential wetland restoration	Design and implement a project to restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation; maintain for three to five years until established	Medium	Private Owner	WDNR, Environmental Consultant/ Contractor	$110K to design, construct, maintain for three years	10-20 Years
6A	See Figure 70 for project location	89.6	Drained and/or farmed hydric soils confirmed in field as good candidate sight for potential wetland restoration	Design and implement a project to restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation; maintain for three to five years until established	High	Private Owner	WDNR, Environmental Consultant/ Contractor	$360K to design, construct, maintain for three years	1-10 Years

ID#	Location	Units (acres or linear feet)	Existing Condition	Management Measure Recommendation	Priority	Owner & Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
74A	See Figure 70 for project location	32.3	Drained and/or farmed hydric soils confirmed in field as good candidate sight for potential wetland restoration	Design and implement a project to restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation; maintain for three to five years until established	High	Private Owner	WDNR, Environmental Consultant/ Contractor	$160K to design, construct, maintain for three years	1-10 Years
7B	See Figure 70 for project location	112.8	Drained and/or farmed hydric soils confirmed in field as good candidate sight for potential wetland restoration	Design and implement a project to restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation; maintain for three to five years until established	High	Private Owner	WDNR, Environmental Consultant/ Contractor	$440K to design, construct, maintain for three years	1-10 Years
88B	See Figure 70 for project location	25.7	Drained and/or farmed hydric soils confirmed in field as good candidate sight for potential wetland restoration	Design and implement a project to restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation; maintain for three to five years until established	Medium	Private Owner	WDNR, Environmental Consultant/ Contractor	$130K to design, construct, maintain for three years	10-20 Years
64A	See Figure 70 for project location	0.9	Rural housing proximate to woodland with actively failing slope	Design and implement a project to stabilize and revegetate slope and maintain	Medium	Private Owner		$30K to design, construct, maintain for three years	10-20 Years
STREAM & RIPARIAN AREA RESTORATION (SEE FIGURE 68)									
Technical and Financial Assistance Needs: Stream restorations are complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration. The project becomes more complex in areas that flow through several governing bodies or multiple private residences. Technical and financial assistance associated with stream maintenance is generally low for minor tasks such as removing debris.									
MR1	See Figure 68 for project locations	32,682	32,682 lf of stream exhibiting no channelization, relatively stable banks, and average overall riparian area condition	Design and implement a project to increase buffers, remove invasives, restore native vegetation and maintain for three years to establish	Low	Washington County, West Bend, private owners	WDNR, Environmental Consultant/ Contractor	$400K to design, construct, maintain for three years	10-20 Years
MR2	See Figure 68 for project locations	18,953	18,953 lf of stream exhibiting no channelization, relatively stable banks, and average overall riparian area condition	Design and implement a project to increase buffers, remove invasives, restore native vegetation and maintain for three years to establish	Low	Washington County, Newburg, private owners	WDNR, Environmental Consultant/ Contractor	$250K to design, construct, maintain for three years	10-20 Years
MR4	See Figure 68 for project locations	14,985	14,985 lf of stream exhibiting no channelization, moderately stable banks, and average overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	Low	Washington County, Ozaukee County, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$950K to design, permit, construct, maintain buffer & bank stabilization for three years	10-20 Years
NBR1	See Figure 68 for project locations	15,430	15,430 lf of stream exhibiting moderate channelization, relatively stable banks, and good overall riparian area condition	Design and implement a project to increase buffers, remove invasives, restore native vegetation and maintain for three years to establish	Low	Washington County, Sheboygan County, private owners	WDNR, Environmental Consultant/ Contractor	$215K to design, construct, maintain for three years	10-20 Years
NBR2	See Figure 68 for project locations	19,980	19,980 lf of stream exhibiting moderate channelization, moderately stable banks, and good overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	Low	Washington County, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$1.25M to design, permit, construct, maintain buffer & bank stabilization for three years	10-20 Years
NBR3	See Figure 68 for project locations	18,620	18,620 lf of stream exhibiting moderate channelization, moderately stable banks, and good overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	Low	Washington County, Ozaukee County, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$1.2M to design, permit, construct, maintain buffer & bank stabilization for three years	10-20 Years
Tr10	See Figure 68 for project locations	7,845	7,845 lf of stream exhibiting low levels of channelization, relatively stable banks, and average overall riparian area condition	Design and implement a project to increase buffers, remove invasives, restore native vegetation and maintain for three years to establish	High	Washington County, private owners	WDNR, Environmental Consultant/ Contractor	$130K to design, construct, maintain for three years	1-10 Years
Tr16	See Figure 68 for project locations	8,474	8,474 lf of stream exhibiting moderate channelization, moderately stable banks, and poor overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	High	Washington County, West Bend, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$550K to design, permit, construct, maintain buffer & bank stabilization for three years	1-10 Years

ID#	Location	Units (acres or linear feet)	Existing Condition	Management Measure Recommendation	Priority	Owner & Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
Tr17	See Figure 68 for project locations	11,810	11,810 lf of stream exhibiting no channelization, relatively stable banks, and good overall riparian area condition	Design and implement a project to increase buffers, remove invasives, restore native vegetation and maintain for three years to establish	Low	Washington County, private owners	WDNR, Environmental Consultant/ Contractor	$165K to design, construct, maintain for three years	10-20 Years
Tr18	See Figure 68 for project locations	3,765	3,765 lf of stream exhibiting high levels of channelization, moderately stable banks, and poor overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	Medium	Washington County, West Bend, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$250K to design, permit, construct, maintain buffer & bank stabilization for three years	10-20 Years
Tr19	See Figure 68 for project locations	14,218	14,218 lf of stream exhibiting high levels of channelization, moderately unstable banks, and poor overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	High	Washington County, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$910K to design, permit, construct, maintain buffer & bank stabilization for three years	1-10 Years
Tr2	See Figure 68 for project locations	8,273	8,273 lf of stream exhibiting high levels of channelization, moderately stable banks, and average overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	Medium	Washington County, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$550K to design, permit, construct, maintain buffer & bank stabilization for three years	10-20 Years
Tr20	See Figure 68 for project locations	2,180	2,180 lf of stream exhibiting low levels of channelization, moderately stable banks, and poor overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	Low	Washington County, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$180K to design, permit, construct, maintain buffer & bank stabilization for three years	10-20 Years
Tr4	See Figure 68 for project locations	8,252	8,252 lf of stream exhibiting moderate channelization, moderately stable banks, and average overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	Medium	Washington County, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$550K to design, permit, construct, maintain buffer & bank stabilization for three years	10-20 Years
Tr8	See Figure 68 for project locations	6,746	6,746 lf of stream exhibiting no channelization, moderately unstable banks, and average overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	High	Washington County, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$440K to design, permit, construct, maintain buffer & bank stabilization for three years	1-10 Years
Tr9	See Figure 68 for project locations	3,146	3,146 lf of stream exhibiting high levels of channelization, moderately stable banks, and average overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	Medium	Washington County, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$240K to design, permit, construct, maintain buffer & bank stabilization for three years	10-20 Years

WEST BEND

ID#	Location	Units (acres or linear feet)	Existing Condition	Management Measure Recommendation	Priority	Owner & Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
OTHER MANAGEMENT MEASURES (SEE FIGURE 70)									
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement these projects varies depending on complexity.									
72C	See Figure 70 for project location	7.0	Existing ball field at Wingate Park, unused or low-use areas could be naturalized and include educational signage	Design and implement a project to naturalize unused or low-use areas and create signage to educate stakeholders about water quality	High	City of West Bend	Environmental Consultant/ Contractor	$75K to design, construct, maintain for three years and create signage	1-10 Years
97B	See Figure 70 for project location	11.3	Commercial/industrial campus with typical landscaping and parking lot areas	Design and implement a project to naturalize landscaping and install parking lot BMP such as pavement alternatives	High	Serigraph Inc.	City of West Bend, Environmental Consultant/ Contractor Bend,	$700K to replace existing asphalt with permeable pavers, naturalize landscaped areas, and install educational signage	1-10 Years
72B	See Figure 70 for project location	33.0	Probably planned development - need to naturalize wet areas to protect headwaters as development occurs	Design and implement a project to protect natural areas from development while maintaining existing density	High	HOA/ Owner/ Developer	Environmental Consultant/ Contractor	$25K to develop NRI/Management Plan and Conservation Development Plan	1-10 Years
STREAM & RIPARIAN AREA RESTORATION (SEE FIGURE 68)									
Technical and Financial Assistance Needs: Stream restorations are complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration. The project becomes more complex in areas that flow through several governing bodies or multiple private residences. Technical and financial assistance associated with stream maintenance is generally low for minor tasks such as removing debris.									
Tr15	See Figure 68 for project locations	6,939	6,939 lf of stream exhibiting high levels of channelization, moderately stable banks, and poor overall riparian area condition	Design and implement a project to increase buffers, remove invasives, spot stabilize eroding banks where necessary, restore native vegetation and maintain for three years to establish	High	West Bend, Washington County, private owners	WDNR, Engineer, Environmental Consultant/ Contractor	$450K to design, permit, construct, maintain buffer & bank stabilization for three years	1-10 Years

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7.0 INFORMATION & EDUCATION PLAN

The health of the Fredonia-Newburg Area watersheds faces challenges and threats from poor land management practices, invasive species, land use changes, and flooding. Since a significant portion of the Fredonia-Newburg Area watersheds is held as private property, any efforts to improve water quality must include significant education and outreach efforts to those landowners and key stakeholders.

This Information & Education Plan (I&E Plan) recommends campaigns that are designed to enhance understanding of the issues, problems, and opportunities within the Fredonia-Newburg Area watersheds. The intention is to promote general acceptance and stakeholder participation in selecting, designing, and implementing recommended Management Measures to improve watershed conditions. The first step in understanding the issues, problems, and opportunities within Fredonia-Newburg Area watersheds is to gain a better perspective of how the watershed evolved over time into what exists today.

The goal of the I&E Plan is to equip municipal staff, elected officials, and other key stakeholders with the tools necessary to establish watershed-based practices and engrain these tools into their respective activities and procedures. If this I&E plan is successfully implemented, developers will follow guidelines that consider watershed health and residents of the Fredonia-Newburg Area watersheds will be actively involved in protecting and restoring the Milwaukee River and its tributaries. They will become aware of the factors that threaten surface waters of these watersheds and adopt specific behaviors that contribute to improving conditions in the watersheds. Through these changes in behaviors, the threats and challenges to the watersheds will decrease, water quality will improve, and the overall health of the watersheds will improve.

Due to the current conditions of water quality within the watershed, it is imperative that the Management Measure recommendations are closely linked with watershed information and education programs. Thorough public information and stakeholder education efforts will ultimately inspire local residents and community members to adopt recommended implementation actions. The cumulative actions of individuals and communities' watershed-wide can accomplish the goals of the watershed plan. Watershed health is of primary importance for the people of Fredonia-Newburg Area watersheds. When people begin to understand the issues related to water quality and natural resource protection, they begin to change their actions and activities, thereby improving the overall health of the watershed.

Many of the stakeholders in the Fredonia-Newburg Area watersheds have been active in the creation and leadership of the Fredonia-Newburg Area Watershed-Based Plan. Key stakeholders include the Milwaukee Metropolitan Sewerage District, the various villages and towns in the watershed, Ozaukee, Sheboygan, and Washington Counties, Southeastern Wisconsin Regional Planning Commission, Riveredge Nature Center, Wisconsin Department of Natural Resources, Milwaukee Riverkeeper, the Milwaukee River Watershed Clean Farm Families, UWM School of Freshwater Sciences, Sweet Water, Community Rivers Program, and many private residents and land owners. These groups, led by MMSD, Milwaukee Riverkeeper, and Riveredge Nature Center, are actively engaging the public in watershed activities such as: educational seminars, watershed outings, Citizen Mobilization programs, Adopt-a-River programs, water quality monitoring, and extensive public education programs and outreach events. The watershed planning process for Fredonia-Newburg began in 2018, but many of the local outreach programs have been underway for much longer. The planning process has allowed watershed partnerships to form that will help with implementing the watershed plan and initiating projects.

Recommended Information & Education Campaigns

A successful I&E Plan first raises awareness among stakeholders of watershed issues, problems, and opportunities. The second step is to provide stakeholders with information on alternatives to implement to address the issues, problems, and opportunities. This I&E Plan includes the following components as referenced in USEPA's *"Handbook for Developing Watershed Plans to Restore and Protect Our Waters"* (USEPA 2008):

- Define I&E goals and objectives.
- Identify and analyze the target audiences.
- Create the messages for each audience.
- Package the message to various audiences.
- Distribute the message.
- Evaluate the I&E program.

Goals and Objectives

Development of an effective I&E Plan begins by defining goals and objectives. Goals were established for the Fredonia-Newburg Area watersheds based on stakeholder participation, voting, and responses during the May 7th stakeholder Goals meeting. The goals and objectives were then refined during the planning process. Objectives assigned to each goal are intended to be measurable where appropriate so that future progress can be assessed. The following goals refer to education and communication goals and objectives only (objectives unrelated to communications have been left out of this section).

Goal 2: ***Encourage agricultural techniques and soil conservation practices that will protect and conserve topsoil and bolster our water resources.***

Objectives:

1) Encourage landowners to utilize existing programs and agencies such as the Natural Resource Conservation Service (NRCS), UW-Extension, and Ozaukee, Sheboygan, and Washington Counties to install conservation practices that protect soil loss and water quality.
2) Educate landowners and inform landowners of both federal and state cost-share programs, which provide incentives for landowners to enroll in conservation programs and implement conservation practices.
3) Increase support for and develop additional financial assistance programs targeted at increasing the installation of conservation practices.
4) Encourage landowners and farmers to leave adequate buffers between agricultural land and waterways.

Goal 3: ***Increase stakeholder awareness of watershed issues through education and stewardship.***

Objectives:

1) Increase environmental stewardship opportunities and encourage stakeholders to participate in watershed plan implementation and restoration campaigns to increase activism in the watershed.
2) Implement the Fredonia-Newburg Area Watershed-Based Plan Information & Education Campaign.

3) Inform public officials on the benefits of conservation and low impact development and importance of ordinance language changes that promotes these developments.
4) Create targeted educational information for land owners along streams.
5) Install watershed interpretation signage at public access points and major roads.

Goal 4: ***Protect groundwater quantity and quality.***

Objectives:

1) Encourage county health departments or other appropriate entities to monitor extent and current conditions of septic systems in the watersheds and educate septic owners of how to properly maintain those systems.
2) Educate stakeholders about potential groundwater contamination issues and encourage private well testing.
3) Encourage landowners to install downspout disconnection practices such as rain gardens and rain barrels and utilize pavement alternatives.
4) Encourage use of Stormwater Treatment Train, Conservation Developments, or Low Impact Designs within new and redevelopment.
5) Encourage additional studies and stakeholder education on connections between well-abandonment and groundwater quality.

Goal 5: ***Increase communication and coordination among stakeholders.***

Objectives:

1) Inform public officials on the benefits of conservation, low impact development, and importance of ordinance language changes.
2) Encourage adoption of the Fredonia-Newburg Area Watershed-Based Plan by local municipalities in the watershed.
3) Leverage existing programs and dedicated to water quality outreach and develop grass roots communication programs and vehicles within the Fredonia-Newburg Area watersheds.
4) Increase awareness of surface water quality issues among the general public and agricultural community.
5) Encourage amendments to municipal comprehensive plans, codes, and ordinances to include watershed plan goals and objectives where necessary.

Goal 7: ***Protect and manage natural and cultural components of the Green Infrastructure Network, including fish and wildlife habitat.***

Objectives:

1) Include the identified Green Infrastructure Network in all county and municipal comprehensive plans and development review maps.
2) Encourage private land owners with parcels within the Green Infrastructure Network to manage their land for ecological and water quality benefits.

Target Audiences

The recommended target audience for each education campaign is selected based on the ability to attain objectives. The target audience is a group of people with a common denominator who are intended to be reached by a particular message. The target audience of the watershed includes people of all demographics, locations, occupations, and watershed roles. There can be multiple target audiences depending on which topic is being presented. The overall umbrella target audiences selected to meet watershed goals and objectives include residential and agricultural landowners, homeowners, general public, local government, elected officials, businesses, and schools. Once the target audience is identified for a specific education campaign, existing local programs and communication vehicles should be leveraged to help distribute the message. This might include existing local interest groups, farm breakfasts, neighbor groups, local churches, school newsletter, etc.

Public Input

Creating and distributing a message for each audience is done via campaigns that address education goal objectives. The I&E Plan objectives for the Fredonia-Newburg Area watersheds were determined through stakeholder meetings. An I&E Plan matrix (Table 42) was developed as a tool to help implement the I&E Plan. Not only does the matrix include recommended education campaigns, it also includes columns for 1) "Target Audience", 2) "Communications Vehicles", 3) "Schedule", 4) "Lead & Supporting Organizations", 5) "Outcomes/ Change in Action", and 6) "Estimated Cost."

Evaluation

The I&E Plan should be evaluated regularly to provide feedback regarding the effectiveness of the outreach campaigns. Evaluation conducted early on in the effort will help determine campaigns that are successful and those that are not. Based on the evaluation, information, money, and time can be saved by focusing on the campaigns that work. Those that do not work should be ended and/or refined. Section 9.0 of this plan contains a "Report Card" with milestones related to watershed education that can be used to evaluate I&E Plan implementation efforts.

The plan will be made available electronically at the WIDNR Website, and on the Ozaukee County and Washington County websites upon DNR and EPA approval. WI DNR approved watershed plans can be found online: https://dnr.wi.gov/topic/Nonpoint/9keyElement/planMap.html

Under the policy and direction of the Land Use and Planning Committee, Washington County LWCD staff provide services to the public as outlined and identified in their Land & Water Resource Management Plan.

Both the Ozaukee County and he Washington County Land and Water Management Plans will reference the Fredonia Newburg Area Watershed Management Plan, as they are updated.

Table 42. Information and Education Plan Matrix.

Education Action of Campaign	Target Audience	Communications Vehicles	Schedule	Lead (Supporting) Organizations	Outcomes, Change in Action	Estimated Cost
Adopt-a-River	Private owners & public facilities	Media blitz, word of mouth	Ongoing	Milwaukee Riverkeeper (Riveredge Nature Center)	Create awareness, activism, and ownership regarding streams and tributaries and their health in the MKE River Watershed.	$1,000/site x 7 sites = $7,000
Citizen Mobilization Programs: (storm drain stenciling, River Clean Ups)	Residents, volunteers, landowners	Social media, Local Newsletters, Websites	Seasonally	Riveredge Nature Center (Sweet Water, Milwaukee Riverkeeper)	Create awareness, activism, and ownership regarding streams and tributaries and their health in the MKE River Watershed.	Community Rivers Program (CRP): $3,000-$5,000/year per community depending on community size
Water Quality Monitoring	All stakeholders	Website, MKE River Report Card	Ongoing	WDNR, Milwaukee Riverkeeper (Riveredge Nature Center, Muncipalities, Counties)	Awareness, education, additional monitoring sites.	See Table 44 for WDNR sampling costs Milwaukee Riverkeeper materials: $2500/site x 19 sites= $47,500 (excludes labor)
Host NCRS presentations geared at improving water quality	Agricultural landowners & farmers	Hold seminar on appropriate NRCS programs, potential funding, and types of project that should be implemented in the watershed.	Immediately following completion of plan.	NRCS (Washington County, Ozaukee County, Sheboygan County, & Clean Farm Families, Cedar Creek Farmers)	Increase level of awareness of NRCS programs and how they relate to agricultural projects in the watershed and increase level of participation in implementing agriculture projects recommendations.	Labor staff time included; Field day events range $4000-10,000 in value

Education Action of Campaign	Target Audience	Communications Vehicles	Schedule	Lead (Supporting) Organizations	Outcomes, Change in Action	Estimated Cost
Educate Elected Officials about the completed plan and 1) Encourage them to adopt the Fredonia/Newburg Watershed Based Plan 2) encourage amendments of municipal comprehensive plans, codes and ordinances to include watershed plan goals/objectives.	Elected officials of Washington, Sheboygan, & Ozaukee Counties, elected officials from the municipalities of these watersheds, and residents of the communities.	Meetings with Village Board, special mailings and presentations to elected officials/community boards.	Immediately following completion of the Plan	MMSD, Counties (Municipalities)	Within 2-3 years each municipality and county board of elected officials adopts the Plan.	N/A
Tour of Watershed	Elected officials and residents	Social Media, Local Newsletters, Websites	Immediately following completion of the Plan	Riveredge Nature Center, Counties (Municipalities, Counties)	Create awareness, inspire action	$2000-$5000 depending on number of stops, partners, amenities required, number of, attendees, etc.
Annual Recognition	Active volunteers, all stakeholders	Watershed Champion Awards ceremony, social media	Annually	Sweet Water	Create awareness of various programs in the watershed, recognizing good to promote more good	$500
Educational Seminars (examples: GI workshops, Certified Wildlife Habitat, Rain garden Workshops)	Residents, homeowners, landowners	Seminar or presentations on programs available to residents and owners.	Annually	Riveredge Nature Center	Create Awareness/ Engage residents	Included in CRP contract work

Education Action of Campaign	Target Audience	Communications Vehicles	Schedule	Lead (Supporting) Organizations	Outcomes, Change in Action	Estimated Cost
Adventure Programs (examples: Kayaking, Fishing, Tubing)	Residents	Newsletters, websites, social media	Seasonally	Riveredge Nature Center (Milwaukee Riverkeeper)	Create Awareness/ Engage residents	TBD
Outreach Events	Residents, homeowners, landowners	Face to face, printed materials, social media	Seasonally	Riveredge Nature Center	Create Awareness	TBD
Landscape Consultations about green practices for healthy watershed	Land owners, homeowners, and businesses	Website, Social media, word-of-mouth	Ongoing	Riveredge Nature Center	Improve property landscapes, increase in implementing BMP to benefit water quality	$75-$100 per site design
Provide the Northern Ozaukee School District (NOSD), West Bend School District (WBSD) & St. John's Lutheran School (Newburg) with information about the Upper Milwaukee River watershed as a means to support outdoor curriculum within the watershed's green infrastructure	Schools, students, teachers	Support and expand reach of water education program to help integrate basic watershed planning and education into existing elementary, middle and high school science curriculum. (Testing the Waters, Determining Water Quality school programs)	Annually	Riveredge Nature Center	Students in NOSD, WBSD & St. John's schools will understand the environment in which they live and realize the importance of maintaining a healthy place for people and nature to live in harmony and understand actions they and their families can take to protect water quality. What is learned will be pass on to parents and future generations, changing local society.	TBD based on hours and activity material costs
Inform Farmland owners & renters about the plan and recommend actions. Inform and support farmland owners and renters to evaluate and implement recommended actions within the watershed plan.	Agricultural landowners & farmers	Meetings of farmland owners & renters. Share available funding for projects, purchase of development rights, buffers and the impacts on water quality and role of wetlands.	Ongoing	Washington & Ozaukee Counties (Clean Farm Families, Cedar Creek Farmers)	Increase awareness of agricultural projects within the watershed that use cover crops and sustainable BMPs. (improve soil health) Increase level of participation in such programs & initiatives.	TBD based on hours

Education Action of Campaign	Target Audience	Communications Vehicles	Schedule	Lead (Supporting) Organizations	Outcomes, Change in Action	Estimated Cost
Adopt-A-Storm Drain	Residents, volunteers, landowners	Block Parties, Social media, Websites, TV, Digital Ads	Ongoing	Sweet Water	Encourage public participation in actions at a residential level that lead to improved overall watershed health	TBD
Respect Our Waters	Residents, homeowners, landowners,	Community Events, Social media, Websites, TV, Digital Ads, Targeted Emails	Seasonally	Sweet Water	Inform the public about stormwater pollution prevention through multiple passive delivery mechanisms	TBD
Mini-Grant Program	Grassroots groups, local communities	Partnerships, signage, other TBD activities	Ongoing	Sweet Water	Encourage local communities and organizations to create projects that improve water quality in a visible way to educate community members	TBD

8.0 PLAN IMPLEMENTATION

8.1 Plan Implementation Roles and Coordination/Responsibilities

Identification of responsible entities for implementation of Management Measure recommendations was first mentioned in the Action Plan section of this report. These entities are key stakeholders that will be responsible in some way for sharing the responsibility required to implement the Watershed-Based Plan. However, no single stakeholder has the financial or technical resources to implement the plan alone. Rather, it will require working together and using the strengths of individual stakeholders to successfully implement this plan. Key stakeholders are listed in Table 43.

There are several important first steps that stakeholders/partners will need to accomplish prior to plan implementation.

1) Watershed stakeholders/partners are encouraged to adopt and/or support (via a resolution) the Fredonia-Newburg Area Watershed-Based Plan.
2) The stakeholders/partners will need to recruit "champions" within each municipality and other stakeholder groups to form a Watershed Implementation Committee that actively implements the Watershed-Based Plan and conducts progress evaluations.
3) The watershed partners may also need to fund a Watershed Implementation Coordinator to follow through on plan implementation.

Table 43. Fredonia-Newburg Area watershed stakeholders/partners.

Key Watershed Stakeholder/Partner	Acronym/Abbreviation
Milwaukee Metropolitan Sewerage District	MMSD
Village of Fredonia	Fredonia
Village of Newburg	Newburg
City of West Bend	West Bend
Town of Farmington	Farmington
Town of Fredonia	Town of Fredonia
Town of Saukville	Saukville
Town of Scott	Scott
Town of Sherman	Sherman
Town of Trenton	Trenton
Town of Waubeka	Waubeka
United States Environmental Protection Agency (Region 5)	USEPA
Wisconsin Department of Natural Resources	WDNR
Southeastern Wisconsin Regional Planning Commission	SEWRPC
Ozaukee County	Ozaukee
Sheboygan County	Sheboygan
Washington County	Washington
USDA Natural Resource Conservation Service	USDA
Riveredge Nature Center	Riveredge
Milwaukee Riverkeeper	MR
Milwaukee River Watershed Clean Farm Families	Clean Farm
UWM School of Freshwater Sciences	UWM Freshwater
UW-Extension	UW-Ext
Community Rivers Program	Comm Rivers
Sweetwater	Sweetwater
Ozaukee Washington Land Trust	OWLT
Developers	Developer
Farming Community	Farm
Private Landowners	Private

8.2 Implementation Schedule

The Watershed Implementation Committee should try to meet at least quarterly each year to guide the implementation of the Fredonia-Newburg Area Watershed-Based Plan. The development of an implementation schedule is important in the watershed planning process because it provides a timeline for when each recommended Management Measure should be implemented in relation to others. High Priority projects, for example, are generally scheduled for implementation in the short term. A schedule also helps organize project implementation evenly over a given time period, allowing reasonable time availability for developing funding sources and opportunities.

For this plan, each "Site-Specific Management Measure" recommendation located in the Management Measures Action Plan (see Section 6.0) contains a column with a recommended "Implementation Schedule" based on the short term (1-10 years) for most High Priority projects and 10-20 years for most medium and low priority project recommendations. Other recommendations such as maintenance activities have ongoing or as needed schedules. Some projects that are high priority could be recommended for long term implementation based on selected practices, available funds, technical assistance needs, and time frame. In addition, the "Information & Education" plan (see Section 7.0) is designed to be ongoing beginning in 2020. Finally, the "Monitoring Plan" is designed to be conducted and evaluated at least every five years to determine if progress is being made toward achieving plan goals and objectives.

8.3 Project Funding Sources

Opportunities to secure funds for watershed improvement projects are widespread due to the variety and diversity of Management Measure recommendations found in the Action Plan. Public and private organizations that administer various conservation and environmental programs are often eager to form partnerships and leverage funds for land preservation, restoration, and environmental education. In this way, funds invested by partners in Fredonia-Newburg watershed can be doubled or tripled, although actual dollar amounts are difficult to measure. A list of potential funding programs and opportunities is included in Appendix G. The list was developed by Applied Ecological Services, Inc. (AES) through involvement in other watershed and ecological studies.

Funds generally fall into two relatively distinct categories. The first includes existing grant programs, funded by a public agency or by other sources. These funds are granted following an application process. The EPA Nonpoint Source Management Program (Section 319 Grants) is an example: an applicant will submit a grant application to the program, and, if the proposed project meets the required criteria and if the funds appropriated have not been exhausted, a grant may be awarded.

The second category, one that can provide greater leverage, might be referred to as "money to be found." The key to this money is to recognize that any given project may have multiple benefits. It is important to note and explore all of the potential project benefits from the perspective of potential partners and to then engage those partners. Partners may wish to become involved because they believe the project will achieve their objectives, even if they have little interest in the specific objectives of the Watershed-Based Plan.

It is not uncommon for an exciting and innovative project to attract funds that can be allocated at the discretion of project partners. When representatives of interested organizations gather to talk about a proposed project, they are often willing to commit discretionary funds simply because the proposed project is attractive, is a priority, is a networking opportunity, or will help the agency achieve its mission. In this way, a new partnership is assembled.

Leveraging and Partnerships

It is critically important to recognize that no one program is capable of matching the overall investment of the Fredonia-Newburg watershed partners in implementing the Watershed-Based Plan. Rather, partnerships are most likely to be developed in the context of individual and specific land preservation, restoration, or education projects that are recommended in the Plan. Partners attracted to one acquisition may not have an interest in another located elsewhere for jurisdictional, programmatic, or fiscal reasons.

Almost any land or water quality improvement project ultimately requires the support of those who live nearby if it is to be successful over the long-term. Local neighborhood associations, community groups, homeowner associations, and similar groups interested in protecting water resources, open space, shaping development, or protecting wildlife habitat and scenic vistas, make the best partners for specific projects. Those organizations ought to be contacted in the context of specific individual projects.

It is equally important to note that the development of partnerships that will leverage funding or goodwill can be, and typically is, a time-consuming process. In many cases, it takes more time and effort to develop partnerships that will leverage support for a project than it does to negotiate with the landowners for use or acquisition of the property. Each protection or restoration project will be different; each will raise different ecological, political and financial issues, and each will in all likelihood attract different partners. It is also likely that the process will not be fully replicable. That is, each jurisdiction or partner will have a different process and different requirements.

In short, a key task in leveraging additional funds is to assign responsibility to specific staff or for developing relationships with individual agencies and organizations, recognizing that the funding opportunities might not be readily apparent. With some exceptions, it will not be adequate simply to write a proposal or submit an application; more often, funding will follow a concerted effort to seek out and engage specific partners for specific projects, fitting those projects to the interests of the agencies and organizations. Successful partnerships are almost always the result of one or two enthusiastic individuals or “champions” who believe that engagement in this process is in the interests of their agency. There is an old adage in private fundraising: people give to other people, not to causes. The same thing is true with partnerships using public funds.

Partnerships are also possible, and probably necessary, that will leverage assets other than money. By entering into partnerships with some agencies, organizations, or even neighborhood groups, a stakeholder will leverage valuable goodwill, time, effort, and relationships that have the potential to lead to funds and other support, including political support, from secondary sources.

9.0 MEASURING PLAN PROGRESS & SUCCESS

It is essential to have a monitoring plan and evaluation component as part of any watershed plan to evaluate plan implementation progress and success over time. This watershed plan includes two monitoring/evaluation components:

1) The **"Water Quality Monitoring Plan"** includes methods and locations where monitoring should occur and a set of criteria (indicators & targets) used to determine whether impairment reduction targets and other watershed improvement objectives are being achieved over time.

2) **"Report Cards"** for each plan goal were developed that include interim, measurable milestones linked to evaluation criteria that can be evaluated by the planning committee over time.

9.1 Water Quality Monitoring Plan & Evaluation Criteria

Background Information

This subsection provides a monitoring plan that can be implemented to measure changes in watershed impairments related primarily to water quality. Water quality monitoring is performed by first collecting physical, chemical, biological, and/or social indicator data. This data is then compared to criteria (indicators & targets) related to established water quality objectives.

Water quality in the Fredonia-Newburg Area watersheds has been monitored at 26 water quality sampling sites across the Fredonia-Newburg Area watersheds in the last ten years covering a wide range of water quality and sampling parameters and almost entirely conducted by WDNR. A summary of existing water quality data, collected in recent years, can be found in Section 4.3.

The water quality monitoring plan is designed to: 1) capture snapshots of water quality within Fredonia-Newburg Area watersheds through time; 2) assess changes in water quality following implementation of Management Measures, and 3) assess the public's social behavior related to water quality issues. It is crucial that representative water quality samples be carefully collected using method appropriate handling procedures. Unrepresentative samples or samples contaminated during collection or handling can prove useless. It is also critically important that all future monitoring be completed using WDNR or other approved protocols and methods, as the EPA requires the WDNR to submit a Quality Assurance Project Plan (QAPP) for all programs and projects receiving EPA funds. Additional guidance on QAPP requirements can be found in EPA's publication entitled *EPA Requirements for Quality Assurance Project Plans* (USEPA, March 2001).

Physical, chemical, and biological water quality indicators in streams are typically measured during base flow and after significant (≥ 1.5 inches) storm events. Chemical parameters typically include nutrients (nitrogen and phosphorous) and total suspended solids. All samples should be analyzed by certified labs to ensure accurate results. Physical parameters, such as temperature, dissolved oxygen, pH, and water clarity (turbidity) should be collected in the field using properly maintained and calibrated field equipment. It is also important to obtain stream discharge calculations as a determination of potential pollutant loading. These calculations are easily obtained by measuring the stream width, average depth, and flow rate at the monitoring location. Biological (fish and macroinvertebrate) and habitat assessments may also be performed, site assessment criteria dependent.

Once implemented, monitoring related to individual Management Measures should ideally take place. Management Measure implementation sampling locations should include points of water ingress and egress, such as the inflow and outflow points on a retrofitted detention basin as an example. To achieve the best results with respect to performance, Management Measure implementation monitoring should occur during or shortly after large rain events ($\geq$ 1.5 inches). Biological and/or habitat assessments should also be included on any habitat improvement project, such as a stream restoration. Because funding for post implementation monitoring is typically limited, money should be built into the initial Management Measures project budget.

Future Water Quality Monitoring Plan Implementation (sampling locations & frequency)
Generally, it is recommended that WDNR continues with their current monitoring programs, parameters and locations. Additionally, in order to track changes in water quality over time, AES recommends WDNR or another capable entity coordinate water quality monitoring consistently across four sites in the Fredonia-Newburg Area watersheds. The monitoring recommendations in this Nine Key Element watershed plan continue to be focused on implementation and restoration efforts within the Fredonia-Newburg Area watersheds, nested within the broader Milwaukee River watershed context and monitoring.

Through the UWEX/WDNR Water Action Volunteers (WAV) program, Milwaukee Riverkeeper has been conducting volunteer monitoring in the Milwaukee River Basin for over 13 years. A well-designed and managed volunteer monitoring program, such as the work conducted by Milwaukee Riverkeeper, can be an economical way to stretch monitoring dollars. In addition, we recommend that:

- Riverkeeper continue to conduct Level 1 and Level 2 WAV monitoring at the sites within the Fredonia-Newburg Area watersheds where they are currently monitoring,
- Riverkeeper encourage their volunteer monitors to apply to conduct Level 3 WAV monitoring for total phosphorus at sites being monitored,
- Riverkeeper consider establishing monitoring stations on tributary streams within the Fredonia-Newburg Area watersheds that are currently not being monitored, and
- Riverkeeper consider expanding their existing pilot program for volunteer monitoring of E. coli concentrations to include sites that they are monitoring in the Fredonia-Newburg Area watersheds.

Recommended water quality monitoring locations (Table 44 and Figure 71) include continued monitoring at three existing sites as well as the addition of one new site, with the long-term goal of supporting de-listing as a result of progress over the entire watershed. Sites S02, S13, and S22 (newly added) were each included as representative of the three subwatersheds – North Branch Milwaukee River, Town of Fredonia Milwaukee River, and Village of Newburg Milwaukee River, all of which are located at easily accessible sites close to the outlets of the three subwatersheds. Additionally, water quality monitoring should continue at S07 to track any changes in water quality for Fredonia Creek (Tributary 6) since this tributary is identified as impaired.

Additionally, two previously discontinued USGS gage stations on the Milwaukee River and the North Branch of the Milwaukee River should be reactivated. On the mainstem of the Milwaukee River the discontinued gage at Waubeka and one near Fillmore on the North Branch should be reactivated.

Physical, chemical, and microbial sampling should occur at least once annually at all four sites and should include the following parameters: temperature, dissolved oxygen, total phosphorus, total nitrogen, total suspended solids, pH, chloride, and *E. coli*. Future water quality sampling at these four sites should be coordinated to occur on the same days and for the same parameters consistently. In addition, it would be beneficial if at a frequency no less than once every five years, water quality sampling was conducted at these sites at a frequency consistent with the requirements for assessment and listing given in the Wisconsin Consolidated Assessment and Listing Methodology (WisCALM).

Additionally, biological monitoring should occur at the same four sites using WDNR's standard procedures and protocols, but only needs to occur once every three to five years, preferably in May or June.

Note: Monitoring locations related to individual Management Measures are not described and will be developed as these restoration activities are implemented. Similarly, other WDNR sampling locations and regimes are not described here.

In summary, continued physical, chemical, and biological monitoring of the Fredonia-Newburg Area watersheds over the next 20 plus years is paramount to the success of the plan. Only through continued monitoring and assessment will the effectiveness of restoration initiatives in improving watershed health be ascertained.

Table 44. Recommended future water quality monitoring.

Waterbody/ Location	Monitoring Entity	Monitoring Location (See Figure 71)	Monitoring Frequency	Parameters Tested	Cost to Implement
Existing Recommended Monitoring Programs					
North Branch Milwaukee River	WDNR	S02	Annually (Biological every 3-5 years)	Physical; Chemical; Microbial; Biological	Physical, Chemical & Microbial: $1,250/yr Biological: $700/3-5 yrs
Fredonia Creek (Tributary 6)	WDNR	S07	Annually (Biological every 3-5 years)	Physical; Chemical; Microbial; Biological	$1,250-$2,000/yr
Town of Fredonia Milwaukee River	WDNR	S13	Annually (Biological every 3-5 years)	Physical; Chemical; Microbial; Biological	$1,250-$2,000/yr
New Recommended Monitoring Programs					
Village of Newburg Milwaukee River	WDNR	S22	Annually (Biological every 3-5 years)	Physical; Chemical; Microbial; Biological	$1,250-$2,000/yr
Targeted Watershed Assessments	WDNR	HUC12 scale 7-9 sites	One-time baseline	Chemical, Biological	$7,500
Individual Management Measures	Stakeholder in cooperation with Environmental Consultants	Varies: Specific to each measure	Pre and post project	Physical, Chemical, and Biological	varies for each measure
Additional Continuous stream flow gauge stations	USGS, WDNR	(2) TBD	Continuous, automated seasonal install	Physical, Chemical, Microbial	Equipment purchase: $50,000/ea O&M: ~$250,000 ea
				Subtotal: Monitoring at 4 sites:	$8,000-11,000/yr
				WDNR watershed assessments on 3 HUC12s (one-time additional cost)	$22,500
				USGS Monitoring Stations 5-year investment	$500,000+

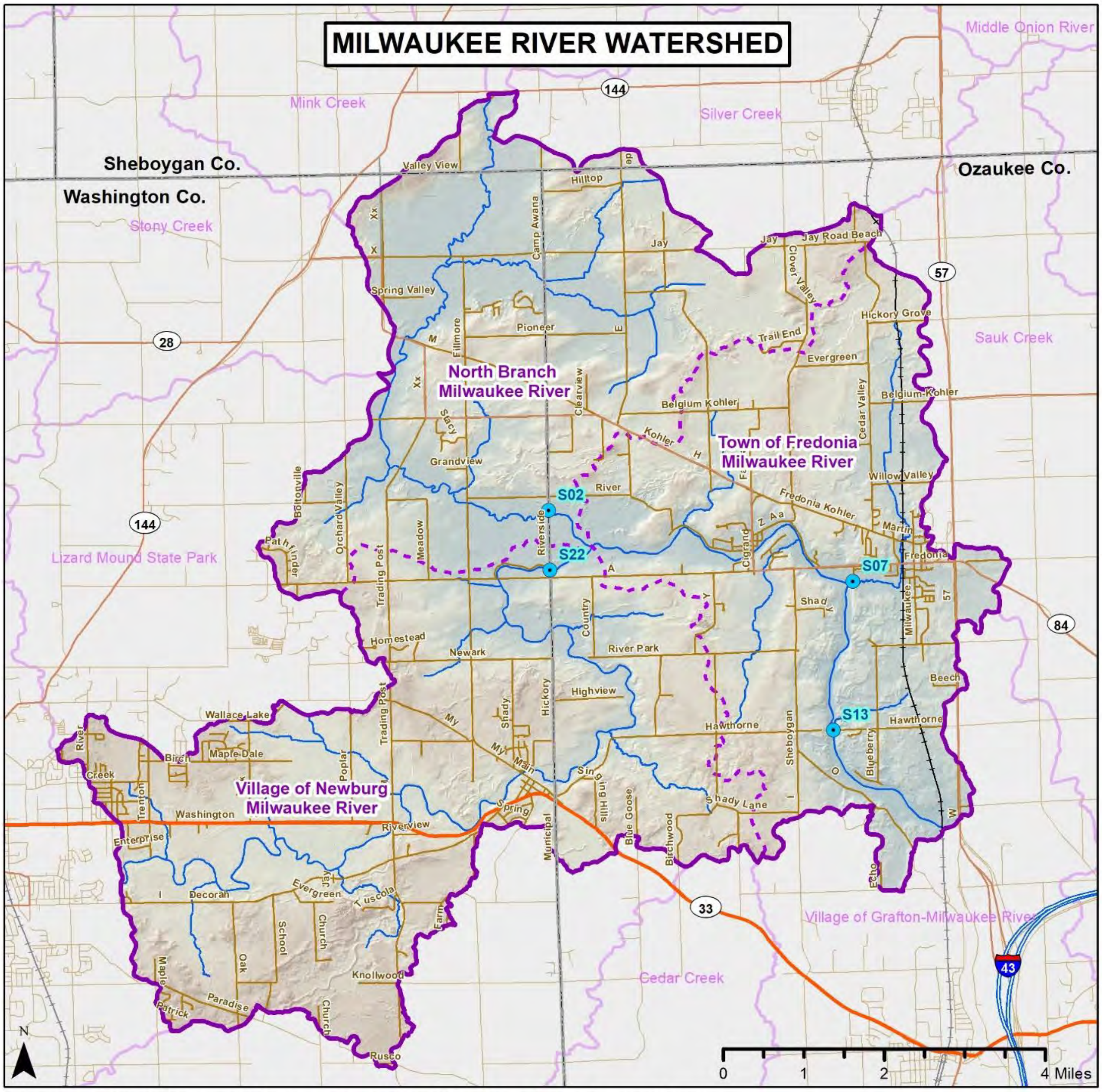
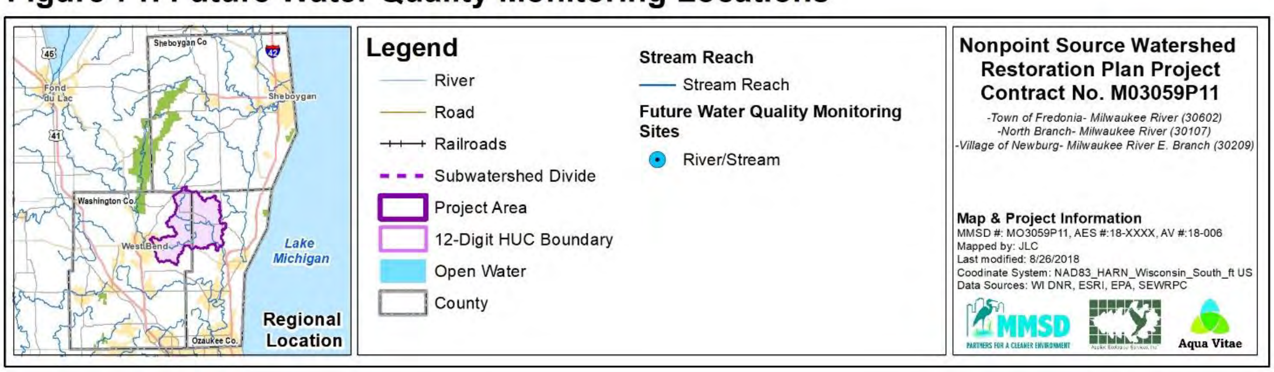


Figure 71. Future Water Quality Monitoring Locations



Recommended Methods

Physical and chemical monitoring of water can be time consuming and expensive depending on the complexity of the sampling program. Usually the budget and/or personnel available for monitoring limit the amount of data that can be collected. Therefore, the monitoring program should be developed to maximize the usable data given available funding and personnel. Monitoring programs should be flexible and subject to change to collect additional information or use newer equipment or technology when available.

Physical Parameters

Many different parameters can be included in physical monitoring of water quality in streams. Measurements of temperature, pH, and dissolved oxygen should be collected in the field or under typical WDNR protocols for any future stream monitoring done within Fredonia-Newburg Area watershed. Where available, the use of properly maintained and calibrated portable instruments is recommended. Field measurements should be recorded directly on data sheets or, if using portable testing equipment with this feature, download data at the laboratory.

Chemical Parameters

There are a variety of chemical components that can be quantified in streams but it is recommended that testing be completed for the parameters outlined in Table 45. Unlike physical monitoring, chemical monitoring requires grab samples analyzed at certified labs. Future monitoring of chemical components in the Fredonia-Newburg Area watersheds should be done following significant precipitation ($\geq$ 1.5 inches within the 24-hour period prior to sample collection) in order to capture storm event data, which can in turn be compared to baseline data and the target pollutant values summarized in Section 4.0. This same monitoring protocol can be used to determine pollutant removal efficiencies resulting from implementation of some Management Measures.

Microbial Parameters

The primary pathogen recommended for assessment in future water quality monitoring is *E. coli*. Presence of this organism is determined with laboratory analysis of a water sample collected at the sampling site using proper protocols.

Table 45. Stream monitoring water quality parameters, collection, and handling procedures.

Parameter	Statistical, Numerical, or General Use Guideline	Container	Volume	Preservative	Max. Hold Time
Physical Parameters Measured in Field					
Dissolved Oxygen	>5.0 mg/l	These parameters are measured in the field			
Temperature	<86° F				
Chemical, Microbial, & Physical Parameters Analyzed in Lab					
Total Suspended Solids	<12 mg/l	Plastic or glass	32 oz	Cool 4 °C	7 days
Nitrate-Nitrite Nitrogen	<1.798 mg/l	Plastic or glass	4 oz	Cool 4 °C 20% Sulfuric Acid	28 days
Total Phosphorus	<0.075 mg/l	Plastic or glass	4 oz	Cool 4 °C 20% Sulfuric Acid	28 days
Chloride	≤395 mg/l	Plastic or glass	32 oz	Cool 4 °C	28 days
E. Coli	< 235 MPN/100 mL is advisory	Plastic or glass	16 oz	Cool 4 °C	24 hours
pH	>6.0 or <9.0	Plastic or glass	16 oz	Cool 4 °C	immediately

Evaluation Criteria

Water Quality Evaluation Criteria

Water quality evaluation criteria (expressed as measurable indicators & targets) need to be developed so that water quality objectives can be evaluated over time. The evaluation criteria are designed to be compared against data gathered from the Water Quality Monitoring Plan as well as other data and analyzed to determine the success of the watershed plan in terms of protecting and improving water quality. These evaluation criteria also support an adaptive management approach by providing ways to reevaluate the implementation process if adequate progress is not being made toward achieving water quality objectives.

Section 2.0 of this plan includes a water quality goal (Goal 1) with five objectives. Evaluation criteria are selected for each water quality objective to determine whether components of the water quality goal are being met (Table 46). Evaluation criteria are based on the State of Wisconsin's water quality criteria, data analysis, reference conditions, literature values, and/or expert examination. Evaluation criteria are also designed to address potential or known sources of water quality impairment identified in Section 5.0. Future evaluation of these criteria will allow the Fredonia-Newburg Area Watershed Implementation Committee to gauge plan implementation success or determine if there is a need for adaptive management. Note: evaluation criteria are included for the water quality goal only; criteria for other plan goals are examined within the appropriate progress evaluation "Report Cards" in Section 9.2.

Table 46. Set of criteria related to water quality objectives.

Goal 1: Improve surface water quality to meet water quality standards.	
Water Quality Objective	**<u>Criteria</u>: Indicators and Targets**
1) Restore 152,621 linear feet of riparian areas buffers and spot stabilization along High Priority and Medium Priority stream reaches.	• *<u># of Restored Stream Reaches:</u>* All streams stabilized, and riparian areas restored on medium and high priority projects. • *<u>Chemical Water Quality Standards:</u>* <12 mg/l TSS, <0.075 mg/l TP, <1.798 mg/l TN, and <235 MPN/100 mL *E. coli* • *<u>Biotic Indexes:</u>* Biological communities achieve at least "Fair" resource quality. • *<u>Social Indicator:</u>* >50% of surveyed residents know that stream & riparian areas are a problem in the watershed and support stream restoration efforts.
2) Restore 1,589 acres of other management measures recommendations identified in the plan	• *# of Other Management Measures:* All Other Management Measure Recommendations implemented. • *<u>Chemical Water Quality Standards:</u>* <12 mg/l TSS, <0.075 mg/l TP, <1.798 mg/l TN, and <235 MPN/100 mL *E. coli* • *<u>Social Indicator:</u>* >50% of surveyed residents know the importance of other management measures such as urban and wetland restoration.
3) Implement agricultural best management practices on 5,052 acres of agricultural land identified in the plan.	• *<u># of Agricultural Management Practices:</u>* Additional agricultural management measures implemented on all identified lands. • *<u>Tillage Practices and Residue Management:</u>* Utilize Landsat Satellite imagery to calculate a minimum Normalized Tillage Index and track changes over time. • *<u>Chemical Water Quality Standards:</u>* <12 mg/l TSS, <0.075 mg/l TP, <1.798 mg/l TN, and <235 MPN/100 mL *E. coli* • *<u>Social Indicator:</u>* >75% of surveyed residents know the water quality benefits of implementing additional agricultural management practice recommendations.
4) Continue existing water quality monitoring programs and implement the Water Quality Monitoring Plan targeting assessment of Total Phosphorus, Total Nitrogen, Total Suspended Solids, and *E. coli* at identified locations	• *<u>Monitoring Program:</u>* WDNR and local health departments implement the outlined water quality plan. • *<u>Chemical Water Quality Standards:</u>* <12 mg/l TSS, <0.075 mg/l TP, <1.798 mg/l TN, and <235 MPN/100 mL *E. coli*
5) Track changes in water quality over time as related to the Milwaukee River TMDL and make adaptive management changes to the plan as necessary to ensure water quality improvements toward meeting the TMDL reductions	• *<u>Monitoring Program:</u>* Fredonia-Newburg Area watershed Implementation Committee tracks changes in water quality towards Milwaukee River TMDL targets.

Biological Indicators of Water Quality

Biological data can be used alone or in conjunction with physical-chemical data to make an impairment assessment on a waterbody in Wisconsin. A Fish Index of Biotic Integrity (Fish IBI) is one method of assessing biological health and water quality through several attributes of fish communities found in streams. The WDNR uses biological data to determine water quality conditions of streams because fish and macroinvertebrates are relatively easy to sample/identify and reflect specific and predictable responses to human induced changes to the landscape, stream habitat, and water quality.

Indices have been developed that measure water quality using fish (fish Index of Biotic Integrity (fIBI)) and macroinvertebrates (Macroinvertebrate Index of Biological Integrity (M-IBI) and Family Biotic Indexing (FBI)). These indices are best applied prior to a project such as a stream restoration to obtain baseline data and again following restoration to measure the success of the project. Or, they can be conducted to simply assess resource quality in a stream reach.

Fish Indices of Biotic Integrity (fIBI)
The fIBI is designed to assess water quality and biological health directly through several attributes of fish communities in streams. After the fish have been collected using electrofishing equipment and identified, the data is used to evaluate 12 metrics and a rating is assigned to each metric based on whether it deviates strongly from, somewhat from, or closely approximates the expected values found in high quality reference stream reaches. The sum of these ratings gives a total IBI score for the site. The best possible IBI score is 100. The WDNR has determined that a score less than 30 indicates a stream is not fully supporting for *Warm Water Sport Fish*.

Macroinvertebrate Indices of Biological Integrity (M-IBI) and Family Biotic Indexing (FBI)
The M-IBI is designed to rate water quality using aquatic macroinvertebrate samples. An M-IBI score of 0-2.5 is considered grounds for 303(d) listing a stream.

The FBI is performed by collecting macroinvertebrates samples and sorting specimens by taxonomic order and family. The number of organisms within each Family and their respective tolerance to organic pollution is used to determine the FBI score. Higher scores are indicative of a higher degree of organic pollution and poor water quality.

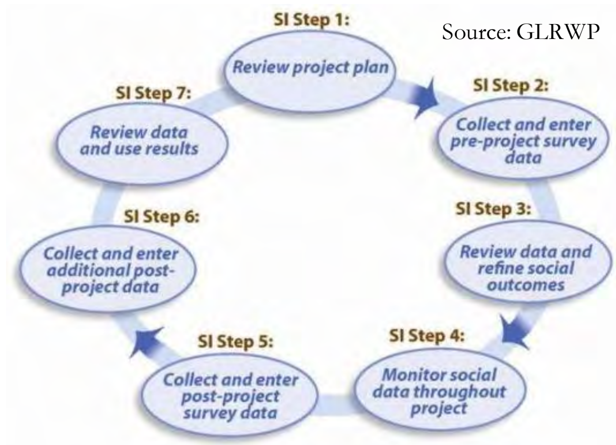
Tillage Practices and Residue Management
Changes in agricultural management practice implementation, such as tillage conditions within watersheds can be difficult to assess and track over time. Recently, analysis of satellite imagery has been used to track these changes in conservation practices at the watershed scale. Since tillage takes place at different times, a series of satellite images can be analyzed in spring and fall months to calculate a minimum Normalized Difference Tillage Index (NDTI) for the Fredonia-Newburg Area watersheds. The NDTI estimates crop residue levels based on shortwave infrared wavelengths. This analysis of imagery can also be used to track implementation of cropping practices in a watershed as more years of imagery is collected, since satellites are always updating aerial imagery (Meyer, 2018).

For more information, a webinar produced by Elliot Meyer and called "Satellite Imagery Used in Conservation" as well as a document on how to calculate vegetation indices using ArcMap and Earth Explorer can be found online at http://wislandwatermedia.org/2018/05/02/webinar-satellite-imagery-used-in-conservation/.

Social Indicators of Water Quality
Quantifying social indicators of success in a watershed planning initiative is difficult. It is subjective to a large degree and complaints about poor conditions are often heard rather than compliments on improvements. The Great Lakes Regional Water Program (GLRWP), a leading organization that addresses water quality research, education, and outreach in Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin, defines social indicators as standards of comparison that describe the context, capacity, skills, knowledge, values, beliefs, and behaviors of individuals, households, organizations, and communities at various geographic scales. The GLRWP suggests that social indicators used in water quality management plans and outreach efforts are effective for several reasons including:

- Help watershed committee evaluate projects related to education and outreach;
- Help support improvement of water quality projects by identifying why certain groups install Management Measures while other groups do not;
- Measure changes that take place within grant and project timelines;
- Help watershed committee with information on policy, demographics, and other social factors that may impact water quality;
- Measure outcomes of water quality programs not currently examined.

GLRWP has developed a Social Indicators Data Management and Analysis Tool (SIDMA) to assist watershed stakeholders with consistent measures of social change by organizing, analyzing, and visualizing social indicators related to non-point source (NPS) management efforts. The SIDMA tool uses a seven-step process to measure social indicators as shown in Figure 72. Detailed information about GLRWP's social indicator tool can be found at http://35.8.121.111/si/Home.aspx.



Source: GLRWP

Figure 72. Steps to measure social indicators.

Several potential social indicators could be evaluated by the Fredonia-Newburg Area Watershed Implementation Committee using different strategies to assess changes in water quality. For example, surveys, public meetings, and establishment of interest groups can give an indication of the public knowledge about the water quality in the watershed. It is important to involve the public in the water quality improvement process at an early stage through public meetings delineating the plans for improvement and how it is going to be monitored. Table 47 includes a list of potential social indicators and measures that can be used by the watershed committee to evaluate the social changes related to water quality issues.

Table 47. Social indicators related to understanding behavior toward water quality issues.

Social Indicator	Measure
1) Media Coverage	• # of radio broadcasts related to water quality protection • # of newspaper articles related to water quality protection
2) Citizen Awareness	• # of informational flyers distributed per given time period • % of citizens who are able to identify where pollution is originating from • % change in volunteer participation to protect water quality • % change in attendance at water quality workshops • # of requests to create public use areas with interpretive signage • % of stakeholders who are aware of watershed management information
3) Watershed Management Activities	• # of stream miles cleaned up per year • # of linear feet or miles of trails created or maintained each year • # of municipalities adopting watershed management plan • # of watershed groups implementing plan recommendations

Monitoring social indicators in the watershed should be the responsibility of Fredonia-Newburg Area watershed Implementation Committee. On-line internet surveys are among the most popular method to gauge social behavior toward water quality. Demographic information on a county basis can be obtained from the U.S. Census Bureau but will need to be modified based on the watershed boundary. This information is then used to select a random sample of individuals in the watershed. Next, a survey should be developed that identifies citizens' perceptions of water quality problems and protections strategies. Citizens that respond to the survey should be given a chance to donate a small amount of money ($1 for example) to a not for profit environmental group, then sent thank you letters, while those that did not respond should be sent a second survey. The results of the survey can be used to develop appropriate media, citizen awareness, and watershed management activities to improve social behavior.

9.2 Goal Milestones/Implementation & Progress Evaluation "Report Cards"

Milestones are essential when determining if Management Measures are being implemented and how effective they are at achieving plan goals over given time periods. Tracking milestones allows for adaptive management whereby periodic plan updates and changes can be made if milestones are not being met.

Watersheds are complex systems with varying degrees of interaction and interconnection between physical, chemical, biological, hydrological, habitat, and social characteristics. Criteria that reflect these characteristics may be used as a measure of watershed health. Goals and objectives in the watershed plan determine which criteria should be monitored to evaluate the success of the watershed plan.

A successful watershed plan involves stakeholder participation to get projects completed and must include a feedback mechanism to measure progress toward meeting goals. Watershed "Report Cards," developed specifically for each goal in this plan, provide this information. Each Report Card provides:

1) Summaries of current conditions for each goal to set the stage for what efforts are needed
2) Most important performance criteria related to goal objectives (see Section 2.0)
3) Milestones to be met for various time frames
4) Monitoring needs and efforts required to evaluate milestones
5) Remedial actions to take if milestones are not met
6) Notes section

Report Cards were developed for each of the five plan goals and are located at the end of this section. The milestones are generally based on "Short Term" (1-10 years; 2020-2030) and "Long Term" (10-20 years; 2030-2040) objectives. Grades for each milestone term should be calculated using the following scale: 80%-100% of milestones met = A; 60%-79% of milestones met = B; 40%-59% of milestones met = C; and < 40% of milestones met = failed.

Report Cards should be used to identify and track plan implementation to ensure that progress is being made towards achieving the plan goals and to make corrections as necessary. Lack of progress could be demonstrated in factors such as monitoring that shows no improvement, new environmental problems, lack of technical assistance, or lack of funds. In these cases, the Report

Card user should explain why other factors resulted in milestones not being met in the notes section of the Report Card.

Early on in the plan implementation process, the Watershed Planning Committee should fund a Watershed Implementation Coordinator to update the committee on plan implementation progress by way of the Report Cards. If needed, adaptive management should be implemented accordingly by referencing the adaptive management recommendations on each Report Card then developing a strategy to either change the milestone(s) or decide how to implement projects or actions to achieve the milestone(s).

Report Cards can be evaluated at any time. However, it is recommended that they be evaluated *at least* every five years to determine if sufficient progress is being made toward achieving milestones or if adaptive management is needed.

Goal 1 Report Card

Improve surface water quality to meet water quality standards.

Current Conditions:

- The findings of this report suggest moderate water quality impairment caused by degraded riparian areas and wetlands, and high nutrients, total suspended solids, and *E. coli* in agricultural and urban stormwater runoff.
- Biological data suggests that the North Branch Milwaukee River is substantially affected by organic pollution.
- There are two WPDES permitted sites in the watershed: Fredonia Municipal Sewer and Water Utility & the Village of Newburg.
- There are 2 CAFO (or feedlot) sites located in the watershed.

Criteria/Targets to Meet Goal Objectives:

- Restore 152,621 linear feet of riparian areas buffers and spot stabilization along High Priority and Medium Priority stream reaches.
- Restore 1,589 acres of other management measures recommendations identified in the plan.
- Implement agricultural best management practices on 5,052 acres of agricultural land identified in the plan.
- Implement future water quality monitoring program to measure success of completed water quality improvement projects.

Goal/Objective Milestones:	**Grade**
1-10 Yrs: 1) Restore at least 77,000 linear feet (50%) of riparian buffers along High and Medium Priority stream reaches. *(Short)* 2) Restore 800 acres (50%) of other management measures recommendations identified in the plan. 3) Implement agricultural best management practices on 2,526 acres (50%) of agricultural land. 4) Implement water quality monitoring program recommendations included in Section 9.1.	
10-20 Yrs: 1) Restore all 152,621 linear feet of riparian buffers along High and Medium Priority stream reaches. *(Long)* 2) Restore all 1,589 acres of other management measures recommendations identified in the plan. 3) Implement agricultural best management practices on all 5,052 acres of agricultural land. 4) Implement water quality monitoring program recommendations included in Section 9.1.	

Monitoring Needs/Efforts:

- Track stream and riparian area restoration & stabilization projects.
- Track other management measure restoration project implementation and success.
- Track acres of agricultural areas implementation of additional conservation practices identified in plan.
- Track additional acres of agricultural areas implementation of additional conservation practices.
- Monitor water quality per the "Monitoring Plan" in this report.

Remedial Actions:

- Identify USEPA 319 and other grants that are being submitted for recommended stream & riparian area, other management measures, and agricultural management practice projects and determine success rate.
- NRCS/Counties contact farmers to determine gaps in implementing additional conservation practices.

Notes:

Grade Evaluation: 80%-100% met = A; 60%-79% met = B; 40%-59% met = C; and < 40% = failed.

Goal 2 Report Card

Encourage agricultural techniques and soil conservation practices that will protect and conserve topsoil and bolster our water resources.

Current Condition:

- Agricultural land comprises nearly half of the watershed at 23,045 acres.
- Watershed health faces challenges and threats from agricultural land which if not managed properly can increase nutrient loading. The pollutant loading model suggests that cropland and feedlot areas are the leading cause of nutrient and sediment loading in the watershed. At the root of these challenges and threats is that key audiences may lack the necessary tools and funding to make informed decisions and adopt positive behaviors to mitigate such threats and challenges. Since a significant amount of the watershed is held as private agricultural property, any efforts to improve water quality will need to include significant education, outreach, and funding efforts targeting the agricultural community.
- A survey of agricultural areas identified 5,052 acres that could be improved with agricultural management measures.
- In order to meet the TMDL reduction targets, additional conservation practices will be needed on 80% of remaining agricultural lands watershed-wide.

Criteria/Targets to Meet Goal Objectives:

- At least one agricultural related workshop dedicated to cost-share programs is held annually.
- At least one workshop dedicated to implementation of additional conservation practices is held annually.
- At least 50% of High Priority agricultural landowners utilize existing NRCS programs to install recommended conservation practices.
- Implement agricultural best management practices on 5,052 acres of agricultural land identified in the plan.

Goal/Objective Milestones:	Grade
1-10 Yrs: *(Short)* 1) Ten agricultural related workshops dedicated to cost-share programs are held. 2) Ten workshops dedicated to implementation of additional conservation practices are held. 3) At least 25% of High Priority agricultural landowners utilize existing NRCS programs to install recommended conservation practices. 4) At least 50% (2,526 acres) implement recommended agricultural management practices.	
10-20 Yrs: *(Long)* 1) Ten agricultural related workshops dedicated to cost-share programs are held. 2) Ten workshops dedicated to implementation of additional conservation practices are held. 3) At least 50% of High Priority agricultural landowners utilize existing NRCS programs to install recommended conservation practices. 4) Implement agricultural best management practices on all 5,052 acres of agricultural land.	

Monitoring Needs/Efforts:

- Track number of conservation practice workshops held every 10 years.
- Track number of agricultural/NRCS workshops held every 10 years.
- Track number of agricultural landowners participating in NRCS cost-share programs.
- Track number of agricultural land owners/acres where recommended agricultural management practices are implemented.

Remedial Actions:

- Counties & MMSD work with NRCS to raise funds for and/or sponsor agricultural related workshops.
- Counties & MMSD work with NRCS to increase participation in existing programs.
- NRCS approach land owners individually to offer assistance with implementing management practices.

Notes:

Grade Evaluation: 80%-100% met = A; 60%-79% met = B; 40%-59% met = C; and < 40% = failed.

Goal 3 Report Card

Increase stakeholder awareness of watershed issues through education and stewardship.

Current Condition:

Many of the stakeholders in the Fredonia-Newburg Area watersheds have been active in the creation and leadership of the Fredonia-Newburg Area watershed-Based Plan. Key stakeholders include the Milwaukee Metropolitan Sewerage District, the various villages and towns in the watershed, Ozaukee and Washington Counties, Southeastern Wisconsin Regional Planning Commission, Riveredge Nature Center, Wisconsin Department of Natural Resources, Milwaukee Riverkeeper, UWM School of Freshwater Sciences, Sweetwater, Community Rivers Program, and many private residents and land owners. These groups, led by MMSD, Riverkeeper, and Riveredge Nature Center, are actively engaging the public in watershed activities such as: educational seminars, watershed outings, Citizen Mobilization programs, Adopt-a-River programs, water quality monitoring, and extensive public education programs and outreach events. The watershed planning process has allowed watershed partnerships to form that will help with implementing the watershed plan and initiating projects.

Criteria/Targets to Meet Goal Objectives:

- Number of public officials that support conservation development and ordinance language changes.
- Number of Education Actions completed from Information & Education Campaign.
- Number of landowners adjacent to tributaries that are informed about healthy land management.
- Number of educational and environmental interpretation signs posted throughout the watershed.
- Number of people attending public education events regarding fertilizer, road salt, and pet waste disposal.

Goal /Objective Milestones:	Grade
1-10 Yrs: (Short) 1) At least one municipality adopts conservation development within their ordinances. 2) At least half of Education Actions completed from Information & Education Campaign. 3) At least 25% of landowners adjacent to tributaries are educated about healthy land management. 4) Educational signage is installed in at least two locations in the watershed. 5) At least 20 people attend fertilizer, road salt, and pet waste disposal education campaigns.	
10-20 Yrs: (Long) 1) At least three municipalities adopt conservation development within their ordinances. 2) All Education Actions completed from Information & Education Campaign. 3) At least 50% of landowners adjacent to tributaries are educated about healthy land management. 4) Educational signage is installed in at least four locations in the watershed. 5) At least 40 people attend fertilizer, road salt, and pet waste disposal education campaigns.	

Monitoring Needs/Efforts:

- Track number of public officials with each municipality that support conservation development.
- Track number of Education Actions completed from Information & Education Campaign
- Track amount of information targeted to landowners adjacent to tributaries.
- Track number of educational signs that are installed in the watershed.
- Track number of people that attend education campaigns related to management of fertilizer, road salt use, and pet waste.

Remedial Actions:

- Meet with public officials to discuss the importance of conservation development and ordinance changes.
- Ask municipalities for funding related to implementing the Information & Education Campaign.
- Ask municipalities for funding related to creating and installing watershed signage.
- Actively recruit public to attend watershed education campaigns.

Notes:

Grade Evaluation: 80%-100% met = A; 60%-79% met = B; 40%-59% met = C; and < 40% = failed.

<table>
<tr><th colspan="2">Goal 4 Report Card
Protect groundwater quantity and quality.</th></tr>
<tr><td colspan="2">Current Conditions:
• Much of the Fredonia-Newburg Area watershed is rural with a large amount of private septic systems in use.
• Studies point to potential groundwater and well contamination issues in the watershed.
• The upper aquifers found beneath Fredonia-Newburg Area watershed consists of the sandstone and dolomite of the Ancell and Prairie du Chien Groups; the lower sandstone aquifer is made up of thick sedimentary sequences of the Cambrian sandstone.
• SEWRPC studies suggest that deep water aquifers are experiencing drawdowns between 200 and 400 feet.
• “Traditional” development over the past 20 years generally did not incorporate groundwater infiltration practices.</td></tr>
<tr><td colspan="2">Criteria/Targets to Meet Goal Objectives:
• Counties identify and encourage replacement of potentially failing septic systems.
• 10 downspout disconnection practices installed at homes or businesses every 10 years.
• All municipalities in the watershed implement groundwater recharge policies for development located in “High” and “Very High” groundwater recharge potential areas.
• Stormwater Treatment Train designs are used in all new and redevelopment.</td></tr>
<tr><td>Goal/Objective Milestones:</td><td>Grade</td></tr>
<tr><td>1-10 Yrs: 1) Counties identify and replace half of potentially failing septic systems.
(Short) 2) At least 10 downspout disconnection practices are installed as homes or businesses.
3) Half of municipalities implement groundwater recharge policies.
4) Stormwater Treatment Train designs are used in all new and redevelopment.</td><td></td></tr>
<tr><td>10-20 Yrs: 1) Counties identify and replace all potentially failing septic systems.
(Long) 2) At least 10 downspout disconnection practices are installed as homes or businesses.
3) All municipalities implement groundwater recharge policies.
4) Stormwater Treatment Train designs are used in all new and redevelopment.</td><td></td></tr>
<tr><td colspan="2">Monitoring Needs/Efforts:
• Track number of potentially failing septic systems replaced each year.
• Track number of rain gardens and rain barrels installed each year.
• Track number of municipalities that adopt policy requiring stormwater infiltration.
• Track development that uses stormwater infiltration when located within sensitive groundwater recharge areas.</td></tr>
<tr><td colspan="2">Remedial Actions:
• Counties develop additional funding sources for homeowners to replace potentially failing septic systems.
• Municipalities develop funding sources for homeowners and businesses to install rain gardens and rain barrels.
• Meet with municipalities to review policy changes related to developments.</td></tr>
<tr><td colspan="2">Notes:</td></tr>
</table>

Grade Evaluation: 80%-100% met = A; 60%-79% met = B; 40%-59% met = C; and < 40% = failed.

Goal 5 Report Card

Increase communication and coordination among stakeholders

Current Condition:

- Currently, there is not a committee or working group dedicated to plan implementation.
- A number of practices and projects will require multi-jurisdictional and public-private participation/cooperation.
- Municipal decision-makers have not always worked collectively in the past to develop productive multijurisdictional partnerships related to funding, grant proposals, cost sharing ideas.
- WDNR produces monthly newsletter for the Milwaukee Basin TMDL.

Criteria/Targets to Meet Goal Objectives:

- All municipalities in the watershed that adopt the Fredonia-Newburg Area watershed-Based Plan.
- Develop a "Watershed Planning Council" that meets quarterly.
- One workshop is held every year to teach municipal stakeholders how to use and implement plan recommendations.
- Number of municipalities that amend current comp plans, codes, and ordinances to include watershed plan recommendations.
- Number of planning, funding, and implementation mechanisms implemented by multi-jurisdictional and/or public-private partnerships.

Goal /Objective Milestones:	**Grade**
1-10 Yrs: (Short) 1) All municipalities adopt the Fredonia-Newburg Area watershed-Based Plan. 2) A "Watershed Planning Council" is developed and meets quarterly to coordinate plan implementation. 3) One workshop is held annually to teach stakeholders how to use the plan to implement projects. 4) At least two municipalities amend comprehensive plans/codes/ordinances and implement projects that support the plan. 5) At least three multi-jurisdictional and/or public-private projects are implemented.	
10-20 Yrs: (Long) 1) "Watershed Planning Council" continues to meet quarterly to coordinate implementation. 2) One workshop is held annually to teach stakeholders how to use the plan to implement projects. 3) All municipalities amend comprehensive plans/codes/ordinances and implement projects that support the plan. 4) At least six multi-jurisdictional and/or public-private projects are implemented.	

Monitoring Needs/Efforts:

- Track number of municipal and other governing bodies that adopt the Fredonia-Newburg Area watershed-Based Plan and implement recommendations.
- Track number of "Watershed Planning Council" meetings.
- Track number of workshops related to plan implementation for municipal stakeholders.
- Track number of multijurisdictional and/or public-private projects implemented during each milestone time period.

Remedial Actions:

- Watershed Council conducts meetings with government officials to adopt the watershed plan if it is not adopted in years 1-10.
- Watershed Council recommend multi-jurisdictional projects by bringing representatives to the table.

Notes:

Grade Evaluation: 80%-100% met = A; 60%-79% met = B; 40%-59% met = C; and < 40% = failed.

Goal 6 Report Card

Manage and mitigate for existing and future structural flood problems.

Current Condition:

- Fifteen potential Flood Problem Areas (FPAs) were identified during the watershed field inventory.
- SMU's 3, 8, 11, 12, 25, 33, 34, and 35 were identified as being highly vulnerable to future development.
- FEMA's 100-year floodplain occupies 8,145 acres of the watershed generally found adjacent to the streams and tributaries.

Criteria/Targets to Meet Goal Objectives:

- All 15 (100%) Flood Problem Areas are mitigated for.
- 100% of new development that occurs within SMU's 3, 8, 11, 12, 25, 33, 34, and 35 incorporates runoff reduction measures.
- Limited development is allowed within FEMA's 100-year floodplain.
- At least half of potential wetland restoration projects (50%, 245 acres) are restored.

Goal/Objective Milestones:	**Grade**
1-10 Yrs: *(Short)* 1) At least 8 of 15 Flood Problem Areas are addressed. 2) 50% of new development in SMU's 3, 8, 11, 12, 25, 33, 34, and 35 reduces stormwater runoff. 3) Limited development occurs within FEMA's 100-year floodplain and is mitigated for. 4) Restore at least 122 acres (25%) of potential wetland restoration sites.	
10-20 Yrs: *(Long)* 1) Remaining 7 Flood Problem Areas are addressed. 2) 100% of new development in SMU's 3, 8, 11, 12, 25, 33, 34, and 35 reduces stormwater runoff. 3) Limited development occurs within FEMA's 100-year floodplain and is mitigated for. 4) Restore 245 acres (50%) of potential wetland restoration sites.	

Monitoring Needs/Efforts:

- Track number of Flood Problem Areas that area addressed.
- Track number of new developments that incorporate stormwater runoff reduction measures.
- Track number of new developments that are allowed within FEMA's 100-year floodplain and mitigation measures used.

Remedial Actions:

- Conduct follow-up visits to Flood Problem Area sites during flood events to determine if additional remedial work is needed.
- Meet with municipalities to discuss codes/ordinances related to runoff reduction measures.
- Meet with municipalities to discuss policies related to development within FEMA's 100-year floodplain.

Notes:

Grade Evaluation: 80%-100% met = A; 60%-79% met = B; 40%-59% met = C; and < 40% = failed.

Goal 7 Report Card

Protect and manage natural and cultural components of the Green Infrastructure Network, including fish and wildlife habitat.

Current Condition:

- Ecological communities were balanced ecosystems with clean water and diverse with plant and wildlife populations among woodlands, prairies, and wetlands prior to European settlement in the 1830s.
- Following European settlement, fires rarely occurred, woodlands were harvested for timber, prairies were tilled for farmland or developed, wetlands were drained, and several streams were channelized.
- Degraded riparian areas and invasive species establishment are causing loss of wildlife habitat and reduced floodplain function.
- Important Natural Areas in the watershed include Riveredge Creek & Ephemeral Pond, Huiras Lake, Fellenz Woods, Mayhew Preserve, and Kratzsch Conservancy.
- Nine Natural Area Restoration sites and 2 Golf Course Naturalization projects were identified in the Action Plan.

Criteria/Targets to Meet Goal Objectives:

- Riparian buffers along 11 priority area stream reaches are enhanced for wildlife, pollutant filtering, and floodplain purposes.
- Detailed ecological management plans are developed for all 9 Natural Area Restoration sites.
- All golf courses within the Green Infrastructure Network incorporate native landscaping.
- >50% of land owners along streams/tributaries take steps to manage land for green infrastructure benefits.

Goal Milestones:	**Grade**
1-10 Yrs: *(Short)* 1) At least 6 riparian buffers along priority stream reaches are enhanced. 2) Detailed ecological management plans are developed for 5 Natural Area Restoration sites. 3) At least one golf course implements native landscaping recommendations. 4) At least 25% of land owners along streams/tributaries manage their land for green infrastructure benefits.	
10-20 Yrs: *(Long)* 1) All 11 riparian buffers along priority stream reaches are enhanced. 2) Detailed ecological management plans are developed for all 9 Natural Area Restoration sites. 3) Both golf courses implement native landscaping recommendations. 4) At least 50% of land owners along streams/tributaries manage their land for green infrastructure benefits.	

Monitoring Needs/Efforts:

- Track number of riparian buffer projects implemented each year that include ecological benefits.
- Track management plan status and implementation progress at Natural Area Restoration sites.
- Track implementation progress at both golf course naturalization sites.
- Track land owner management practices along streams/tributaries

Remedial Actions:

- Work with WDNR and Counties to find funding for riparian are restoration projects
- Appropriate entities prepare budgets for creating and implementing ecological management plans.
- Hold additional meeting with landowners to educate them on need for managing their land as part of the green infrastructure network.

Notes:

Grade Evaluation: 80%-100% met = A; 60%-79% met = B; 40%-59% met = C; and < 40% = failed.

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10.0 LITERATURE CITED

Apfelbaum, Steve & Haney, Alan. 2010. *Restoring Ecological Health to Your Land*. Washington: Island Press. 240p.

Applied Ecological Services, Inc. (AES). 2007. *Applied Ecological Services Helping Developers go – and* make – *green*. Brodhead, WI.

Arendt, Randall. *Growing Greener: Putting Conservation into Local Plans and Codes*, Island Press, 1999.

Bay-Lake Regional Planning Commission. Updated November 2004. A Guide to Planning for Coastal Communities in Wisconsin.

Benedict, Mark A. and Edward T. McMahan. 2006. *Green Infrastructure: linking landscapes and communities*. Washington: Island Press.

Booth, D. and L. Reinelt. 1993. Consequences of Urbanization on Aquatic Systems-measured effects, degradation thresholds, and corrective strategies, pp. 545-550 *cited in* Schueler, T. 1994. The Importance of Imperviousness. Watershed Protection Techniques. 1(3): 100-111.

Center for Watershed Protection. 1998. A Comprehensive Guide for Managing Urbanizing Watersheds. Prepared for USEPA Office of Wetlands, Oceans and Watersheds and Region V.

Cigrand, Dr. Bernard J. Apr 29, 1916. Parental Stories of Pioneer Times. Wisconsin State Historical Society. Retrieved Sept 24, 2018 from: https://www.wisconsinhistory.org/Records/Newspaper/BA1591

City of West Bend. October 29, 2018. Airport. http://www.ci.west-bend.wi.us/Airport/

Conservation Research Institute. February 2005. *Changing Cost Perceptions: An Analysis of Conservation Development*. Prepared for Illinois Conservation Foundation and Chicago Wilderness.

Conservation Technology Information Center (CTIC). 2002. *No-Till and Conservation Buffers in the Midwest: Economic Benefits with Environmental Protection*. West Lafayette, Indiana. Retrieved: http://www.ctic.org/media/pdf/Economic%20Benefits.pdf

Curtis, John T. 1959. The Vegetation of Wisconsin- An Ordination of Plant Communities. The University of Wisconsin Press.

Daly, J., T. Lutes et. al. "Federal Township Plats of Illinois 1804-1891, Glaciation." Accessed July 11, 2011. http://landplats.ilsos.net/FTP_Illinois.html

Deverede, I.C., et. al. 2004. "Phosphorus runoff from incorporated and surface-applied liquid swine manure and phosphorus fertilizer." Journal of Environmental Quality. 2004 Jul-Aug;33(4):1535-44.

ECONorthwest. November 2007. *The Economics of Low-Impact Development: A Literature Review*. Eugene, Oregon.

Epstein, Eric; Judziewicz, Emmet, and Spencer, Elizabeth. 2012. *Recognized Natural Communities – Working Document*. Wisconsin Natural Heritage Inventory.

Fazio, Dr. James R. 2010. How Trees Can Retain Stormwater Runoff. Tree City USA Bulletin No. 55. Arbor Day Foundation. Nebraska City, NE.

Federal Aviation Administration. October 11, 2018. FAA Airport Master Record for ETB. https://www.gcr1.com/5010web/airport.cfm?Site=ETB&AptSecNum=0

Fuhrer, Jay. 2018. "5 Principles of Soil Health." Natural Resources Conservation Service, North Dakota. US Department of Agriculture. Retrieved Aug 9, 2019: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/nd/soils/health/?cid=nrcseprd1300631

Galli, J. 1990. Thermal impacts associated with urbanization and stormwater management best management practices. Metro. Wash. Counc. Gov., Maryland Dep. Environ. Washington, D.C. 188 pp *cited in* Schueler, T. 1994. The Importance of Imperviousness. Watershed Protection Techniques. 1(3): 100-111.

Hansel, A. "Glaciation." *Encyclopedia of Chicago*. Last modified 2005. Accessed June 30, 2011. http://www.encyclopedia.chicagohistory.org/pages/516.html

Hilsenhoff, William. March, 1988. "Rapid Field Assessment of Organic Pollution with a Family-Level Biotic Index." *Journal of the North American Benthological Society*. Vol. 7, No. 1: pp. 65-68.

Kent, P. G. & T. A. Dudiak. 2001. *Wisconsin Water Law-A Guide to Water Rights and Regulations, Second Edition*. University of Wisconsin-Extension; Cooperative Extension-University of Wisconsin-Stevens Point. Board of Regents of the University of Wisconsin System.

Kluessendorf, Joanne. Oct 2010. A Look at the Ledge – Celebrate the Rocky Ridge that Cleaved Glaciers, Resists Pounding Waterfalls and Forms the Terroir of Fine Wines. WDNR Magazine - Wisconsin Department of Natural Resources.

Lacy, Jeff. 1990. "An Examination of Market Appreciation for Clustered Housing With Permanent Open Space." *Center for Rural Massachusetts*. University of Massachusetts/Amherst, Department of Landscape Architecture and Regional Planning.

Lawrence, Joe, Q. Ketterings, K. Czymmek, S. Mahoney, E. Young, L. Geohring. 2011. *Subsurface (Tile) Drainage Best Management Practices*. Agronomy Fact Sheet Series, Fact Sheet 58. Cornell University Cooperative Extension – College of Agriculture and Life Sciences, Field Crops Extension.

Luczaj, John A. 2013. Geology of the Niagara Escarpment in Wisconsin. Geoscience Wisconsin vol. 22, part 1. Department of Natural and Applied Science – UW-Green Bay.

Lyons, John. 1992. "Using the Index of Biotic Integrity (IBI) to Measure Environmental Quality in Warmwater Streams of Wisconsin." United States Department of Agriculture. St. Paul, MN.

Michigan Department of Environmental Quality. June 1999. Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual.

Gibb, Terry. 2012. "Yard waste practices impact water quality." Michigan State University Extension. Retrieved July 23, 2019: https://www.canr.msu.edu/news/yard_waste_practices_impact_water_quality

Meyer, Elliot. 2018. "Webinar: Satellite Imagery Used in Conservation." Rara Journal. Retrieved Aug 8, 2019: http://wislandwatermedia.org/2018/05/02/webinar-satellite-imagery-used-in-conservation/

Milwaukee Metropolitan Sewerage District (MMSD). March 2003. "Memorandum: Evaluation of Stormwater Reduction Practices." Retrieved November 6, 2012: http://v3.mmsd.com/AssetsClient/Documents/stormwaterweb/PDFs/Appendix_L.pdf

Milwaukee Public Museum. 2018. Indian Country – Potawatomi Treaties and Treaty Rights. Retrieved September 2018 from: http://www.mpm.edu/content/wirp/ICW-107.html

Mohamed, Rayman. January 2006. "The Economics of Conservation Subdivisions: Price Premiums, Improvement Costs, and Absorption Rates." *Urban Affairs Review*: Vol. 41, No. 3. pp. 376-399. Sage Publications.

Needleman, Hannah. 2015. "The Use, Impact, and Ban of Coal Tar-Based Sealants." Virginia Coastal Polucy Center at William & Mary Law School. Sea Grant Virginia.

Omernik, J.M., S.S. Chapman, R.A. Lillie, and R.T. Dumke. 2000. "Ecoregions of Wisconsin." Transactions of the Wisconsin Academy of Sciences, Arts, and Letters 88:77-103.

Ozaukee County. April 2008. *A Multi-Jurisdictional Comprehensive Plan for Ozaukee County: 2035*. Prepared by SEWRPC and Ozaukee County Planning and Parks Department. Community Assistance Planning Report No. 285.

Ozaukee County. June 2011. *A Park and Open Space Plan for Ozaukee County*. Prepared by SEWRPC and Ozaukee County Planning and Parks Department. Community Assistance Planning Report No. 133, 3rd Edition.

Ozaukee Washington Land Trust (OWLT). 2019. "Visit Our Preserves." Accessed February 5, 2019: https://owlt.org/visit-our-preserves

Ruark, M.D., J.C. Panuska, E.T. Cooley, and J. Pagel. May 2009. Fact Sheet, No. 1. *Tile Drainage in Wisconsin: Understanding and Locating Tile Drainage Systems*. University of Wisconsin – Extension: Discovery Farms. Madison, Wisconsin.

Schueler, T. 1994. The Importance of Imperviousness. Watershed Protection Techniques. 1(3): 100-111.

Simonson, T.D., J. Lyons, and P.D. Kanehl. 1994. *Guidelines for Evaluating Fish Habitat in Wisconsin Streams*. Gen. Tech. Rpt NC-164, USFS North Central Experiment Station, St. Paul, MN.

Southeastern Wisconsin Regional Planning Commission (SEWRPC). 2002. *Groundwater Resources of Southeastern Wisconsin*. SEWRPC Technical Report No. 37.

Southeastern Wisconsin Regional Planning Commission (SEWRPC). 2007. *A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report*. SEWRPC Planning Report No. 13.

Southeastern Wisconsin Regional Planning Commission (SEWRPC). July 2008. *Groundwater Recharge in Southeastern Wisconsin Estimated by a GIS-Based Water-Balance Model*. Technical Report Number 47.

Southeastern Wisconsin Regional Planning Commission (SEWRPC). 2010. *Groundwater Budget Indices and Their Use in Assessing Water Supply Plans for Southeastern Wisconsin*. SEWRPC Technical Report No. 46.

Southeastern Wisconsin Regional Planning Commission (SEWRPC). 2010. *Managing the Water's Edge: Making Natural Connections*.

Southeastern Wisconsin Regional Planning Commission (SEWRPC). July 2010. *The Conservation Subdivision Design Process*. Retrieved November 6, 2012: http://www.sewrpc.org/SEWRPCFiles/CommunityAssistance/ConservationSubdivisions/conservation_subdivision_design.pdf?

Southeastern Wisconsin Regional Planning Commission (SEWRPC). April 2013. *The Economy of Southeastern Wisconsin*. Technical Report Number 10, 5th Edition.

Southeastern Wisconsin Regional Planning Commission (SEWRPC). April 2013. *The Population of Southeastern Wisconsin*. Technical Report Number 11, 5th Edition.

Southeastern Wisconsin Regional Planning Commission (SEWRPC). May 2013. *A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds*. Amended May 2013. Planning Report Number 50.

Sperling's Best Places. "Climate in West Bend." Retrieved Sept 2018: https://www.bestplaces.net/climate/city/wisconsin/west_bend

Syverson, Kent and Colgan, Patrick. 2004. "The Quaternary of Wisconsin: a Review of Stratigraphy and Glaciation History." *Quaternary Glaciations - Extent and Chronology, Part II*, edited by J. Ehlers and P.L. Gibbard, Elsevier B. V., 2004.

United States Department of Agriculture. 1986. Technical Release 55 (TR-55). Urban Hydrology for Small Watersheds.

United States Environmental Protection Agency. December 2000. *Ambient Water Quality Criteria Recommendations: Information Supporting the Development of State and Tribal Nutrient Criteria for Rivers and Streams in Nutrient Ecoregion VI*. EPA 822-B-00-017.

United States Environmental Protection Agency. March 2001. *EPA Requirements for Quality Assurance Project Plans*. EPA QA/R-5. Retrieved Aug 26, 2019: https://www.epa.gov/sites/production/files/2016-06/documents/r5-final_0.pdf

United States Environmental Protection Agency. March 2005. *A Homeowner's Guide to Septic Systems*. Report No. EPA-832-B-02005. Washington, D.C.

United States Environmental Protection Agency. March 2008. *Handbook for Developing Watershed Plans to Restore and Protect Our Waters*. Office of Water-Nonpoint Source Control Branch. Washington, DC. EPA 841-B-08-002.

United States Environmental Protection Agency. 2009. "Advance Identification (ADID)." Accessed March 21, 2013: http://www.epa.gov/owow/wetlands/facts/fact28.html

United States Environmental Protection Agency. 2012. "5.11 Fecal Bacteria." Water: Monitoring & Assessment. Retrieved: http://water.epa.gov/type/rsl/monitoring/vms511.cfm.

United States Environmental Protection Agency. 2012. "Overview of EPA Authorities for Natural Resource Managers Developing Aquatic Invasive Species Rapid Response and Management Plans: CWA Section 402-The National Pollutant Discharge Elimination System (NPDES)." Retrieved: http://water.epa.gov/type/oceb/habitat/cwa402.cfm

United States Environmental Protection Agency. 2012. *Water: Monitoring and Assessment – Fecal Bacteria*. Accessed January 22, 2012. Retrieved from: http://water.epa.gov/type/rsl/monitoring/vms511.cfm

United States Environmental Protection Agency (USEPA). 2016. "Stormwater Best Management Practice: Coal-Tar Sealcoat, Polycyclic Aromatic Hydrocarbons, and Stormwater Pollution." Office of Water, 4203M. EPA 833-F-12-004. Retrieve Apr 5, 2019: https://www3.epa.gov/npdes/pubs/coaltar.pdf

United States Environmental Protection Agency (USEPA). 2016. Stormwater Trees. Technical Memorandum. Retrieved Apr 9, 2019: https://www.epa.gov/sites/production/files/2016-11/documents/final_stormwater_trees_technical_memo_508.pdf

United States Geological Survey in cooperation with United States Environmental Protection Agency. 2006. *Present and Reference Concentrations and Yields of Suspended Sediment in Streams in the Great Lakes Region and Adjacent Areas*.

United States Geological Survey, January 2008. *Ozaukee County Groundwater Findings*. https://wi.water.usgs.gov/gwcomp/find/ozaukee/index.html

United States Geological Survey, January 2008. *Washington County Groundwater Findings*. https://wi.water.usgs.gov/gwcomp/find/washington/index.html

University of New Hampshire (UNH) Stormwater Center, Virginia Commonwealth University, and Antioch University New England. July 2011. *Forging the Link: Linking the Economic Benefits of Low Impact Development and Community Decisions*. Millerworks: Portsmouth, NH.

University of Wisconsin- Stevens Point, December 2018. *Well Water Quality Viewer: Private Well Data for Wisconsin*. https://www.uwsp.edu/cnr-ap/watershed/Pages/WellWaterViewer.aspx

Vidon, Philippe, M. Campbell, M. Gray. 2008. "Unrestricted cattle access to streams and water quality in till landscape of the Midwest." *Agricultural Water Management*. 95 (3): 322-330

Washington County. March 2004. *A Park and Open Space Plan for Washington County*. Prepared by SEWRPC and Washington County Planning and Parks Department. Community Assistance Planning Report No. 136, 3rd Edition.

Washington County. April 2008. *A Multi-Jurisdictional Comprehensive Plan for Washington County: 2035*. Prepared by SEWRPC and Washington County Planning and Parks Department. Community Assistance Planning Report No. 287.

Watco Companies. 2016. Wisconsin and Southern Railroad (WSOR). Accessed October 29, 2018. https://www.watcocompanies.com/services/rail/wsor/

Waters, T.F. 1995. Sediment in Streams: Sources, Biological Effects, and Control. American Fisheries Society Monograph 7. Bethesda, Maryland, 251pp.

Weigel, Brian M. 2003. "Development of Stream Macroinvertebrate Models That Predict Watershed and Local Stressors in Wisconsin." *Journal of the North American Benthological Society*, 22(1): 123-142.

West Bend, City of. 2013. *2020 Comprehensive Plan for the City of West Bend*. Last amended Feb 2013.

Wisconsin Board of Commissioners of Public Lands. 1848. "Wisconsin Public Land Survey Records: Original Field Notes and Plat Maps." Retrieved from: http://images.library.wisc.edu/awareImageServer/SurveyNotesImageNav.Home

Wisconsin Department of Administration (WDOA), Office of Coastal Management and Wisconsin Department of Natural Resources (WDNR), Scientific Areas Section. 1980. *Natural Area Inventory: Wisconsin Great Lakes Coast*.

Wisconsin Department of Natural Resources. 2003. Rain Gardens- a how-to manual for homeowners. In conjunction with USGS, AES, Prairie Nursery, and CRM Ecosystems Inc.

Wisconsin Department of Natural Resources. 2009. *North Branch Milwaukee River Wildlife and Farming Heritage Area*. Madison, WI. Last Revised February 20, 2017. Retrieved Aug 9, 2019: https://dnr.wi.gov/topic/lands/WildlifeAreas/northbranch.html

Wisconsin Department of Natural Resources. September 2013. *A Water Quality Trading How To Manual*. Guidance #: 3400-2013-03.

Wisconsin Department of Natural Resources. 2017. "WPDES permits." Madison, WI. Accessed January 30, 2019: https://dnr.wi.gov/topic/wastewater/Permits.html

Wisconsin Department of Natural Resources. February 2017. *North Branch Milwaukee River Wildlife and Farming Heritage Area.* Accessed December 7, 2018: https://dnr.wi.gov/topic/lands/wildlifeareas/northbranch.html

Wisconsin Department of Natural Resources. April 2017. *Wisconsin 2018 Consolidated Assessment and Listing Methodology (WisCALM) for CWA Section 303(d) and 305(b) Integrated Reporting.* Bureau of Water Quality Program Guidance. Guidance # 3200-2017-02.

Wisconsin Department of Natural Resources. 2018. "Agricultural NPS pollution: Erosion Vulnerability Assessment for Agricultural Lands (EVAAL)." Accessed March 7, 2019: https://dnr.wi.gov/topic/Nonpoint/EVAAL.html

Wisconsin Department of Natural Resources. 2018. *Wisconsin State Natural Areas Program. Riverededge Creek & Ephemeral Pond (No. 197).* Accessed December 3, 2018: https://dnr.wi.gov/topic/Lands/naturalareas/index.asp?SNA=197

Wisconsin Department of Natural Resources. 2018. Wisconsin State Natural Areas Program. Huiras Lake (No. 153). Accessed December 3, 2018: https://dnr.wi.gov/topic/Lands/naturalareas/index.asp?SNA=353

Wisconsin Department of Natural Resources & Milwaukee Metropolitan Sewerage District. 2018. Total Maximum Daily Loads for Total Phosphorus, Total Suspended Solids, and Fecal Coliform Milwaukee River Basin. CDM Smith for USEPA Region 5. Final Report

Wisconsin Department of Natural Resources – Water Division. 2018. *Wisconsin Water Quality Report to Congress – Year 2018*.

Wisconsin Department of Transportation. October 2009. WisDOT Connections 2030. Accessed October 29, 2018.: https://wisconsindot.gov/Pages/projects/multimodal/conn2030.aspx

Wisconsin Initiative on Climate Change Impacts. 2006. *Maps of Recent and Projected Climate Change in Wisconsin*. Madison, WI.

Wisconsin State Cartographer's Office (WSCO). 1937. Wisconsin Historic Aerial Imagery Finder. Accessed September 25, 2018: https://maps.sco.wisc.edu/WHAIFinder/#7/44.750/-89.750

Wolfson, Lois and Harrigan, Tim. January 2010. "Cows, Stream, and E. Coli: What everyone needs to know." Michigan State University Extension. East Lansing, Michigan.

Zielinski, J. 2002. Watershed Vulnerability Analysis. Center for Watershed Protection. Ellicott City, MD, 22pp.

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11.0 GLOSSARY OF TERMS

100-year floodplain: A 100-year flood is a flood that has a 1-percent chance of being equaled or exceeded in any given year. A base flood may also be referred to as a 100-year storm and the area inundated during the base flood is called the 100-year floodplain.

303(d) (CWA Section 303d): The Federal Clean Water Act requires states to submit a list of impaired waters to the USEPA for review and approval using water quality assessment data from the Section 305(b) Water Quality Report. States are then required to develop total maximum daily load analyses (TMDLs) for waterbodies on the 303(d) list.

ADID wetlands: Advanced identification of wetland disposal areas (ADID) studies conducted by the United States Environmental Protection Agency (USEPA) in conjunction with the United States Army Corps of Engineers (USACE) and the Wisconsin Department of Natural Resources (WDNR), with further technical assistance provided by Southeastern Wisconsin Regional Planning Commission (SEWRPC). Both the regional and ADID wetland inventories were completed in 2005. The wetland features were delineated according to the definitions of the Wisconsin Wetland Inventory Classification Guide, with the addition of special features such as drained wetlands and drainage ditches. ADID wetlands and waters include all aquatic resources located within primary environmental corridors and natural areas as identified by SEWRPC and categorized as either wetlands, lakes/ponds, or natural area wetlands.

Applied Ecological Services Inc. (AES): A broad-based ecological consulting, contracting, and restoration firm that was founded in 1978. The company consists of consulting ecologists, engineers, landscape architects, planners, and contracting staff. The mission of AES is to bring wise ecological decisions to all land use activities.

Aquatic habitat: Structures such as stream substrate, woody debris, aquatic vegetation, and overhanging vegetation that is important to the survival of fish and macroinvertebrates.

Base Flood Elevation (BFE): The elevation delineating the level of flooding resulting from the 100-year flood frequency elevation. (See also **Floodplain**.)

Base flow: The flow that a perennially flowing stream reduces to during the dry season. It is often supported by groundwater seepage into the channel.

Bedrock: The solid rock that underlies loose material, such as soil, sand, clay, or gravel.

Best Management Practices (BMPs): See **Management Measure**

Biodiversity: The variety of organisms (plants, animals and other life forms) that includes the totality of genes, species and ecosystems in a region.

Rain gardens: Excavated depressional areas where stormwater runoff is directed and allowed to infiltrate back into groundwater rather than allowing to runoff. Infiltration areas are planted with appropriate vegetation.

Biological Oxygen Demand (BOD): The amount of dissolved oxygen that is required by microscopic organism (e.g. bacteria) to decompose organic matter in waterbodies.

Biological Stream Characterization (BSC): A multi-tiered stream quality classification based primarily on the attributes of lotic (living in moving water) fish communities. The predominant stream quality indicator used in this process is the Index of Biotic Integrity (IBI), comprised of 12 metrics, which form a basis for describing the health or integrity of the fish community. When insufficient fishery data are available for calculating an IBI value, BSC criteria allow the use of sport fishing information or macroinvertebrate data to rate streams. BSC provides a uniform process of characterizing streams statewide and is used by a variety of sources for stream protection, restoration and planning efforts.

Bioengineering (or Soil Bioengineering): Techniques for stabilizing eroding or slumping stream banks that rely on the use of plants and plant materials such as live willow posts, brush layering, coconut logs and other "greener" or "softer" techniques. This is in contrast to techniques that rely on creating "hard" edges with riprap, concrete and sheet piling (metal and plastic).

Center for Watershed Protection (CWP): Non-profit 501(c)3 corporation founded in 1992 that provides local governments, activists, and watershed organizations around the country with the technical tools for protecting some of the nation's most precious natural resources such as streams, lakes and rivers.

Channelized stream: A stream that has been artificially straightened, deepened, or widened to accommodate increased stormwater flows, to increase the amount of adjacent land that can be developed or used for urban development, agriculture or for navigation purposes. In addition to being unsightly, channelized streams have a uniform gradient, no riffle and pool development, no meanders (curves) and very steep banks. The vegetation is frequently removed and replaced with riprap, concrete or other hard surfaces. During low flow periods in the summer, many channelized streams have low dissolved oxygen levels, in part due to shallow, slow-moving water. Under these conditions, they provide poor habitat for fish or other stream organisms such as benthic macroinvertebrates.

Channel: Any river, stream, creek, brook, branch, natural or artificial depression, ponded area, lakes, flowage, slough, ditch, conduit, culvert, gully, ravine, swale, wash, or natural or man-made drainageway, in or into which surface or groundwater flows, either perennially or intermittently.

Conservation development: A development designed to protect open space and natural resources for people and wildlife while at the same time allowing building to continue. Conservation design developments designate half or more of the buildable land area as undivided permanent open space.

Conservation easement: The transfer of land use rights without the transfer of land ownership. Conservation easements can be attractive to property owners who do not want to sell their land now, but would support perpetual protection from further development. Conservation easements can be donated or purchased.

Clean Water Act (CWA): The CWA is the basic framework for federal water pollution control and has been amended in subsequent years to focus on controlling toxics and improving water quality in areas where compliance with nationwide minimum discharge standards is insufficient to meet the CWA's water quality goals.

Debris Jam: Natural and man-made debris in a stream channel including leaves, logs, lumber, trash and sediment.

Designated Use: EPA requirements that states and authorized Indian Tribes specify appropriate water uses to be achieved and protected. Appropriate uses are identified by taking into consideration the use and value of the water body for public water supply, for protection of fish, shellfish, and wildlife, and for recreational, agricultural, industrial, and navigational purposes. In designating uses for a water body, States and Tribes examine the suitability of a water body for the uses based on the physical, chemical, and biological characteristics of the water body, its geographical setting and scenic qualities, and economic considerations. Each water body does not necessarily require a unique set of uses. Instead, the characteristics necessary to support a use can be identified so that water bodies having those characteristics can be grouped together as supporting particular uses.

Detention basin: A man-made structure for the temporary storage of stormwater runoff with controlled release during or immediately following a storm.

Discharge (streamflow): The volume of water passing through a channel during a given time, usually measured in cubic feet per second.

Digital Elevation Model (DEM): Regularly spaced grid of elevation points used to produce elevation maps.

Dissolved oxygen (DO): The amount of oxygen in water, usually measured in milligrams/liter.

Downcutting: The action of a stream to deepen itself, often as a result from channelization.

Drainage basin: Land surface region drained by a length of stream channel; usually 1,000 to 10,000 square miles in size.

Ecosystem: An ecological community together with its environment, functioning as a unit.

Erosion: Displacement of soil particles on the land surface due to water or wind action.

European settlement: A period in the early 1800s when European settlers moved across the United States in search of better lives. During this movement, much of the historical communities were altered for farming and other types of development.

Federal Emergency Management Agency (FEMA): Government agency within the Department of Homeland Security that responds to, plans for, recovers from, and mitigates against disasters/emergencies, both natural and man-made.

Fee in lieu: Defined by the USACE and EPA as a payment "to a natural resource management entity for implementation of either specific or general wetland or other aquatic resource development projects" for projects that "do not typically provide compensatory mitigation in advance of project impacts."

Filter strip: A long narrow portion of vegetation used to retard water flow and collect sediment for the protection of watercourses, reservoirs or adjacent properties.

Flash hydrology/flooding: A quickly rising and falling overflow of water in stream channels that is usually the result of increased amounts of impervious surface in the watershed.

Flood Insurance Rate Map (FIRM): A map prepared by the Federal Emergency Management Agency that depicts the special flood hazard area (SFHA) within a community. The FIRM includes zones for the 100-year and 500-year floodplains and may or may not depict Regulatory Floodways.

Floodplain (100-year): Land adjoining the channel of a river, stream, watercourse, lake or wetland that has been or may be inundated by floodwater during periods of high water that exceed normal bank-full elevations. The 100-year floodplain has a probability of 1% chance per year of being flooded.

Floodway: The floodway is the portion of the stream or river channel that includes the adjacent land areas to that must be reserved to discharge the 100-year flood without increasing the water surface.

Geographic Information System (GIS): A computer-based approach to interpreting maps and images and applying them to problem-solving.

Glacial Drift: Earth and rocks which have been transported by moving ice or land ice.

Global Positioning System (GPS): Satellite mapping systems that enables locators and mapping to be created via satellite.

Green infrastructure: An interconnected network of waterways, wetlands, woodlands, wildlife habitats, and other natural areas; greenways, parks and other conservation lands, farms, and forests of conservation value; and wilderness and other open spaces that support native species, maintain natural ecological processes, sustain air and water resources and contribute to the health and quality of life.

Greenways: A protected linear open space area that is either landscaped or left in its natural condition. It may follow a natural feature of the landscape such as a river or stream, or it may occur along an unused railway line or some other right of way. Greenways also provide wildlife corridors and recreational trails.

Groundwater recharge: Primary mechanism for aquifer replenishment which ensures future sources of groundwater for commercial and residential use.

Headcut: A headcut is an erosional feature of both intermittent and perennial streams where an abrupt vertical drop, also known as a knickpoint in the stream bed occurs following hydrologic disturbances in the contributing watershed. As erosion of the knickpoint and the streambed continues, the headcut migrates upstream. This can cause significant streambank erosion and often results in a disconnected floodplain that then increased channel incision.

Headwaters: Upper reaches of tributaries in a drainage basin.

Hydraulic and Hydrologic modeling: Engineering analysis that predicts expected flood flows and flood elevations based on land characteristics and rainfall events.

Hydraulic structures: Low head dams, weirs, bridges, levees, and any other structures along the course of the river.

Hydric inclusion soil: A soil unit (usually adjacent to hydric soils) that are not wet enough to form hydric properties but do have some hydric properties.

Hydric soil: Soil units that are wet frequently enough to periodically produce anaerobic conditions, thereby influencing the species composition or growth, or both, of plants on those soils.

Hydrograph: A way of measuring and graphing stream flow, or discharge, as it varies with time.

Hydrologic Soil Groups (HSG): Soils are classified by the Natural Resource Conservation Service into four Hydrologic Soil Groups based on the soil's runoff potential. The four Hydrologic Soils Groups are A, B, C and D. A's generally have the smallest runoff potential and D's the greatest.

Hydrology: The scientific study of the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.

Hydrophytic vegetation: Plant life growing in water, soil or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content; one of the indicators of a wetland.

Impervious cover/surface: An area covered with solid material or that is compacted to the point where water cannot infiltrate underlying soils (e.g. parking lots, roads, houses, patios, swimming pools, tennis courts, etc.). Stormwater runoff velocity and volume can increase in areas covered by impervious surfaces.

Impervious Cover Model: Simple urban stream classification model based on impervious cover and stream quality. The classification system contains three stream categories, based on the percentage of impervious cover that predicts the existing and future quality of streams based on the measurable change in impervious cover. The three categories include sensitive, impacted, and non-supporting.

Incised channel: A stream that has degraded and cut its bed into the valley bottom. Indicates accelerated and often destructive erosion.

Index of Biotic Integrity (IBI): The IBI is based on fish surveys with the rating dependent on the abundance and composition of the fish species in a stream. Fish communities are useful for assessing stream quality because fish represent the upper level of the aquatic food chain and therefore reflect conditions in the lower levels of the food chain. Fish population characteristics are dependent on the physical habitat, hydrologic and chemical conditions of the stream, and are considered good indicators of overall stream quality because they reflect stress from both chemical pollution and habitat perturbations. For example, the presence of fish species that are intolerant of pollution are an indicator that water quality is good. The IBI is calculated on a scale of 12 to 60, the higher the score the better the stream quality.

Infiltration: That portion of rainfall or surface runoff that moves downward into the subsurface soil.

Invasive vegetation/plant: Plant species that are not native to an area and tend to out-compete native species and dominate an area (e.g. European buckthorn or garlic mustard).

Loess: A fine-grained unstratified accumulation of clay and silt deposited by wind.

Macroinvertebrates: Invertebrates that can be seen by the unaided eye (macro). Most benthic invertebrates in flowing water are aquatic insects or the aquatic stage of insects, such as stonefly nymphs, mayfly nymphs, caddisfly larvae, dragonfly nymphs and midge larvae. They also include such things as clams and worms. The presence of benthic macroinvertebrates that are intolerant of pollutants is a good indicator of good water quality.

Macroinvertebrate Index of Biotic Integrity (MBI): Data derived from aquatic macroinvertebrate samples, which can be combined with stream habitat and fish assemblages, to provide valuable information on the physical, chemical and biological condition of streams. Most aquatic macroinvertebrates live for one or more years in streams, reflecting various environmental stressors over time. Since the majority of aquatic invertebrates are limited in mobility, they are good indicators of localized conditions, upstream land use impacts and water quality degradation.

Management Measures: Also known as Best Management Practices (BMPs) are non-structural practices such as site planning and design aimed to reduce stormwater runoff and avoid adverse development impacts - or structural practices that are designed to store or treat stormwater runoff to mitigate flood damage and reduce pollution. Some BMPs used in urban areas may include stormwater detention ponds, restored wetlands, vegetative filter strips, porous pavement, silt fences and biotechnical streambank stabilization.

Marsh: An area of soft, wet, low-lying land, characterized by grassy vegetation and often forming a transition zone between water and land.

Meander (stream): A sinuous channel form in flatter river grades formed by the erosion on one side of the channel (pools) and deposition on the other (point bars).

Mitigation: Measures taken to eliminate or minimize damage from development activities, such as construction in wetlands or Regulatory Floodplain filling, by replacement of the resource.

Moraine: see Terminal Moraine.

National Wetland Inventory (NWI): U.S. Fish and Wildlife Service study that provides information on the characteristics, extent, and status of U.S. wetlands and deepwater habitats and other wildlife habitats.

Native vegetation/plants: Plant species that have historically been found in an area.

Natural community: an assemblage of plants and animals interacting with one another in a particular ecosystem.

Natural divisions: Large land areas that are distinguished from each other by bedrock, glacial history, topography, soils, and distribution of plants and animals.

No-net-loss: A policy for wetland protection to stem the tide of continued wetland losses. The policy has generated requirements for wetland mitigation so that permitted losses due to filling and other alterations are replaced and the net quality wetland acreage remains the same.

Nonpoint source pollution (NPS or NPSP): Refers to pollutants that accumulate in waterbodies from a variety of sources including runoff from the land, impervious surfaces, the drainage system and deposition of air pollutants.

Normalized Difference Tillage Index (NDTI): Using the analysis of satellite imagery, the NDTI estimates crop residue levels based on shortwave infrared wavelengths of land cover.

Nutrients: Substances needed for the growth of aquatic plants and animals such as phosphorous and nitrogen. The addition of too many nutrients (such as from sewage dumping and over fertilization) will cause problems in the aquatic ecosystem through excess algae growth and other nuisance vegetation.

Open space: Any land that is not developed and is often set aside for conservation or recreation purposes. It can be either protected or unprotected. Protected open space differs from unprotected in that it is permanently preserved by outright ownership by a body chartered to permanently save land, or by a permanent deed restriction such as a conservation easement. Open space is important to a watershed's hydrology, habitat, water quality, and biodiversity.

Outwash: Sand and gravel deposits removed or washed out from a glacier.

Partially open parcel: Parcels that have been developed to some extent, but still offer some opportunities for open space and Best Management Practice (BMP) implementation. They typically include private residences with acreage exceeding the surrounding minimum zoning, partly developed industrial sites, or institutions (churches, schools, etc.) with extensive grounds.

Point source pollution: Refers to discharges from a single source such as an outfall pipe conveying wastewater from an industrial plant or wastewater treatment facility.

Pollutant load: The amount of any pollutant deposited into waterbodies from point source discharges, combined sewer overflows, and/or stormwater runoff.

Pool: A location in an active stream channel usually located on the outside bends of meanders, where the water is deepest and has reduced current velocities.

Prairie: A type of grassland characterized by low annual moisture and rich black soil characteristics.

Preventative measures: Actions that reduce the likelihood that new watershed problems such as flooding or pollution will arise, or that those existing problems will worsen. Preventative techniques generally target new development in the watershed and are geared toward protecting existing resources and preventing degradation.

Private onsite wastewater treatment systems (POWTS): Wastewater systems designed to treat and dispose of effluent on the same property that produces the wastewater. A septic tank and drainfield combination is a fairly common type of on-site sewage facility.

Regulatory floodplain: Regulatory Floodplains may be either riverine or non-riverine depressional areas. Projecting the base flood elevation onto the best available topography delineates floodplain boundaries. A floodprone area is Regulatory Floodplain if it meets any of the following descriptions:

1. Any riverine area inundated by the base flood where there is at least 640 acres of tributary drainage area.
2. Any non-riverine area with a storage volume of 0.75 acre-foot or more when inundated by the base flood.
3. Any area indicated as a Special Flood Hazard Area on the FEMA Flood Insurance Rate Map expected to be inundated by the base flood located using best available topography.

Remedial measures: Used to solve known watershed problems or to improve current watershed conditions. Remedial measures include retrofitting drainage system infrastructure such as detention basins and stormsewer outfalls to improve water quality, adjust release rates, or reduce erosion.

Remnant: a small fragmented portion of the former dominant vegetation or landscape which once covered the area before being cleared for human land use.

Retrofit: Refers to modification to improve problems with existing stormwater control structures such as detention basins and conveyance systems such as ditches and stormsewers. These structures were originally designed to improve drainage and reduce flood risk, but they can also be retrofitted to improve water quality.

Ridge: A line connecting the highest points along a landscape and separating drainage basins or small-scale drainage systems from one another.

Riffle: Shallow rapids, usually located at the crossover in a meander of the active channel.

Riparian: Referring to the riverside or riverine environment next to the stream channel, e.g., riparian, or streamside, vegetation.

Runoff: The portion of rain or snow that does not percolate into the ground and is discharged into streams by flowing over the ground instead.

Savanna: A type of woodland characterized by open spacing between its trees and by intervening grassland.

Section 319: see U.S. Environmental Protection Agency Section 319.

Sediment: Soil particles that have been transported from their natural location by wind or water action.

Sedimentation: The process that deposits soils, debris and other materials either on other ground surfaces or in bodies of water or watercourses.

Silt: Fine mineral particles intermediate in size between clay and sand.

Southeastern Wisconsin Regional Planning Commission (SEWRPC): Established in 1960 as the official areawide planning agency for the southeastern region of the State, SEWRPC serves the seven counties of Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha. It was created to provide objective information and professional planning initiatives to help solve problems and to focus regional attention on key issues of regional consequence.

Stakeholders: Individuals, organizations, or enterprises that have an interest or a share in a project. (see also Watershed Stakeholders).

State Natural Areas (Program): The Wisconsin Department of Natural Resources manages the State Natural Areas Program which works to identify ecological communities that remain predominantly untouched from pre-European settlement times. These areas have been assessed according to field inventories conducted by WDNR staff and account for the quality, diversity, extent of past disturbance, context within the greater landscape, and rarity of features.

State Scientific Areas: Areas that meet the qualifications of a State Natural Area and have also been identified as areas of statewide significance.

Stormwater management: A set of actions taken to control stormwater runoff with the objectives of providing controlled surface drainage, flood control and pollutant reduction in runoff.

Stormsewershed: An area of land whose stormwater drains into a common storm sewer system.

Stream corridor: The area of land that runs parallel to a stream.

Stream reach: A stream segment having fairly homogenous hydraulic, geomorphic and riparian cover and land use characteristics (such as all ditched agriculture or all natural and wooded). Reaches generally should not exceed 2,000 feet in length.

Streambank stabilization: Techniques used for stabilizing eroding streambanks.

Stream monitoring: Chemical, biological and physical monitoring used to identify the causes and sources of pollution in the river and to determine the needs for reduction in pollutant loads, streambank stabilization, debris removal and habitat improvement.

Substrate (stream): The composition of the bottom of a stream such as clay, silt or sand.

Subwatershed: Any drainage basin within a larger drainage basin or watershed.

Subwatershed Management Unit (SMU): Small unit of a watershed or subwatershed that is delineated and used in watershed planning efforts because the effects of impervious cover are easily measured, there is less chance for confounding pollutant sources, boundaries have fewer political jurisdictions, and monitoring/mapping assessments can be done in a relatively short amount of time.

Swale: A vegetated channel, ditch or low-lying or depressional tract of land that is periodically inundated by conveying stormwater from one point to another. Swales are often used in natural drainage systems instead of stormsewers.

Threatened and Endangered Species (T&E): An "endangered" species is one that is in danger of extinction throughout all or a significant portion of its range. A "threatened" species is one that is likely to become endangered in the foreseeable future.

Tax increment financing (**TIF**): Public financing method that is used as a subsidy for redevelopment, infrastructure, and other community-improvement projects in many countries, including the United States.

Till: A heterogeneous mixture of clay, silt, sand, gravel, stones, and boulders deposited directly by and underneath a glacier without stratification.

Terminal moraines: A ridge-like accumulation of till and other types of drift that was produced at the outer margin or farthest advance, of a retracting glacier.

Topography: The relative elevations of a landscape describing the configuration of its surface.

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

Treatment Train: Several Management Measures/Best Management Practices (BMPs) used together to improve water quality, infiltration and reduce sedimentation.

Turbidity: Refers to the clarity of the water, which is a function of how much material including sediment is suspended in the water.

United States Environmental Protection Agency Section 319 (Section 319): Section 319 of the Clean Water Act encourages and funds nonpoint source pollution control projects (any indirect pollution, like runoff, stormwater discharge, road salt, sediment, etc.) or NPS reduction at the source.

United States Geological Survey (USGS): Government agency established in 1879 with the responsibility to serve the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.

United States Army Corps of Engineers (USACE): Federal group of civilian and military engineers and scientists that provide services to the nation including planning, designing, building and operating water resources and other Civil Works projects. These also include navigation, flood control, environmental protection, and disaster response.

USDA TR55 Document: A single event rainfall-runoff hydrologic model designed for small watersheds and developed by the USDA, NRCS, and EPA.

Urban runoff: Water from rain or snow events that runs over surfaces such as streets, lawns, parking lots and directly into storm sewers before entering the river rather than infiltrating the land upon which it falls.

Vegetated buffer: An area of vegetated land to be left open adjacent to drainageways, wetlands, lakes, ponds or other such surface waters for the purpose of eliminating or minimizing adverse impacts to such areas from adjacent land areas.

Vegetated swale: An open channel drainageway used along residential streets and highways to convey stormwater and filter pollutants in lieu of conventional storm sewers.

Velocity (of water in a stream): The distance that water can travel in a given direction during a period of time expressed in feet per second.

Water Quality Standards (State): WDNR developed four general Designated Uses which define the goals for a waterbody for all Wisconsin surface waters: Fish and Aquatic Life, Recreational Use, Public Health and Welfare, and Wildlife. Each designated use is associated with particular water quality criteria that are either numeric or narrative in nature and set the standards a waterbody must meet in order to protect the intended use.

Waters of the United States (WOUS): For the purpose of this Ordinance the term Waters of the United States refers to those water bodies and wetland areas that are under the U. S. Army Corps of Engineers jurisdiction.

Watershed: An area confined by topographic divides that drains to a given stream or river. The land area above a given point on a waterbody (river, stream, lake, wetland) that contributes runoff to that point is considered the watershed.

Watershed partner(s): Key watershed stakeholders who take an active role in the watershed management planning process and implementing the watershed plan.

Watershed stakeholder: A person who has a personal, professional, legal or economic interest in the watershed and the outcome of the watershed planning process.

Watershed Vulnerability Analysis: Rapid planning tool for application to watersheds and subwatersheds that estimates future and impervious cover and provides guidance on factors that might alter the initial classification or diagnosis of a watershed or subwatershed.

Wetland: A wetland is considered a subset of the definition of the Waters of the United States. Wetlands are land that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support, under normal conditions, a prevalence of vegetation adapted for life in saturated soil conditions (known as hydrophytic vegetation). A wetland is identified based upon the three attributes: 1) hydrology, 2) hydric soils and 3) hydrophytic vegetation.

Wet meadow: A type of wetland away from stream or river influence with water made available by general drainage and consisting of non-woody vegetation growing in saturated or occasionally flooded soils.

Wisconsin Department of Natural Resources (WDNR): A government agency established to manage, protect and sustain Wisconsin's natural and cultural resources; provide resource-compatible recreational opportunities and to promote natural resource-related issues for the public's safety and education.

Wisconsin Pollutant Discharge Elimination System (WPDES): The Wisconsin Department of Natural Resources (WDNR) developed the Wisconsin Pollutant Discharge Elimination System (WPDES) Storm Water Discharge Permit Program which is administered under the authority of ch. NR 216, Wis. Adm. Code. The WPDES Storm Water Program regulates the discharge of storm water from construction sites, industrial facilities, and municipal separate storm sewer systems (MS4s).