THE MENOMONEE RIVER WATERSHED UPDATED IMPLEMENTATION PLAN

A COMPREHENSIVE WATERSHED RESTORATION PLAN

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CHERYL NENN, MILWAUKEE RIVERKEEPER

DECEMBER 2021

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PART 1. BACKGROUND

INTRODUCTION

The Menomonee River Watershed is one of three watersheds that discharge into Lake Michigan via the Milwaukee River and Harbor Estuary. At 136 square miles, it is the second most urbanized of the watersheds and, in some areas, is projected to experience a population growth of 30 to 35 percent by the year 2050 due to increased urban development and suburban sprawl. Although the Menomonee has a fairly large percentage of natural streambanks, water quality has been steadily declining, large amounts of sediment and other pollutants continue to runoff of massive, multi-year freeway construction projects, and fish and organism passage is blocked by human-made structures and dams. Due to historic flood management projects, 8% of the Menomonee's waterways are lined with concrete, and flood events frequently damage property, erode stream banks, and cause dangerous stream flows. Approximately, 71 miles of streams are not meeting water quality standards and designated as impaired.

Despite these challenges, great headway has been made in the past decade by committed stakeholders in the watershed and a general momentum towards watershed restoration has begun. For example, the recently approved Milwaukee River Basin Total Maximum Daily Loads (TMDL) allocate stricter than ever pollutant reductions to the region's point sources, building off of a series of watershed restoration planning efforts, and are helping to build a watershed mind-set required for implementation of best management practices and policy changes. Several manmade structures have been removed to allow for improved fish passage in the Menomonee, and over 2 miles of concrete channel have been removed from the main stem of the Menomonee River and Underwood Creek. In addition, preexisting collaborations between diverse partners in the Menomonee River Watershed, like the Menomonee Watershed-Based Stormwater Permit Group of watershed municipalities, are strengthening relationships and collaborating on group restoration projects and education efforts. Overall, however, watershed restoration efforts are far behind established timelines of prior watershed plans and the watershed is in need of major improvements to meet water quality and aquatic life goals.

It is clear the Menomonee River Watershed is at critical juncture. Now, more than ever, stakeholders understand that true watershed restoration requires a plan that moves the needle on multiple fronts including improvements in water quality, managing water quantity, addressing aquatic and terrestrial habitat, and creating new opportunities for recreation and access to this incredible asset. Without such a plan, impactful, orchestrated and visible watershed improvements may be unobtainable. The Menomonee River Watershed Updated Implementation Plan (The Plan) does just that. The Plan is an effort to localize and strengthen watershed improvement projects in the watershed by focusing on strategic implementation, collaboration, and accountability. It is the product of a multi-year effort to collect and analyze data, establish diverse stakeholder collaborations, and to successfully implement best management practices in the Menomonee River

Watershed, and it provides an update to the Implementation Plan developed in 2010 by the Southeastern Wisconsin Watersheds Trust, Inc. (SWWT) and the watershed plans that informed it. In addition, the Plan is structured to comply with the United States Environmental Protection Agency's (US EPA) "Nine Minimum Elements" of a watershed plan.

SWWT is a non-profit organization dedicated to restoring the Greater Milwaukee watersheds to conditions that are healthy for swimming and fishing. The organization brings diverse partners together and provides the leadership and innovation necessary to protect and restore our shared water resources. SWWT achieves this by taking a watershed approach to restoration that bridges jurisdictional and social boundaries and recognizes that how we manage the land affects our water resources. SWWT will use their unique understanding of conditions in the watershed in order to play a key role in the dissemination, implementation, and tracking of the Plan effort in the Menomonee River Watershed. This will be achieved by housing and updating the Plan on an as needed basis, facilitating collaboration between key stakeholders, serving as an advisor for implementers, tracking metrics associated with implementation and assisting with fund identification.

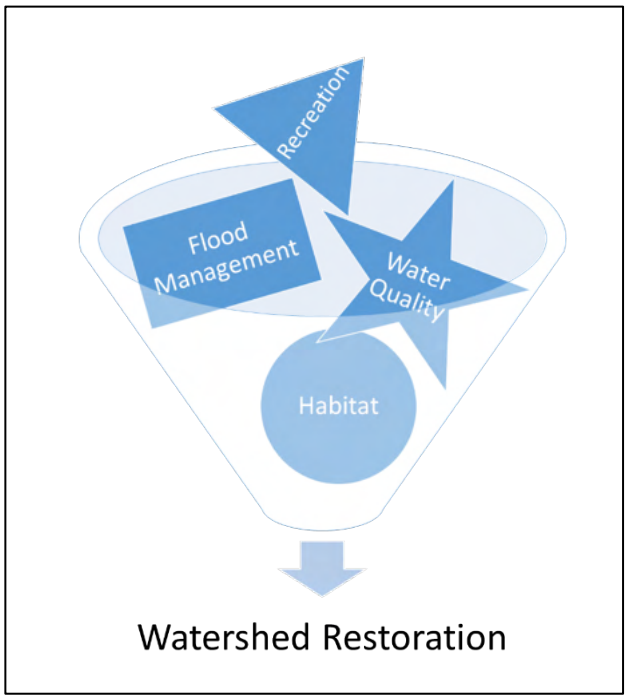


FIGURE 1. COMPONENTS OF SUCCESSFUL WATERSHED RESTORATION

The most successful watershed restoration plans recognize the unique features of the watershed and shape their approach around those existing conditions. With this philosophy in mind, SWWT has worked diligently hard to solicit input from numerous stakeholders directly working in the Menomonee River Watershed, and thoroughly researched the characteristics of the area in the development of The Plan. There exists no magic bullet approach to watershed restoration and it is crucial that watershed wide plans are driven by the specific topography, land use, politics, environmental factors, and culture of the area. The Menomonee River Watershed is no exception. The Plan for the Menomonee River Watershed is a ten-year plan created to make improvements in four main categories: water quality, flood management and water quantity, aquatic habitat and fish passage, and recreational use, through a comprehensive and collaborative implementation of priority projects and practices (Figure 1).

PLAN OBJECTIVES

The Menomonee River Watershed Updated Implementation Plan lays out a comprehensive and strategic approach to watershed restoration in three parts. Part 1 of The Plan provides the background and history of the watershed. Part 2 describes the current conditions and goals of the watershed restoration plan, and Part 3 provides the actual implementation and evaluation process needed to achieve the goals over a ten-year time period.

The objectives of The Plan for the Menomonee River Watershed are to:

1. Provide guidance for a watershed-wide collaborative, adaptive, and cost-effective approach by combining water quality, water quantity, aquatic habitat and recreational improvements to restore the Menomonee River Watershed to the greatest possible extent.
2. Ensure eligibility for 319 funding by gaining US EPA approval for the Nine (Minimum) Key Elements of a watershed plan.
3. Make recommendations for Total Maximum Daily Load implementation in the Menomonee River Watershed for Total Suspended Solids, Phosphorus, and Fecal Coliform.
4. Make recommendations for water quality improvement actions for emerging pollutants such as chlorides and serve as a template for future watersheds looking to gain US EPA Nine Key Element approval.
5. Create a roadmap for the eventual protection, restoration and delisting of Menomonee waterways from the section 303(d) Clean Water Act impaired waters list.
6. Incorporate restoration projects and opportunities into planned flood management and channel improvement investments, where possible.
7. Improve the livability of the Menomonee watershed neighborhoods through terrestrial and aquatic habitat improvements, improved fish passage, and increased recreational opportunities and green space.
8. Consolidate, connect and expand efforts to implement existing watershed plans and projects, and provide coordination to prevent duplicity of efforts.

HOW TO USE THIS PLAN

Who: As a whole, the Plan will be useful to any entity seeking to improve water quality in the Menomonee River Watershed: water resource managers, county conservationists, municipalities, non-profit organizations, environmental consultants, and other public and private sector actors. In addition, this plan should serve as a starting point for permitted point sources in the watershed that are working to comply with TMDL driven waste load reductions.

When: Watershed restoration efforts, especially those that focus on nonpoint source pollution reduction, are part of a long-term adaptive process that may span decades to achieve measurable improvements in water quality and aquatic habitat. As such, this iteration of The Plan will influence watershed restoration in the Menomonee River Watershed over the next ten years but should be considered a living document that will be adapted and amended over time as watershed land use and water quality conditions change.

How: First and foremost, the Plan should be used as a guide for governmental and non-governmental entities to select water quality, stormwater, flood control and aquatic habitat related projects in the Menomonee Watershed. For example, the priorities and practices presented in the Plan are built on past watershed restoration planning and implementation efforts as well as the Milwaukee River Basin Total Maximum Daily Load (TMDL) Plans for the Menomonee River Watershed.

Secondly, as the Plan is updated, it can be used as a reference and management tool for watershed restoration projects by providing a process for feedback and evaluation from project implementers. Lastly, as a US EPA approved Nine Key Element plan, it should be used as a mechanism to leverage federal 319 and other funding to help implement watershed restoration projects.

Since the focus of a Nine Key Element plan is on reducing non-point sources of pollution, the approach can facilitate holistic watershed planning and implementation that goes beyond point-source discharge permit driven reductions in the watershed. This focus implicitly and explicitly encourages collaboration among a broad range of watershed stakeholders, including property owners, farmers, permitted point sources, and NGOs, among others. This not only raises awareness of all of the sources of pollutants in a watershed, but can also result in new collaborative strategies for reducing pollutant loads to improve water quality. For example, water quality trading can bring point sources and non-point sources together in mutually beneficial partnerships that may achieve phosphorus and sediment pollutant reductions at lower costs than alternative methods. Water quality trading explicitly recognizes and credits watershed habitat improvements, so its benefits can extend beyond a focus on specific pollutants.

Another benefit of nine key element planning is the recognition that watershed improvement, especially in regard to pollutant reductions from non-point sources, is a long-term adaptive process that may span decades. Where investments in point source "end-of-pipe" technology may achieve relatively rapid progress, this progress often comes at a high economic cost. By utilizing a nine key element framework, nonpoint pollution sources in the Menomonee River Watershed can be reduced throughout the geographical expanse of the watershed before entering a stormwater system or the river, and at a much lower cost. In addition, once point source discharge permit reductions to meet a TMDL have been reached, remaining progress in a watershed will only be achieved by non-point source reductions. Finally, the nine key element plan framework establishes a set of standards to evaluate and conduct watershed planning, over time, using measurable milestones, to provide planners clear criteria to evaluate if plan implementation will meet or not meet watershed goals.

The Plan will:

- Provide an in-depth description of the Menomonee River Watershed;
- Explain the history leading up to The Plan and the need for a Nine Key Element Approach;

- Establish the Water Quality/TMDL, Flood Management, Aquatic Habitat/Fish Passage, and Recreational goals of the watershed and the metrics used to evaluate how and when they are met;
- List the priority projects identified to achieve the aforementioned goals;
- Recommend the implementation process for future watershed restoration in the Menomonee River Watershed; and
- Provide a detailed tracking and data housing process for determining the success of watershed restoration over time.

OVERVIEW OF THE WATERSHED

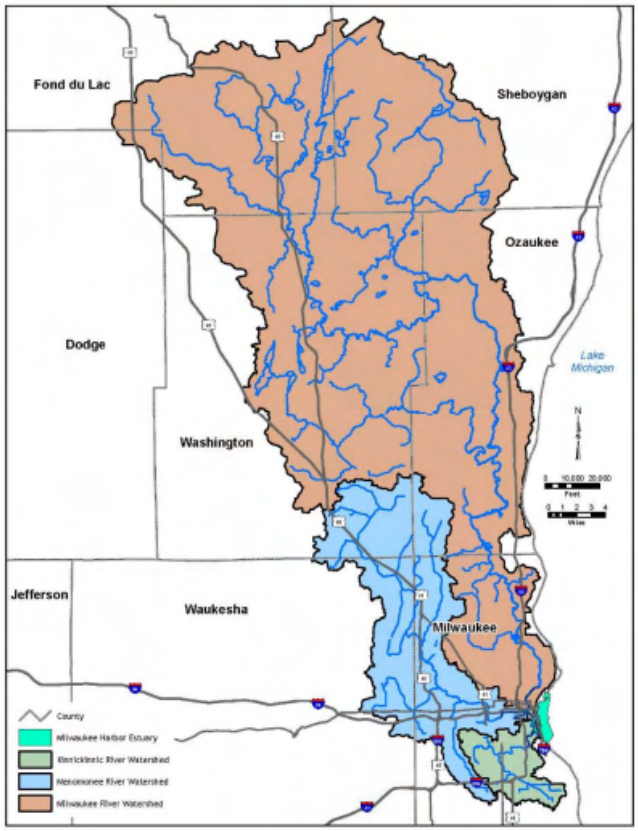


FIGURE 2. MILWAUKEE RIVER BASIN AND SUBBASINS

The Menomonee River Watershed lies within the larger Milwaukee River Basin, a 900-square mile basin comprised of six watersheds that drain directly to Lake Michigan (Figure 2). The Watershed drains approximately 136 square miles, and contains 96 miles of streams, no major lakes, and 4,537 acres of wetlands. The Menomonee River has 13 tributaries and is itself a tributary to the Milwaukee River, which drains directly into Lake Michigan (Table 1). The watershed contains seven major sub-basins and consists of the following five HUC 12 sized watersheds: 040400030401, 040400030402, 040400030403, 040400030404, 040400030405 (Figure 3).

The river originates in the Village of Germantown and the City of Mequon and flows in a southeasterly direction for about 32 miles before it meets the Milwaukee and Kinnickinnic Rivers in the Milwaukee Harbor Estuary. The Menomonee River Watershed is very densely populated (2367 persons per square mile) when compared to the State of Wisconsin as a whole (99 persons per square mile). The Menomonee River Watershed includes portions of Waukesha, Washington, Ozaukee and Milwaukee counties (Figure 2), and includes land from nine cities, six villages, and four towns (Table 2). The multiplicity of civil boundaries may make project implementation and credit allocation more challenging.

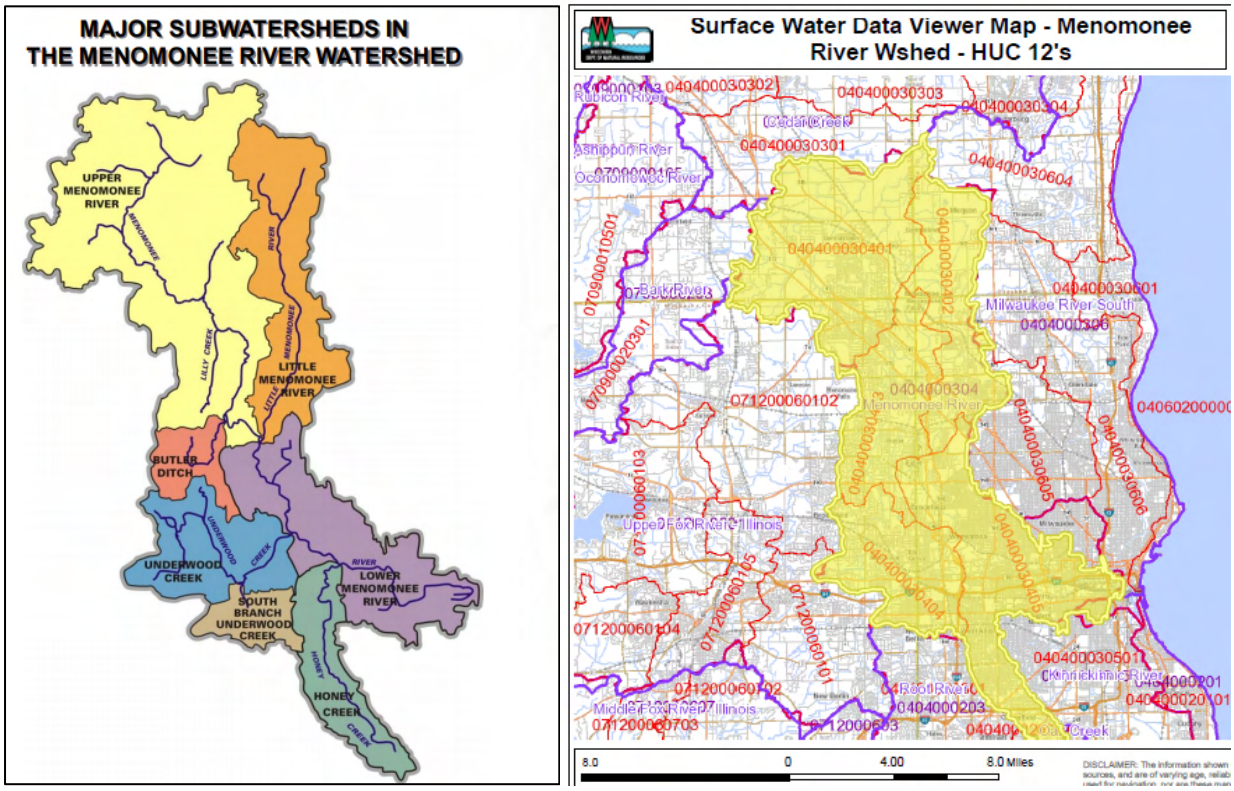


FIGURE 3. MENOMONEE WATERSHED MAJOR SUB-BASINS AND HUC 12 WATERSHED BOUNDARIES

The Menomonee Watershed is heavily urbanized, with 63.8% of its land mass fully developed and 35.2% in rural uses. From 1970 to 2000, agriculture and related land uses declined by 43%, but agriculture comprises approximately 17.2% of the watershed (SEWRPC 2007b). Many remaining agricultural areas in the watershed have been converted to development in the last few decades, especially in the northern part of the watershed (i.e., 040400030401 and 040400030402 HUC 12 watersheds). A recent land use analysis was completed by WDNR in 2020-21 to assist in the development of this plan. The WDNR analysis found that 42% - 4,110 of the remaining 9,815 agricultural acres in the watershed are expected to convert to other uses in the next ten years (see Appendix K). The Menomonee River Watershed is predicted to continue having increased population growth in both Ozaukee and Washington Counties. Estimates from SEWRPC's Regional Water Quality Management Plan Update are as high as 30% increase by 2050 (SEWRPC 2007b). This population increase and resulting agricultural/wetland/open land use conversion to urban uses (with more impervious surfaces) is expected to negatively impact the water resources in the Menomonee River Watershed over the next 20-30 years.

Of the "urban" land use, 16.8% of land is dedicated to transportation and utilities 29.8% for residential use, and 9% for commercial and industrial uses. Of the "rural" land use, 7.8% of land is wetlands, 2% is woodlands, and only 8% of its rural land is left undeveloped as open space (SEWRPC 2007b).

The watershed hydrology is very flashy due to urban development, with major changes in water flow and water levels due to rainfall events, which causes or contributes to both water quality and water quantity problems. Approximately 90% of the watershed population receives sanitary sewer service, with the Milwaukee Metropolitan Sewerage District (MMSD) providing service for most of that area, and the rest of the population on septic systems. Only 8% of the watershed is connected to the combined sewer system, where stormwater and wastewater run through the same sewer lines to be treated by MMSD. This is an important distinction for determining projects and strategies to reach water quality improvements in the Plan. The remaining 92% of the watershed discharges stormwater directly into the Menomonee River and its tributaries, untreated (See Milwaukee River Basin TMDL for more information on point and nonpoint source pollutant loading).

TABLE 1. THE MENOMONEE RIVER AND MAIN TRIBUTARIES.

Name	Length in Miles
Menomonee River	32.00
Little Menomonee River	9.94
West Branch Menomonee	2.45
Underwood Creek	8.60
Honey Creek	8.96
Lilly Creek	4.70
Nor-X-Way	4.90
Little Menomonee Creek	3.90
Dretzka Creek	3.30
Goldenthal Creek	3.50
Dousman Ditch	2.50
Willow Creek	2.80
Noyes Park Creek	3.54
South Branch Underwood Creek	1.48
Butler Creek/Ditch	2.85
South Menomonee Canal	0.40
Burnham Canal	1.20
Wood Creek	0.50
Grantosa Creek	1.02

Source: WDNR Surface water viewer stream list (MI03) and WDNR State of the Milwaukee River Basin Report 2001

TABLE 2. CIVIL DIVISIONS IN THE MENOMONEE RIVER WATERSHED.

Civil Division	Square Miles
Milwaukee County	
City of Greenfield	2.90
City of Milwaukee	31.60
City of Wauwatosa	13.23
City of West Allis	6.77
Village of Greendale	0.12
Village of West Milwaukee	0.64

Civil Division	Square Miles
Ozaukee County	
City of Mequon	11.69
Washington County	
City of Milwaukee	0.02
Town of Germantown	0.76
Town of Richfield	1.55
Village of Germantown	29.37
Waukesha County	
City of Brookfield	13.54
City of New Berlin	0.67
City of Milwaukee	0.08
Town of Brookfield	0.21
Town of Lisbon	0.29
Village of Butler	0.79
Village of Elm Grove	3.29
Village of Menomonee Falls	18.54
Total	136.6

Source: SEWRPC 2007A

Approximately 8% of the streams within the Menomonee River system are concrete lined or enclosed, with the rest of stream miles experiencing various levels of erosion (SEWRPC 2010). Concrete lined streams, such as Honey Creek and Underwood Creek, provide very little habitat, are very flashy with erosive flows, and tend to have warmer water due to lack of groundwater infiltration. Within the last 40 years, many of unpaved and less disturbed sections of the Menomonee have experienced up to four to five feet of down cutting, or loss of streambank, and this disconnects the stream from many floodplain and wetland habitats that would be otherwise available for migrating fish and other aquatic organisms in the watershed.

Long range planning conducted jointly by MMSD and the Southeastern Wisconsin Regional Planning Commission (SEWRPC) in 2007 determined that nonpoint source pollution loading represents the most significant threat posed to Southeastern Wisconsin's regional water resources. For example, the Regional Water Quality Management Plan (more information below) estimates that 78% of phosphorus (TP), 98% of Total Suspended Solids (TSS), and 69% of bacteria (FC) in the greater Milwaukee watersheds comes from non-point sources (using 2000 land use simulation). Just recently, these sources and amounts of pollutant loading was confirmed in the development and approval of the Milwaukee Basin Total Maximum Daily Load report in March 2018 (https://dnr.wisconsin.gov/topic/TMDLs/Milwaukee/index.html). Specifically, the Milwaukee Basin TMDL identifies stormwater runoff and the suspended solids, bacteria, phosphorus and other pollutants that it carries to waterways, need to be addressed in a comprehensive manner and in a way that results in the widespread application of practices along the full continuum of land uses in the watershed. The Menomonee River basin has a combined MS4 discharge permit that regulates many of the municipalities listed in Table 2 to reduce stormwater runoff and pollutants

from entering stormwater drainage systems that discharge to the Menomonee River or its tributaries (see pages 16-17 and 43-45 for MS4 permit requirements). The TMDL contains waste-load allocations for MS4 permittees in the watershed. Additionally, while the frequency of combined sewer overflows has been drastically reduced over the past twenty years, increased attention is being placed on the role that stormwater plays in triggering dramatic inflow and infiltration (I&I) into combined and separate sewer systems. In Southeastern Wisconsin, I&I often results in basement backups, localized sewer bypasses, sewer overflows, and property damage.

Previous and Ongoing Planning Efforts in the Watershed

Many years of research and planning efforts were conducted for the Menomonee River Watershed prior to the creation of this plan. Most recently, the Total Maximum Daily Load Report for the Milwaukee River Basin, including the Menomonee River Watershed, was submitted to US EPA in Fall 2017 and approved in Summer 2018. This plan builds on previous watershed-based efforts prior to the TMDL; references or includes TMDL findings, as well as green infrastructure, fish passage, and flood management projects and plans. Collectively, this plan provides a roadmap moving forward to identify and implement cohesive and effective solutions to restore the watershed from further degradation. The planning efforts listed below have all been incorporated into the development of this plan. A full list of referenced plans is available in Appendix A.

Regional Water Quality Management Plan (2007) and Update (2013)

The Regional Water Quality Management Plan Update (RWQMPU), or Planning Report 50, was developed by SEWRPC in cooperation with the Wisconsin Department of Natural Resources (WDNR) and US Geological Survey (USGS) in 2007 and updated in 2013. There is a companion Technical Report (TR-39), which includes in-depth data analysis and modelling of decades of water quality data. The RWQMPU covers the geographic area of the Greater Milwaukee Watersheds, which includes the Milwaukee, Menomonee, Oak Creek, Root, and Menomonee Rivers and spans the years 2007-2020. It was developed in conjunction with MMSD's 2020 Facilities Planning Report to represent a larger scale integrated water quality management plan. Together, the plans are called the Water Quality Initiative (WQI). The purpose of the WQI was to develop a framework for the management of surface water for the greater Milwaukee watersheds incorporating measures to abate existing pollution problems (bacteria, total suspended solids, and nutrients) and elements intended to prevent future pollution problems in the most cost-effective manner.

Part 1-Chapters 1-12 Part 2-Appendices

Supplement to Part 2-Appendices C-F and 2013 Update

https://www.mmsd.com/government-business/2020-water-quality-initiative/2020-facilities-plan-reports

Menomonee River Watershed Restoration Plan (2010)

The Watershed Restoration Plan (WRP) for the Menomonee River Watershed was developed by MMSD, in collaboration with SWWT, with the goal of implementing the recommendations of the WQI in the Menomonee River Watershed in an adaptive and phased approach. It is a second-level planning effort that builds upon the sound science, data and alternatives analysis presented in the WQI, and included more recent data (through 2008). After several public reviews and comments, the WRP established habitat restoration and aesthetics as the primary goals of the plan along with bacteria/human health and phosphorus/nutrients goals that were set out in the RWQMPU and 2020 Facilities plans.

Part 1 Part 2 Part 3 Part 4

Stream Habitat Conditions and Biological Assessment of the Menomonee and Menomonee Rivers (MR-194) (2010)

The Stream Habitat Conditions and Biological Assessment of the Kinnickinnic and Menomonee Rivers (MR-194) was published by SEWRPC in 2010. It addresses and expands on the habitat-related content in the RWQMPU/PR-50 plan and includes fishery, macroinvertebrate and habitat data gathered since completion of that plan up to 2009. This report also provides recommendations for the integration of wildlife and habitat-related projects into the more water quality focused WRPs and corresponding Implementation Plans.

MR-194

Menomonee River Implementation Plan (2010)

Both the Watershed Restoration Plan and Stream Habitat Conditions plans identified SWWT as the organizational vehicle for plan implementation. As such, SWWT's Water Action Team took on the responsibility of developing and implementing on-the-ground projects to meet the water quality and habitat goals of the RWQMP and WRP by creating the Menomonee River Implementation Plan. This plan identified foundation and priority actions to implement in the Menomonee River Watershed from the years 2011-2016 based on the modeling conducted in the WRP and RWQMP. The 2010 Implementation Plan, however, has run its course and the Plan will serve as its update. Part 3 of this Plan discusses what actions have been taken already, and incorporates non-implemented items for future action, if appropriate. Several projects are no longer possible due to current conditions, politics, or fiscal realities.

Implementation Plan

MMSD Regional Green Infrastructure Plan (2013)

The Regional Green Infrastructure Plan (2013) presents information by watershed necessary to achieve the goal of capturing 740 million gallons of stormwater runoff in the MMSD service area (see detailed discussion in the GI section below).

https://www.freshcoast740.com/resources/our-plans

Milwaukee Basin Total Maximum Daily Load (2018)

The Milwaukee Basin Total Maximum Daily Load (MRB TMDL) is a calculation of the allowable pollutant loadings to meet water quality standards in the Menomonee, Kinnickinnic, and Milwaukee River Watersheds, as well as the Milwaukee Harbor Estuary. TMDLs are required by the Clean Water Act when water bodies are not meeting numeric or narrative water quality standards and are established by WDNR and the USEPA. This TMDL sets phosphorus, sediment, and bacteria pollutant load allocations for point and nonpoint sources within the TMDL watershed. The Milwaukee River Basin TMDL identifies urban and stormwater runoff as the leading cause of phosphorus, sediment and Fecal Coliform bacteria pollutants in the Menomonee watershed, followed by agriculture.

Milwaukee River Basin TMDL DNR webpage

Plan Consolidation

As with most complex watershed-based problems and planning efforts, variations of nomenclature and planning boundaries have occurred in Menomonee and other watersheds during decades of restoration work. To provide a consistent nomenclature that also aligns with regulatory permits throughout the watershed and Greater Milwaukee region, the nomenclature presented in the Milwaukee River Basin TMDL will be used in this plan for the Menomonee River Watershed and future planning efforts. If the region hopes to collaboratively address watershed improvements as a whole, agreed upon boundaries are essential.

The restoration efforts put forth prior to development of the Milwaukee Basin TMDL, however, must be addressed and incorporated into future efforts to best achieve watershed goals. The Menomonee River Updated Implementation Plan is, in part, a summary of past efforts and the varied nomenclatures are referenced throughout. Each variation in the body of the Plan is called out and crossed referenced in Appendix B.

Where is the Watershed Today?

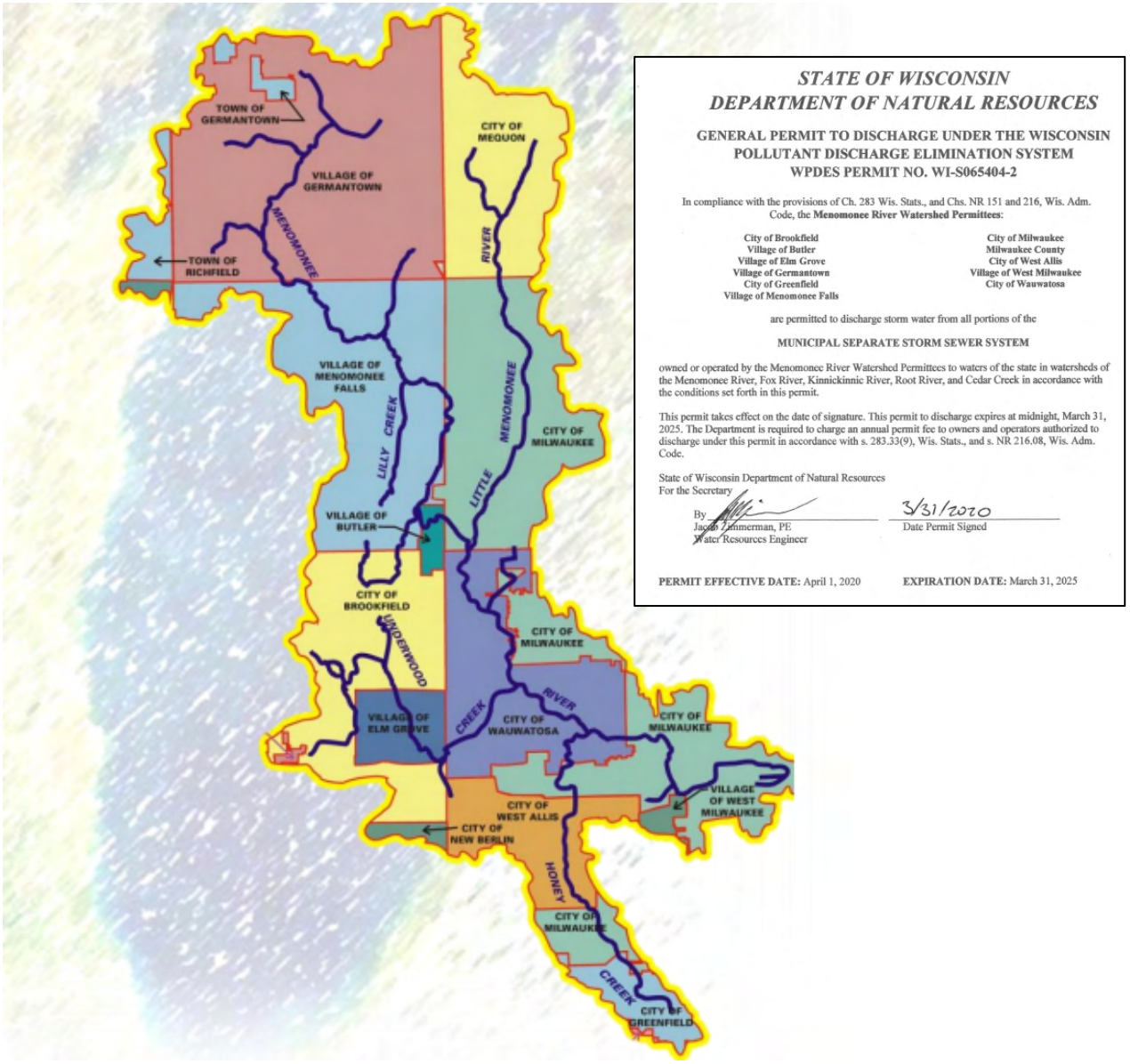
Since the creation of the Watershed Restoration Plan for the Menomonee River Watershed in 2010, several of the priority restoration actions have been completed and additional restoration goals identified. Despite these successes, the watershed is not yet meeting the goals and timelines set in the Watershed Restoration Plan and Implementation Plan. A reexamination of watershed restoration planning is needed. In addition, this Plan also better addresses the TMDL findings for the watershed.

Major restoration successes in the Menomonee River Watershed in the last ten years (2010-2020) include:

- the removal of 4 low flow fish passage barriers, and construction of a rock ramp over one additional barrier in Hoyt Park;
- a survey of fish passage obstructions in the Menomonee River Watershed was completed, as well as removal of dozens of woody debris barriers for better fish passage;
- the removal of 3,700 linear feet of concrete channel from the lower Menomonee River by MMSD and incorporation of more riffle/run and pool habitat;
- the removal of 4,400 linear feet of concrete and re-meandering and naturalizing of Underwood Creek downstream from Mayfair Road;
- the identification of numerous illicit discharges of bacteria from 2008-2016 along the lower Menomonee River and tributaries by Milwaukee Riverkeeper and Dr. McLellan at the University of Wisconsin-Milwaukee School of Freshwater Sciences, and the repair or elimination of approximately 12 illicit discharge sources;
- widespread water quality monitoring at approximately 63 locations in the watershed by MMSD, Milwaukee Riverkeeper, WDNR, Ozaukee County and other partners;
- repair of eroding streambanks and targeted tree planting in several locations (e.g., Rotary Park in Menomonee Falls, Frontier Park in Butler, Hart Park, Menomonee River Parkway, Lilly Creek Industrial Park);
- creation of 22 stormwater treatment bioswales along the lower Menomonee River Parkway (35,907.6 square feet) as part of a collaborative group project by watershed municipalities;
- enhancement and restoration of a wetland for stormwater treatment (93,785.8 square feet) in Elm Grove; and
- installation of dozens of additional green infrastructure practices in many Menomonee municipalities.

In addition, the Menomonee River Watershed-Based Stormwater Permit was created by the WDNR in 2012, which was the first watershed-based group stormwater permit in the US. This permit applies to all MS4 permittees in the watershed (see Figure 4), and focuses on reducing watershed-specific pollutants of concern, such as bacteria, TSS, and phosphorus identified in the MRB TMDL, from entering a municipalities stormwater drainage system. This watershed-based stormwater permit is helping to facilitate collaboration between municipalities in watershed education efforts as well as restoration efforts such as green infrastructure and streambank stabilization projects. In April of 2020, the second iteration of this watershed-based stormwater permit was issued by the WDNR and incorporated the Milwaukee Basin TMDL load reductions and enhanced requirements relating to municipal stormwater ordinances, updates - to facilitate green infrastructure - as well as increased bacteria reduction efforts through monitoring and illicit discharge detection and elimination programs. Within Figure 4, 100% of each municipality area shown is subject to MS4 permit requirements, except for the City of Mequon and Village and

Town of Germantown, which have only some of area subject to MS4 permit because of remaining agricultural and non-urban land uses.



STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

GENERAL PERMIT TO DISCHARGE UNDER THE WISCONSIN POLLUTANT DISCHARGE ELIMINATION SYSTEM
WPDES PERMIT NO. WI-S065404-2

In compliance with the provisions of Ch. 283 Wis. Stats., and Chs. NR 151 and 216, Wis. Adm. Code, the **Menomonee River Watershed Permittees**:

City of Brookfield
Village of Butler
Village of Elm Grove
Village of Germantown
City of Greenfield
Village of Menomonee Falls
City of Milwaukee
Milwaukee County
City of West Allis
Village of West Milwaukee
City of Wauwatosa

are permitted to discharge storm water from all portions of the

MUNICIPAL SEPARATE STORM SEWER SYSTEM

owned or operated by the Menomonee River Watershed Permittees to waters of the state in watersheds of the Menomonee River, Fox River, Kinnickinnic River, Root River, and Cedar Creek in accordance with the conditions set forth in this permit.

This permit takes effect on the date of signature. This permit to discharge expires at midnight, March 31, 2025. The Department is required to charge an annual permit fee to owners and operators authorized to discharge under this permit in accordance with s. 283.33(9), Wis. Stats., and s. NR 216.08, Wis. Adm. Code.

State of Wisconsin Department of Natural Resources
For the Secretary

By
Jacob Zimmerman, PE
Water Resources Engineer

3/31/2020
Date Permit Signed

PERMIT EFFECTIVE DATE: April 1, 2020 **EXPIRATION DATE:** March 31, 2025

FIGURE 4. MENOMONEE RIVER MUNICIPALITIES AND MENOMONEE RIVER WATERSHED MS4 PERMIT

The Milwaukee Estuary Area of Concern

In 1987, the Milwaukee Estuary was designated an Area of Concern (AOC) by the International Joint Commission because of historical modifications and pollutant loads that contributed toxic contaminants to the AOC and Lake Michigan. Sediments contaminated with PCBs, PAHs and heavy metals contribute to nearly all of the eleven beneficial use impairments (BUIs) within the original boundaries of the AOC. The original boundaries of the AOC included the lower 4 km of

the Kinnickinnic River downstream of Chase Avenue; the Milwaukee River downstream from North Avenue, and the Menomonee River downstream from 25th Street; the inner and outer harbors; and nearshore waters of Lake Michigan.

In 2008, the boundaries of the AOC were expanded for the purposes of addressing sites that contributed significant loads of contaminated sediments to the estuary. These expanded portions of the AOC are associated with the beneficial use impairments that are directly connected to contaminated sediment. For the Menomonee River Watershed, the AOC boundaries were expanded to include the Little Menomonee River downstream from Brown Deer Road (a federal Superfund site known as Moss American/Kerr McGee/Tronox), which was largely contaminated with PAHs, Fuel Oil, and other contaminants from a former railroad creosote/wood treatment operation, as well as the Menomonee River main stem from the Little Menomonee River to the confluence with the Milwaukee River. Remediation of that site is largely complete with ongoing monitoring requirements.

The DNR worked with community stakeholders to develop an original Remedial Action Plan in 1991, with major updates in 1994 and 1999, and Remedial Action Plan Updates annually. Since that time, much work has been completed and significant progress made towards improving conditions in the AOC. There are several contaminated dredging projects underway and in planning in the Burnham Canal (the Miller Compressing Alternative Superfund Site) and lower Menomonee River (downstream from 25th Street), as well as several restoration projects planned for these same areas to address the fish and wildlife habitat BUI. In addition, there are several habitat projects proposed to address the fish and wildlife populations BUI within the watershed, mostly consisting of restoration work in Milwaukee County Park properties adjacent to the Menomonee River.

More information is available here: http://dnr.wi.gov/topic/greatlakes/milwaukee.html

Despite considerable progress made, there is considerable work remaining to overcome the remaining stream impairments and restore designated uses in the watershed. As of 2020, the majority of river miles in the Menomonee are not meeting water quality standards, pathogen levels above criteria, flooding events and stream flashiness continue to cause property damage and erosion that threatens bridges and other infrastructure, and waters are not safe enough for recreational uses such as swimming, wading, or fishing in most locations.

Major barriers to watershed restoration in the Menomonee River Watershed:

1. Capacity:
   There is significant planning and implementation capacity in the region, exemplified by the efforts of MMSD, SEWRPC, Milwaukee Riverkeeper, SWWT, and others. However, current and prior watershed restoration efforts have been either too broad or too narrowly focused, and have not leveraged the full benefits of a Nine Key Element approach (see 9 Key Elements overview below). Given adequate resources, a lead organization, such as

SWWT, can develop watershed plans at appropriate scales, coordinate implementation with other watershed residents and stakeholders, assist with monitoring, and adapt planning efforts as needed to ensure positive water quality improvements in the face of climate change, environmental justice and other challenges.

2. Funding:
   Budget cuts and new budgetary controls at the state and local levels have drastically affected available funding for municipalities and counties to apply for and use to implement watershed restoration projects. Funding for Nine Key Element plans in turn can increase eligibility for a broader range of funding, including funding for TMDL implementation.
3. Cohesive Approach:
   A cohesive approach is needed for project implementation that includes all sources of water quality impairments, multiple facets of watershed restoration, and community benefits including public access, recreation, and education and outreach.
4. Timing:
   Future flood management efforts or upstream development can conversely alter the flow of streams and could affect current best management practices, streambank stabilization projects, access projects, etc. in the watershed. An updated Plan can anticipate and incorporate multiple planning initiatives and timelines to help achieve maximum long-term effectiveness.
5. Flashiness of Streams:
   Flashiness of the system and frequency of big storms or "channel forming" flows impede the design and implementation of projects; project success is limited by increased flows from upstream concrete channelized streams and/or stormwater inputs. As noted above, the Plan is a comprehensive tool that both anticipates and adapts, and helps to mitigate but not eliminate uncertainty.

SWWT and other stakeholders in the watershed recognize that restoration efforts that occur in relative isolation may waste valuable resources and are not as successful as collaborative, thoughtful planning efforts. Therefore, this Plan identifies a comprehensive approach to move past these barriers and create a more comprehensive and cohesive approach to all major facets of watershed restoration: water quality, quantity, habitat, policy, and recreational opportunities.

Overview of Nine Key Elements

The 1987 amendments to the Clean Water Act (CWA) established the US EPA's Section 319 Nonpoint Source Management Program. Under Section 319, states, territories and tribes receive grant money that supports a wide variety of activities including technical assistance, financial assistance, education, training, technology transfer, demonstration projects and monitoring to assess the success of specific nonpoint source implementation projects. Eligibility for Section 319 funding, and increasingly, other sources of funding, depends on providing "reasonable assurance" for plan implementation and focusing on management measures in critical areas to achieve

pollutant reduction and other plan goals. Generally, this assurance is demonstrated through achieving EPA approval for a nine key element watershed plan.

The Nine Key Element designation comes from EPA guidance that has identified nine key elements that are critical for achieving improvements in water quality. Nine Key Element plans are designed to address documented nonpoint source-related water quality problems and to help prevent future nonpoint source water quality-related problems.

Additionally, EPA guidelines outline that existing plans can be amended by incorporating new or adjusted information and other key elements not contained in the original plan. If separate documents support the plan and the nine elements but are too lengthy to be included in the watershed plan, they can be summarized or referenced in the appropriate sections of the plan. The EPA supports this overall approach—building on prior efforts and incorporating related information—as an efficient, effective response to the need for comprehensive watershed plans that address impaired and threatened waters. Due to the large amount of prior watershed planning and implementation efforts already in progress in the Menomonee watershed, SWWT and their associated partners have opted for this recommendation.

PART 2. WATER RESTORATION GOALS

WATER QUALITY IN THE MENOMONEE RIVER WATERSHED

The Menomonee River Watershed has a long history of watershed restoration and flood management efforts, and water quality monitoring and modeling work. The water quality section of the Plan will utilize these efforts to establish a water quality baseline, identify causes and sources of impairments, and finally to determine water quality goals and measures of progress in the Menomonee River Watershed over the next ten years.

CURRENT CONDITIONS AND CRITICAL SOURCE AREAS

Currently, of the 96 stream miles in the Menomonee River system, 71 miles are listed as impaired for some pollutant, and only approximately 25 miles are meeting their designated uses. Major impairments include: recreational use restrictions, habitat degradation, low dissolved oxygen, fecal coliform, total phosphorus, chloride, and polychlorinated biphenyls (PCBs) and chronic aquatic toxicity (Table 5 and Figure 11).

In 2018, a TMDL was approved by the USEPA for the Menomonee River, Kinnickinnic River and Milwaukee River watersheds, as well as for the Milwaukee Harbor Estuary for Total Phosphorus (TP), Fecal Coliform (FC) and Total Suspended Solids (TSS): https://dnr.wisconsin.gov/topic/TMDLs/Milwaukee/index.html. The Milwaukee River Basin TMDL (MRB TMDL) specifies pollutant allocations for each section, or reach, of the watersheds that are needed to obtain water quality standards set by the US EPA and WDNR (This TMDL information is shown in Figure 12 and Tables 6, 7 and 8 within the Water Quality Goals and Metrics section of this plan).

The Milwaukee River Basin TMDL identifies urban and stormwater runoff as the leading cause of TP, TSS, and FC pollutants, followed by agriculture. In addition, several related indicators of poor water quality in the Menomonee River include: lack of riparian habitat, increasing frequency of flood events, lack of widespread policy supporting water quality improvement efforts, and a growing disconnect between community members and their water resources. These indirect causes are discussed in the following sections. Water Quality improvement projects identified in the Updated Implementation Plan for the Menomonee River Watershed will target the TMDL identified pollutants and help prepare for the anticipated chloride impairments in the area.

Although investments made at the municipal and regional level have reduced combined sewer system overflows and other causes of poor water quality, other stressors continue to degrade water quality in the Menomonee River Watershed. Impervious pavement in the Menomonee River Watershed is a large contributor to runoff and resulting pollutant loading of TSS and TP. The large expanses of dense impervious surfaces in the watershed transmit high volumes of untreated and pollutant heavy stormwater to runoff into waterways through the area's storm sewers during rainfall or snowmelt events. In 2012, MMSD estimated that 28.7 square miles, or approximately

21% of the almost 132 square mile watershed are covered with impervious surfaces such as roofs and pavement.

In 2013, SWWT conducted an additional analysis of the watershed to identify critical "priority hot spots" of pollutant loading from industrial and commercial lots to target for green infrastructure (GI) implementation (Figure 5). For this plan, green infrastructure helps to filter and absorb stormwater where it falls, using plant or soil systems, permeable pavement or other permeable

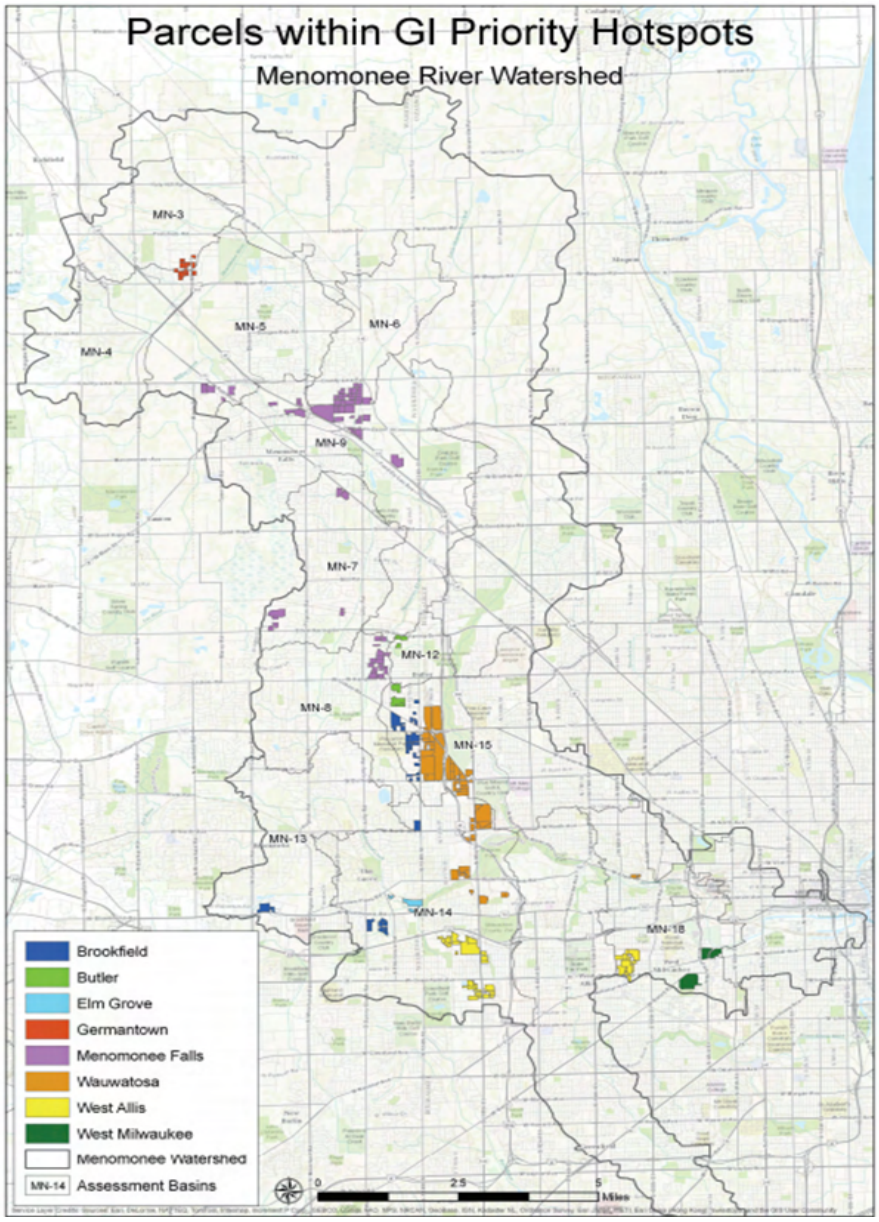


FIGURE 5. GREEN INFRASTRUCTURE HOTSPOTS IN THE MENOMONEE RIVER WATERSHED WITH COMMERCIAL AND INDUSTRIAL LAND USES.

SOURCE: SWWT ANALYSIS 2013 (APPENDIX C).

See Appendix B for cross-reference of reach nomenclature. Source: SWWT analysis 2013

surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspirate stormwater and reduce flows to sewer systems or to surface waters. The GI priority hotspots were determined by the matching up areas with high densities of impervious pavement and industrial or commercial land uses, which SEWRPC predicted to cause the highest runoff of target pollutants. The full study, which identified parcels, property owners, and cost estimates of green infrastructure projects, is provided in Appendix C. Stormwater and urban runoff is closely tied with the amount of impervious surface in a watershed as well as the infiltration rates of a watershed's landscape. The GI priority hotspots analysis reflect critical areas identification requirements within EPA's Nine Key Elements and correspond with some areas in the Menomonee watershed (described below) that do not meet Wisconsin's total phosphorus water quality criteria.

Total Phosphorus Sources

According to Technical Planning Report-39 (TR-39) and the Milwaukee River Basin TMDL, the annual average load of TP to streams of the Menomonee River Watershed is estimated to be 53,120 pounds per year. Combined sewer overflows and sanitary sewer overflows contribute about 3.5 percent and 1.1 percent, respectively, of this load. Industrial discharges contribute about 33 percent of this load. The rest of TP loadings to streams in the watershed, about 62.4 percent, is contributed by runoff, with 54.7 percent of this amount from urban municipal sources and 7.7 percent from rural sources. From 1998-2004, the mean concentration of phosphorus was 0.116 mg/L, which exceeds the state stream standard of 0.075 mg/L and the large river standard of 0.1 mg//L (which applies downstream of 25th Street) in the Menomonee watershed (Figure 6). While phosphorus concentrations have decreased in the Menomonee over the last few decades (per TR-39); water quality monitoring data from 2016-19 from Milwaukee Riverkeeper and other entities show that the majority of monitored sites are not meeting Wisconsin's] phosphorus stream (0.075 mg/L) or river (0.100 mg/L) criteria, and remain impaired for TP (Figure 6). Figure 5 also reveals some additional critical areas in the watershed for prioritizing adoption of TP and TSS reduction practices to reduce primarily urban, but also some agricultural pollutant sources in the watershed.

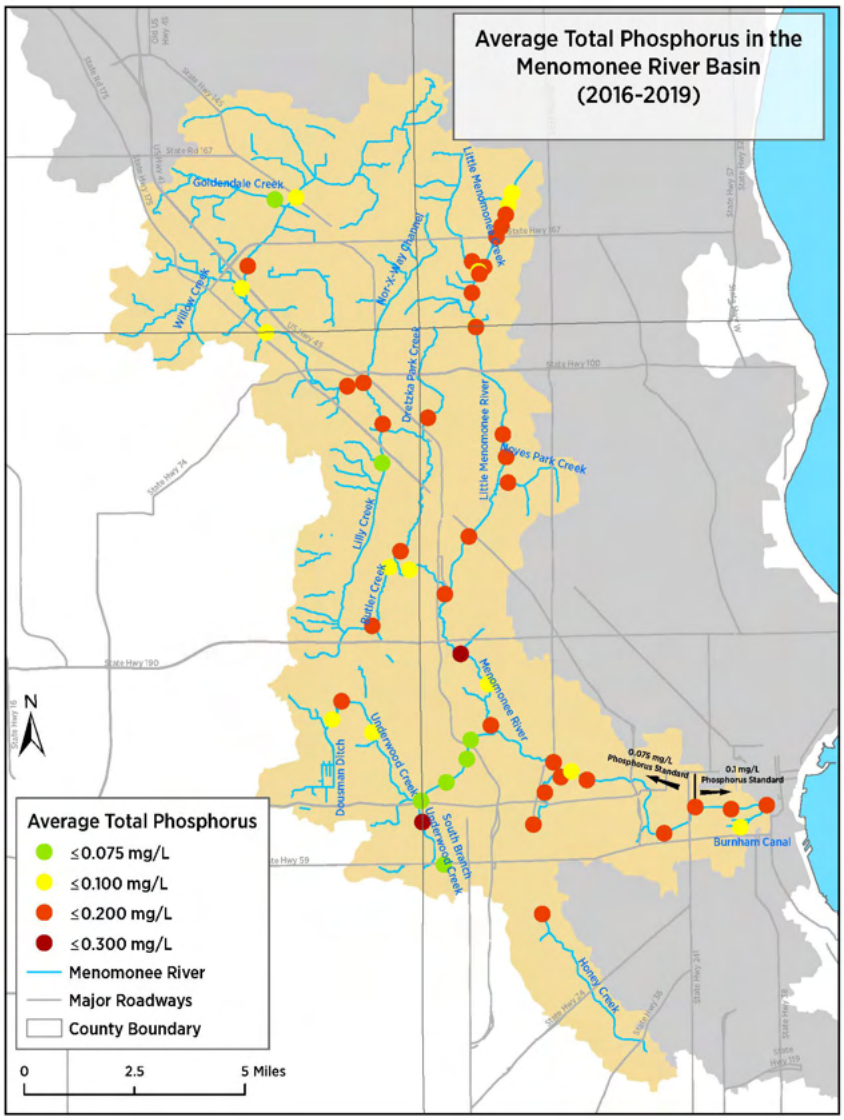


FIGURE 6. AVERAGE TOTAL PHOSPHORUS FOR MONITORING SITES FROM 2016-2019 USING MILWAUKEE RIVERKEEPER, MMSD, AND WDNR DATA.

SOURCE: MILWAUKEE RIVERKEEPER

Bacteria Sources

The TR-39 and the MRB TMDL estimate that average load of bacteria to streams of the Menomonee River Watershed is 16,900 trillion cells per year. Combined sewer overflows and separate sewer overflows contribute about 10.2 percent and 3.8 percent, respectively, of this load. The rest of bacteria loading to streams in the watershed, about 86.0 percent, is contributed by stormwater runoff, with 83.7% of that runoff coming from urban sources such as runoff from paved areas as well as illicit discharges from storm sewers. Per the MRB TMDL, median concentrations of fecal coliform bacteria in the Menomonee River have ranged from about 2,000 to 20,000 cells per 100 mL, far exceeding the recreation use standard of 200 cells per 100 ml. Similarly, *E. coli* is

monitored at 4 locations in the Menomonee River starting in 2000, and the counts have ranged from undetectable to over 160,000 cells per 100 ml (the recreational use standard for beaches is 235 cells/100 ml).

Heavy bacteria loadings to streams has resulted in large portions of the Menomonee River Watershed listed as impaired for recreational use. Typically, fecal coliform or *E. coli* concentration is used as an indicator of bacteria or fecal loading in area waterways-fecal coliform is the standard for recreational use of streams and *E. coli* is the standard for recreational use of Great Lakes beaches. Wisconsin will likely be updating the recreational use standard for all state waters to *E. coli* in 2020. The MRB TMDL is based on load reductions required to meet the fecal coliform standard for streams, but reductions were also modeled to help achieve the *E. coli* standard for downstream beaches, and will be helpful in better understanding compliance with the new State standards when they are approved. It's also important to note that fecal coliform and *E. coli* are imperfect indicators because these bacteria can be found in excrement of many warm bodied animals, in addition to humans, so presence of bacteria may not always indicate a risk to human health.

In order to better target the human health risk of bacteria in the Menomonee watershed that is causing the recreational use impairment, there is a need to better identify and localize bacteria sources from human waste, which poses a significantly higher risk to human health than other forms of bacteria. Milwaukee Riverkeeper in conjunction with Dr. Sandra McLellan's lab at the University of Wisconsin-Milwaukee School of Freshwater Sciences conducted stormwater outfall testing in the Menomonee River watershed from 2008-2016 to locate human sources of bacteria in the waterways. This work was concentrated on a 10.5-mile section of the lower Menomonee River, as well as portions of Underwood and Honey Creeks discharging into this section of river. This area was selected because during SEWRPC's development of their RWQMPU for the Menomonee River, water quality models would not calibrate for this section of the lower Menomonee River due to higher than expected levels of in-stream bacteria (Figure 7). It was suspected that illicit discharges and failing infrastructure were the bacteria sources primarily causing or contributing to the high bacteria concentrations.

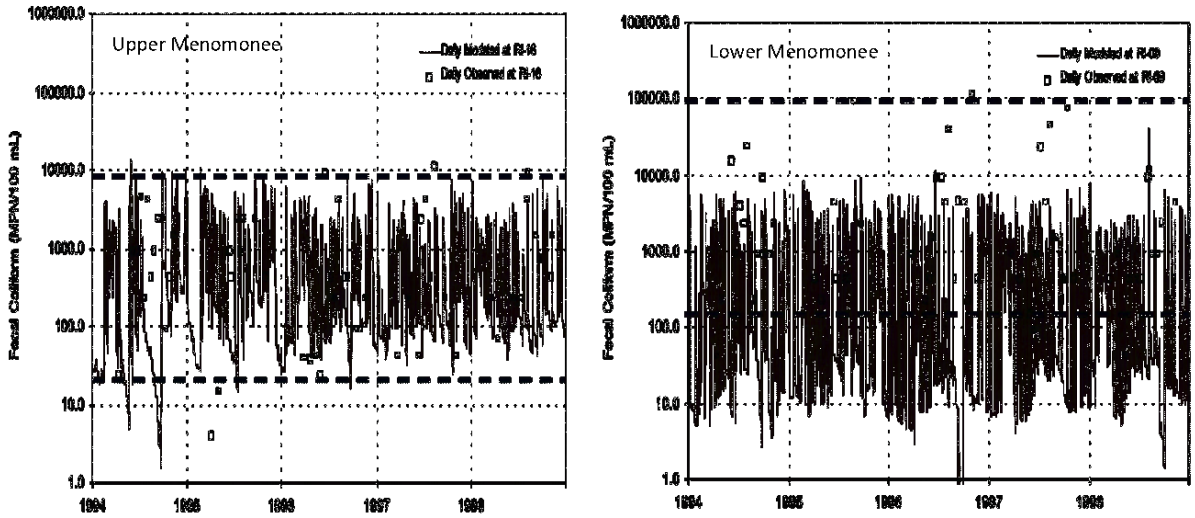


FIGURE 7. ACTUAL VS. MODELED BACTERIA DATA FOR FECAL COLIFORM IN THE UPPER AND LOWER MENOMONEE RIVER.

The higher than modeled bacteria levels in the lower Menomonee River are suspected to from illicit discharges from stormwater outfalls. Source: SEWRPC Technical Report 39 (2007a) Wisconsin's water quality standard for Fecal Coliform bacteria is 200 MPN/100 mL

Bacteria monitoring from stormwater outfalls was conducted during dry and wet weather in this hot spot area from 2008-2016., Approximately 68% of the monitored stormwater outfalls on the mainstem of the Menomonee River in this 10.5-mile area, from Burleigh Street to Hawley Avenue, tested consistently positive for human-specific strains of bacteria (Table 3 and Figure 8). A report summarizing the results from this research is currently in development for 2008-2016, but a summary of 2008-2012 data is available at the following websites:

http://home.freshwater.uwm.edu/mclellanlab/files/2015/03/2008-2012-SW-Report.pdf
http://home.freshwater.uwm.edu/mclellanlab/files/2015/03/2008-2012-SW-Appendix-A.pdf
http://home.freshwater.uwm.edu/mclellanlab/files/2015/03/2008-2012-SW-Appendix-B.pdf

TABLE 3. STORMWATER OUTFALLS TESTED FROM 2008-2016.

		Number of outfalls tested	Contaminated outfalls	Number of samples tested
Total 2008-2016	**Menomonee River**	**62**	**42 (68%)**	**228**
	Honey Creek	**37**	**20 (54%)**	**137**
	Underwood Creek	**26**	**14 (54%)**	**100**
	Kinnickinnic River	**54**	**30 (56%)**	**153**
	Holmes Ave. Creek	**32**	**1 (3%)**	**64**
	Villa Mann Creek	**8**	**3 (38%)**	**10**
	Wilson Park Creek	**44**	**12 (27%)**	**80**

Stormwater Outfalls tested from 2008-2016 by Milwaukee Riverkeeper, with analysis for human bacteria contamination conducted using culture methods and qPCR for human Bacteroides and Lachnospiraceae by McLellan Lab at University of Wisconsin-Milwaukee School of Freshwater Sciences.

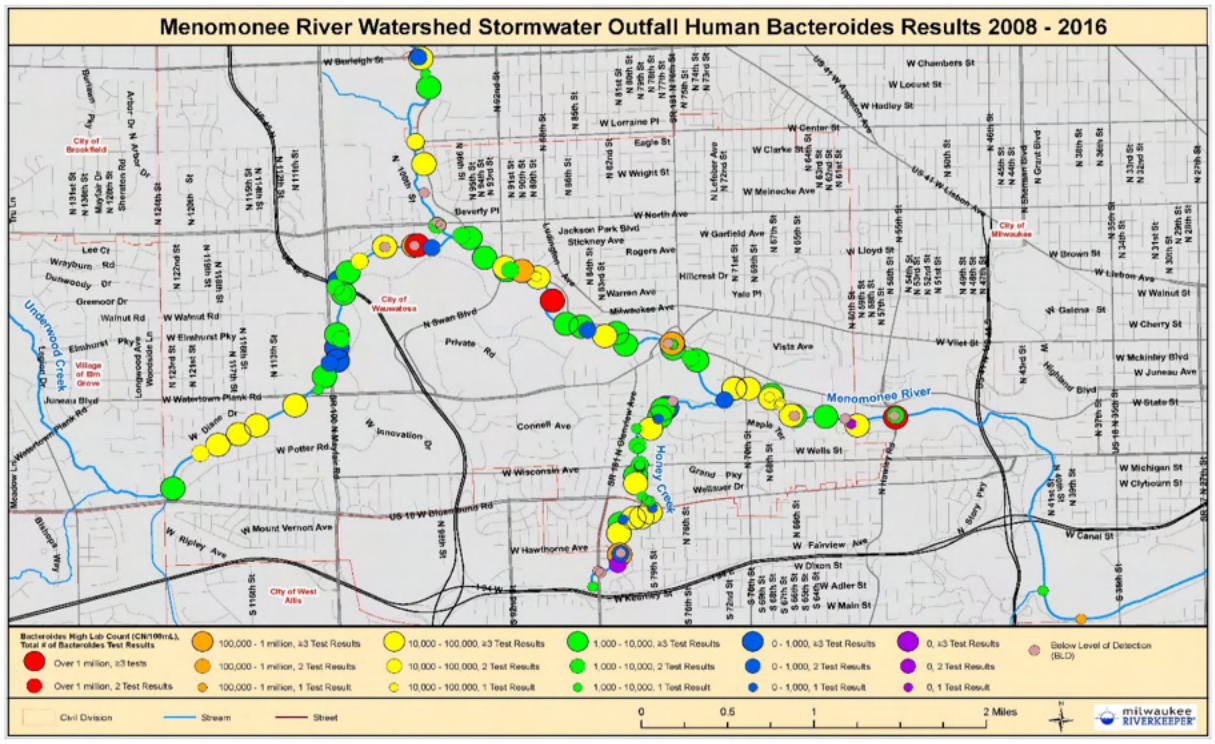


FIGURE 8. HUMAN BACTEROIDES LEVELS FROM STORMWATER OUTFALLS SAMPLED 2008-2016.

SOURCE: MILWAUKEE RIVERKEEPER

In 2017, Milwaukee Riverkeeper surveyed 16 different sites in the Milwaukee River Basin on 5 different occasions, during "low flow", including the following 4 sites in the Menomonee: Willow Creek, Little Menomonee River, Dretzka Park Creek at West Bradley Road, and Underwood Creek at Gravel Shoals (Figure 9). These samples were analyzed by Dr. Ryan Newton at UWM-Milwaukee School of Freshwater Sciences using sequence-based DNA technologies (e.g., Ilumina Myseq) to assess 8 different markers of human sewage within 5 genera of bacteria. This data will also allow for identification of naturally occurring river bacteria, as well as bacteria from livestock and other wildlife sources. This analysis provided robust evidence for presence and degree of human sewage sewer water contamination at the time of testing. Of the sites of interest to this plan (detailed above), Riverkeeper assigned letter grades for degree of bacterial contamination, and all 4 sites received C grades. There is more information on this project in Milwaukee Riverkeeper's Milwaukee River Basin 2017 Report Card: https://www.milwaukeeriverkeeper.org/2017-milwaukee-river-basin-report-card/ and in Appendix J. This genetic data will be used with other information to help identify bacteria sources with other sections of the Menomonee watershed with similar land use, especially in lesser studied creeks, and may be used with other information to prioritize critical areas in the watershed for illicit discharge detection and elimination work and bacteria reduction best management practices as part of implementation of the Milwaukee River Basin TMDL. The Milwaukee Riverkeeper

plans to repeat this study in ten years to assess progress in implementing the TMDL based bacterial reductions.

SWWT convened multi-stakeholder groups in 2017 to develop and implement a framework to identify and prioritize the mitigation of bacteria loading sources. The final report of the Bacteria Working Group is available here: https://www.swwtwater.org/bacteria-white-paper. This is another resource that will be relied upon for identifying and reducing bacteria sources in the Menomonee watershed.

The Menomonee River Watershed Group Stormwater Permit (approved May 2020) contains enhanced requirements for municipalities to create source identification and elimination plans for bacteria, per the TMDL, as well as requirements for addressing those illicit discharges, conducting enhanced monitoring/detection, updating municipal ordinances, and continuing to implement educational and outreach activities to help address this impairment. The prior bacteria sampling results in the watershed, shown above, may help municipalities meet these permit requirements.

Bacteria Water Quality Criteria Update - 2020

In May 2020, the WDNR revised Wisconsin's bacteria water quality criteria for recreation in Ch. NR 102, Wis. Adm. Code, removed fecal coliform criteria for individual waters from Ch. NR 104, Wis. Adm. Code, and revised the permit requirements for publicly owned and privately-owned domestic sewage treatment works in Ch. NR 210, Wis. Adm. Code. WDNR revised the bacteria water quality criteria from fecal coliform to E. coli, because E. coli better predicts the risk of gastrointestinal illness caused by exposure to human fecal contamination and follows EPA recommendations.

Total Suspended Solids Sources

SEWRPC's TR-39 estimates that the annual average load of TSS to streams of the watershed is 18,000,000 pounds (9,000 tons) per year. Combined sewer overflows and separate sewer overflows contribute about 1.0 percent and 0.2 percent, respectively, of this load. Industrial discharges contribute about 0.3 percent of this load. The rest of TSS loading to streams in the watershed, about 98.5 percent, is contributed by stormwater runoff, with 87.6 percent of this coming from urban sources. According to the MRB TMDL, the mean value for TSS concentrations in the Menomonee River during the period of record was 21.4 mg/L, with a range of values from 1.6 to 727.0 mg/L. A target TSS concentration of 12 mg/L expressed as a median of monthly samples collected between May and October, the growing season, was established by WDNR for the purpose of the MRB TMDL.

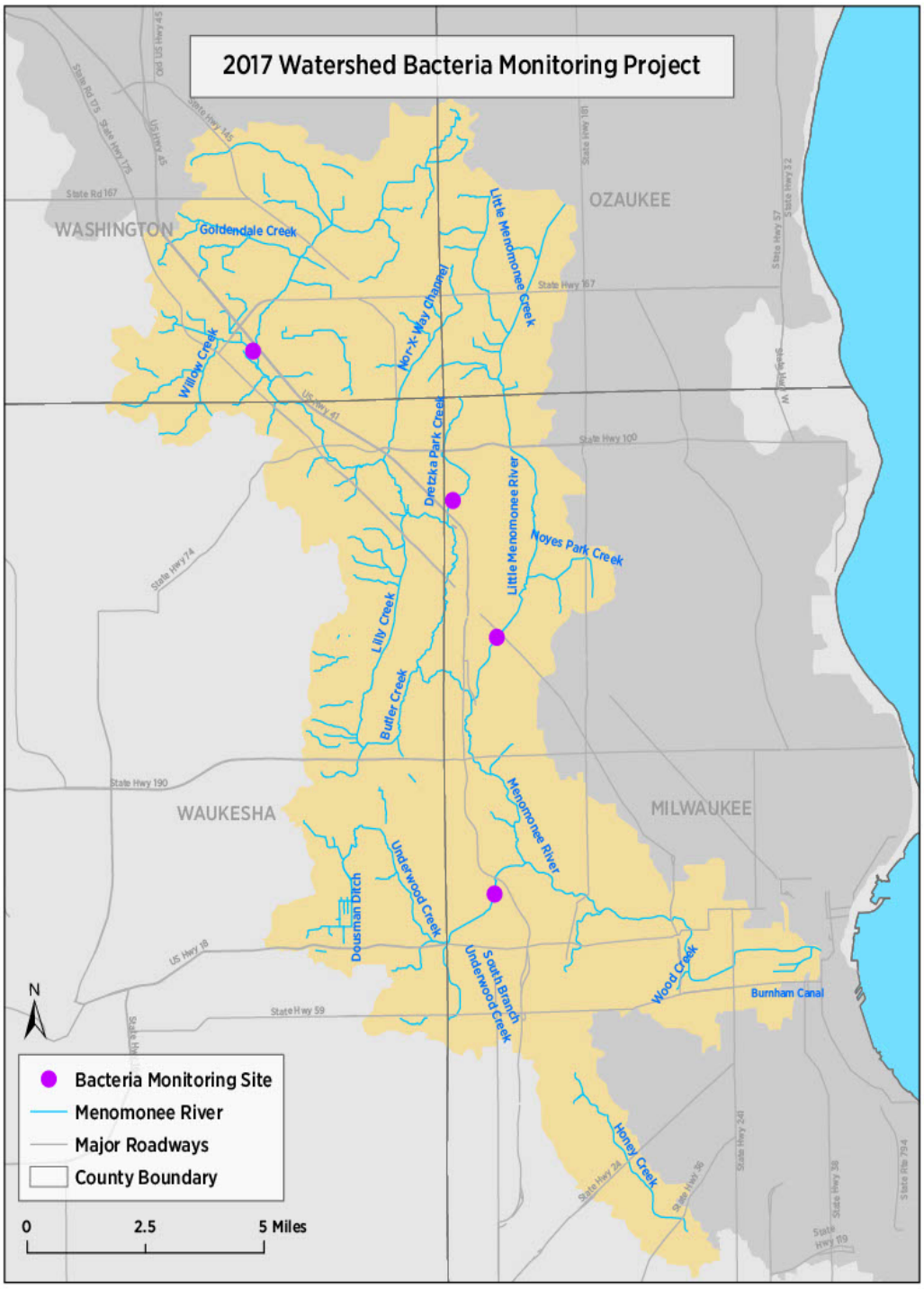


FIGURE 9. COMMUNITY MICROBIAL ASSESSMENT SITES IN THE MENOMONEE RIVER FOR 2017 MILWAUKEE BASIN STUDY.

SOURCE: MILWAUKEE RIVERKEEPER

Chloride Sources

The mean chloride concentration for the Menomonee River Watershed was 99.94 mg/L and has steadily increased since 1993 (TR-39). However, large differences between maximum and minimum levels were observed, as well as large differences across seasons. This chloride concentration was also strongly negatively correlated to ambient temperature, reflecting the use of de-icing salts on streets and highways during cold weather, and levels often rose more quickly than the rate of urbanization (Corsi et. al., 2015). Chloride concentrations in the Menomonee River show strong positive correlations with alkalinity, hardness, and specific conductance, all parameters which, like chloride, measure amounts of material dissolved in water.

Surface water monitoring conducted by Milwaukee Riverkeeper and MMSD in recent years has shown significant exceedances of WDNR acute water quality standards for chloride (levels that can instantly toxic to fish and aquatic life causing mortality and other distress) of 757 mg/L, as well as exceedances of chronic standards (harmful to fish and aquatic organisms at lower levels over a 4-day period) of 395 mg/L. In 2018, 78% of all surface water samples in the watershed met chronic chloride criteria (or 22% of samples exceeded standards). Riverkeeper has also analyzed all available chloride data from 2002-2019 for chloride in the Menomonee River Watershed, and found that approximately 2% of all water samples showed exceedance of acute toxicity standards (Figure 10) and 10.19% of samples exceeded chronic toxicity standards (8.19% of samples were above chronic level and below acute level). Chloride monitoring in the watershed will continue over the next ten years. Such monitoring will not only help assess improvements over time due to improved road salt management and BMP implementation, but may also reveal critical areas in the watershed for focusing road salt BMP adoption. Sites highlighted in Figure 10 will be monitored in 10 years. More information as well as a story map of past chloride and conductivity monitoring results can be found online at: https://milwaukeeriverkeeper.org/road-salt/

Given the large impacts from chlorides to Menomonee watershed streams during winter runoff events, this plan recognizes that looking only at an annual compliance rate or mean chloride levels minimizes the real risk of road salt to fish and aquatic life in streams. Even a handful of very high chloride loading events, leading to chloride levels that exceed acute toxicity criteria, can be catastrophic to stream aquatic life. Given the existing chloride sampling data, a future chloride TMDL for large portions of the Menomonee River Watershed in the next five to ten years may be pursued by Wisconsin DNR. Water quality improvement projects identified in this plan for the Menomonee River Watershed will target the TMDL identified pollutants (TP, TSS, and Bacteria), and, in some cases, help to address chloride-caused impairments (acute and chronic) in the watershed.

In 2016, SEWRPC developed a prospectus to provide a comprehensive inventory of the historic and present sources of chloride loads to surface and groundwater resources; an assessment of the impacts of these loads on the environment, and in particular on the surface water and groundwater resources of the Region; identification of alternative means of achieving desired levels of

management of sources of chloride; and the formulation of recommendations for abatement of the undesirable environmental impacts of the use of chloride via a chloride management program for the Southeastern Wisconsin Region(which includes the Menomonee watershed);.

The 2016 prospectus is intended to provide the information for units and agencies of government concerned about future chloride use to understand the benefits and costs of chloride permit program, and to determine the desirability of its execution. More specifically, this Prospectus is intended to:

1. Establish the need for and purpose of a regional study of the environmental impacts of chloride on surface water and groundwater resources;

2. Identify the scope and content of the needed study, the work required to be undertaken to properly carry out the study, and to document the findings and recommendations of the study;

3. Recommend the most feasible means for organizing and accomplishing the required work;

4. Recommend a practical time sequence and schedule for the work; and

5. Recommend a budget for the required work program, including identification of potential sources of funding.

The regional chloride study is projected to cost $1.7 million, and was fully funded as of 2018. Results and recommendations from the chloride study are expected to inform permit requirements for MS4s and combined sewer service areas (CSSAs) with the Menomonee and adjacent watersheds. In addition, the design, inspection, and ongoing operation and maintenance of GI in areas where road salt is used additional measures to avoid groundwater contamination will be necessary. These considerations, with recommended BMPs to reduce chloride use frequency and amounts, are detailed in a 2016 EPA publication, Operation and Maintenance of Green Infrastructure Receiving Runoff from Roads and Parking Lots: https://www.epa.gov/sites/production/files/2015-09/documents/319-guidelines-fy14.pdf

In addition to the 2018 study, in 2014, the USGS completed a long-term stream study of chloride use and stream concentrations in the Menomonee watershed from 1990-2011. This study better defines chloride concentrations for many Menomonee River tributary streams in relation to streamflow rates, and compared these trends to changes in seasonality, urban land cover, aquatic life criteria, and even road salt sales patterns over the last 30 years. The three conclusions from the USGS study apply to this plan's implementation are:

(1) The research indicates that chloride concentrations in urban streams of the northern U.S. and resulting water quality criteria exceedances have increased at a greater rate than the rate of urban development. Results provide verification that chloride concentrations in urban streams continue to increase, influencing the potential for harming aquatic life in affected streams.

(2) The nature of salt presence in environmental waters makes this issue very difficult to address with common stormwater management practices that rely most commonly on settling or filtration of particulate matter (Waschbusch, 1999; Greb et al., 2000; Horwatich et al., 2011). Since salt dissolves readily in water, these types of management practices will not remove salt from runoff.

(3) The only reliable way to reduce the impact of road salt on receiving streams is to reduce applications. There are a host of techniques that have been identified and documented for reduction of road salt application.

The entire USGS study can be found here: https://www.usgs.gov/centers/wisconsin-water-science-center/science/evaluating-chloride-trends-due-road-salt-use-and-its?qt-science_center_objects=0#qt-science_center_objects

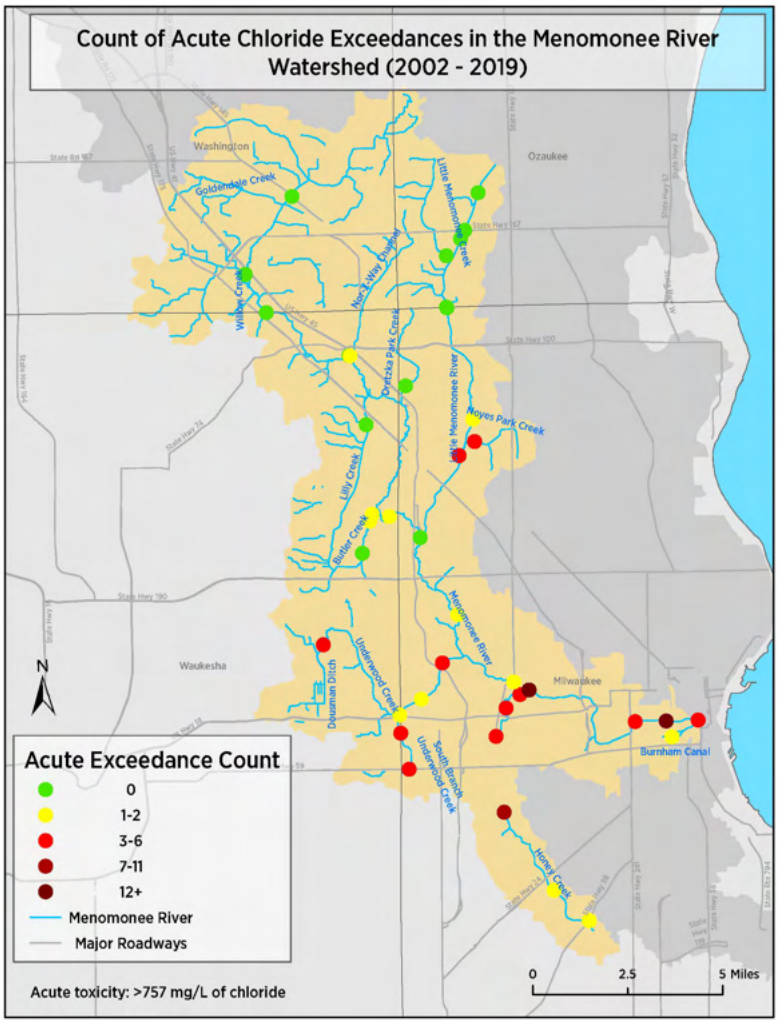


FIGURE 10. COUNT OF ACUTE EXCEEDANCES OF CHLORIDE WATER QUALITY STANDARDS FOR WISCONSIN FROM 2002-2019.

SOURCE: MILWAUKEE RIVERKEEPER

Specific Impairments by River Mile

The specific impairments that result in 303(d) listing for each section of the Menomonee River and its tributaries are listed in Table 5 and displayed in Figure 11. Table 4 provides information to aid in understanding water quality metrics as they relate to current and designated uses. This information will be used with the water quality monitoring data shown above for TP, TSS, bacteria and chloride pollutants, to form baseline watershed conditions to help measure plan implementation/performance and also identify critical areas in the watershed for pollutant-specific practices.

TABLE 4. WATER QUALITY IMPAIRMENT TERMS AND DEFINITIONS.

Term	Definition
Impairment	The assigned condition for a water body not meeting water quality standards set by the Clean Water Act section 303(d) list. This condition is correlated to a specific pollutant.
Impaired water	A waterway that is not meeting water quality standards set by the Clean Water Act section 303(d) list.
Natural Community Classification for Streams and Rivers	Distinct "natural communities" into which different types of streams, rivers and lakes can be grouped. These groupings help us manage the resources more effectively.
Fish and Aquatic Life (FAL)	Use Designation Category
Limited Aquatic Life (LAL)	DO ≥ 3 mg/L; capable of supporting forage fish and macroinvertebrates tolerant of organic pollution
Limited Forage Fishery (LFF)	DO ≥ 1 mg/L; capable of supporting limited organics-tolerant fish and macroinvertebrate populations
Designated Use	Goals and expectations for how a water body is to be used set by the state and required by the Clean Water Act. Water quality standards are then developed for each designated use.
Current Use	The use for which a water body is currently meeting the water quality standards.

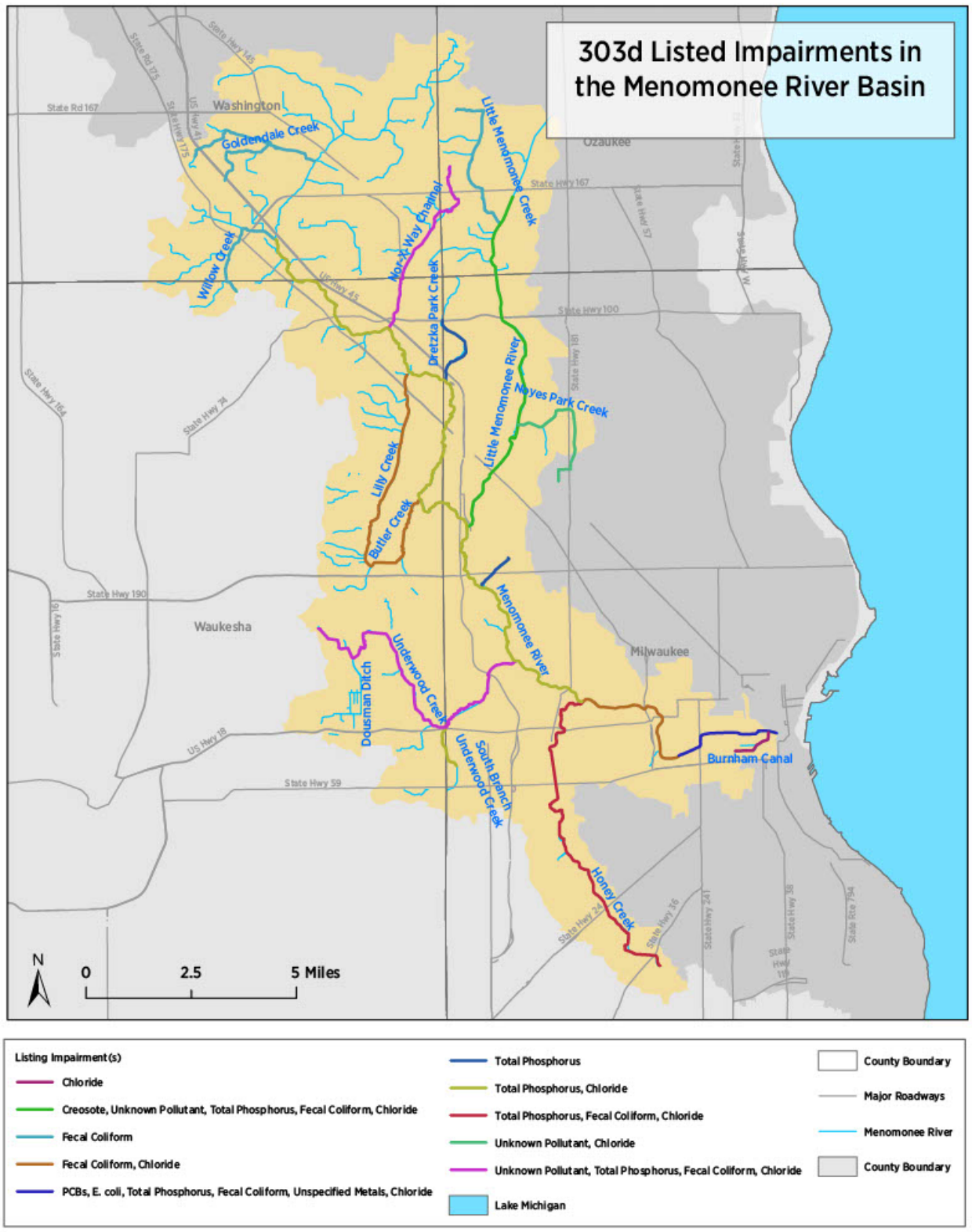


FIGURE 11. MAP OF MENOMONEE IMPAIRED WATERS PER 2018 303D LIST.

SOURCE: WDNR SURFACE WATER VIEWER

TABLE 5. IMPAIRED WATERWAYS IN THE MENOMONEE RIVER WATERSHED.

River Name	Miles	Pollutant	Impairment	Natural Community	Current Use	Designated Use
Goldendale Creek (aka Goldenthal Creek)	0-3.5	Fecal Coliform	Recreational Restrictions-Pathogens	Cool-Cold Headwater	FAL	FAL
Honey Creek	0-8.96	Fecal Coliform, TP, Chloride	Recreational Restrictions-Pathogens, Degraded Biological Community, Chronic Aquatic Toxicity, Acute Aquatic Toxicity	Cool-Warm Headwater	FAL	FAL
Little Menomonee Creek	0-3.9	Fecal Coliform	Recreational Restrictions-Pathogens	Warm Headwater, Cool-Warm Headwater	WWFF	FAL
Little Menomonee River	0-9.00	Unknown, Creosote, Fecal Coliform, TP, Chloride	Recreational Restrictions-Pathogens, Elevated Water Temperature, Degraded Biological Community, Chronic Aquatic Toxicity, Acute Aquatic Toxicity	Cool-Warm Headwater	WWSF	WWSF
Menomonee River	0-2.67	Fecal Coliform, TP, Unspecified Metals, E. Coli, PCBs, Chloride	Recreational Restriction-Pathogens, Low DO, Chronic Aquatic Toxicity, Acute Aquatic Toxicity, PCB contaminated fish tissue	Cool-Warm Mainstem	FAL	FAL
Menomonee River	2.66-6.27	Fecal Coliform, Chloride	Recreational Restrictions-Pathogens, Chronic Aquatic Toxicity, Acute Aquatic Toxicity	Warm Mainstem, Cool-Warm Headwater, Cool-Warm Mainstem	WWSF	FAL
Menomonee River	6.27-12.61	TP, Chloride	Impairment Unknown, Chronic Aquatic Toxicity, Acute Aquatic Toxicity	Cool-Warm Headwater, Cool-Warm Mainstem, No Classification	FAL	FAL

River Name	Miles	Pollutant	Impairment	Natural Community	Current Use	Designated Use
Menomonee River	12.61-24.81	TP, Chloride	Impairment Unknown, Chronic Aquatic Toxicity, Acute Aquatic Toxicity	Cool-Warm Headwater	LAL	Default FAL
Menomonee River	24.81-30.14	TP	NA	Warm Headwater, Macroinvertebrate, Cool-Warm Headwater	FAL	FAL
Underwood Creek	0.00-2.84	Fecal Coliform, TP, Unknown Pollutant, Chloride	Degraded Biological Community, Elevated Water Temperature, Recreational Restrictions-Pathogens, Chronic Aquatic Toxicity, Acute Aquatic Toxicity	Cool-Warm Mainstem	FAL	FAL
Underwood Creek	2.84-8.54	TP, Fecal Coliform, Chloride	Impairment Unknown, Recreational Restrictions-Pathogens, Chronic Aquatic Toxicity, Acute Aquatic Toxicity	Warm Headwater, Cool-Warm Headwater, Cool-Warm Mainstem	FAL	FAL
South Branch of Underwood Creek	0.00-1.11	TP, Chloride	Degraded Biological Community, Chronic Aquatic Toxicity, Acute Aquatic Toxicity	Cool-Warm Headwater	FAL	FAL
Grantosa Creek	0.00-1.02	TP	High Phosphorus Levels, Degraded Biological Community	Cool-Warm Headwater	FAL	FAL
West Br. Menomonee	0.00-2.45	Fecal Coliform	Recreational Restrictions-Pathogens	Cool-Cold Headwater	FAL	FAL
Butler Ditch	0.00-2.85	Fecal Coliform, Chloride	Recreational Restrictions-Pathogens, Chronic Aquatic Toxicity	Cool-Warm Headwater	FAL	FAL
Lilly Creek	0.00-4.70	Fecal Coliform, Chloride	Recreation Restrictions-Pathogens, Chronic Aquatic Toxicity	Cool-Cold Headwater, Cool-Warm Headwater	FAL	FAL
Nor-X-Way Channel	0.00-4.9	Fecal Coliform, TP, Unknown Pollutant, Chloride	Recreational Restrictions-Pathogens, Water Quality Use Restrictions, Elevated Water Temperature, High	Coldwater, Cool-Cold Headwater	FAL	FAL

River Name	Miles	Pollutant	Impairment	Natural Community	Current Use	Designated Use
			Phosphorus Levels, Chronic Aquatic Toxicity			
Willow Creek	0.00-2.80	Fecal Coliform	Recreation Restrictions-Pathogens	Coldwater	FAL	FAL
Noyes Creek	0.00-3.54	Unknown, Chloride	Elevated Water Temperature, Chronic Aquatic Toxicity, Acute Aquatic Toxicity	Macroinvertebrate, Cool-Warm Headwater	FAL	FAL
Unnamed Creek (North Golf Course Creek at R21E S18)	0.00-2.00	TP	Impairment Unknown	Cool-Warm Headwater	FAL	FAL
Local Water (Burnham Canal to confluence with Menomonee)	0.00-1.05	Chloride	Chronic Aquatic Toxicity	Macroinvertebrate	FAL	FAL

Source: WDNR Impaired Waters

WATER QUALITY GOALS AND METRICS

The following goals and metrics were formulated by combining water quality goals of the MRB TMDL and the 2010 Menomonee River Watershed Restoration and Implementation Plan. The plan goals and metrics, shown below, were also informed and vetted by multiple community-based organizations in the watershed, numerous conversations with environmental non-profit groups, the Menomonee River Watershed-Based Stormwater Permit Group, and other government agencies responsible for regulation, planning, and watershed restoration.

Goals	Metrics
1. Make substantial progress towards meeting and maintaining water quality standards and pollutant reductions set in Milwaukee River TMDL for Phosphorus, Total Suspended Solids and Fecal Coliform in the Menomonee River reaches (Tables 6-7 and Figure 12). 2. Make progress toward delisting 303(d) impaired waterways and pollutants in the Menomonee River Watershed (Figure 11 and Table 5). 3. Reduce chloride concentrations in waterways. 4. Increase infiltration and treatment of stormwater via implementation of green infrastructure and other practices. 5. Prioritize and implement projects for green infrastructure from the Commercial/Industrial Hot Spot Analysis (Appendix C), the CH2M capital project analysis for Menomonee municipalities (Appendix D), the streambank stabilization designs developed for SWWT (Appendix E), and using other resources and best available science. 6. Find and fix illicit discharges from stormwater to help implement the bacteria TMDL (Figure 8, McLellan 2012; Menomonee Group Permit, Figure 4). 7. Implement best management practices on remaining agricultural acres.	1. Instream monitoring results show improving water quality 2. Number of point sources in compliance with TMDL based permits 3. Load reductions achieved as documented from pollutant load model analysis or instream monitoring 4. Number, type and area of GI practices installed 5. Linear feet of streambank stabilization projects 6. Number of streams delisted from 303d List, or number of pollutants removed for listed streams 7. Number, type and area of water quality improvement projects in the watershed 8. Number, type and location(s) of agricultural BMPs in the watershed

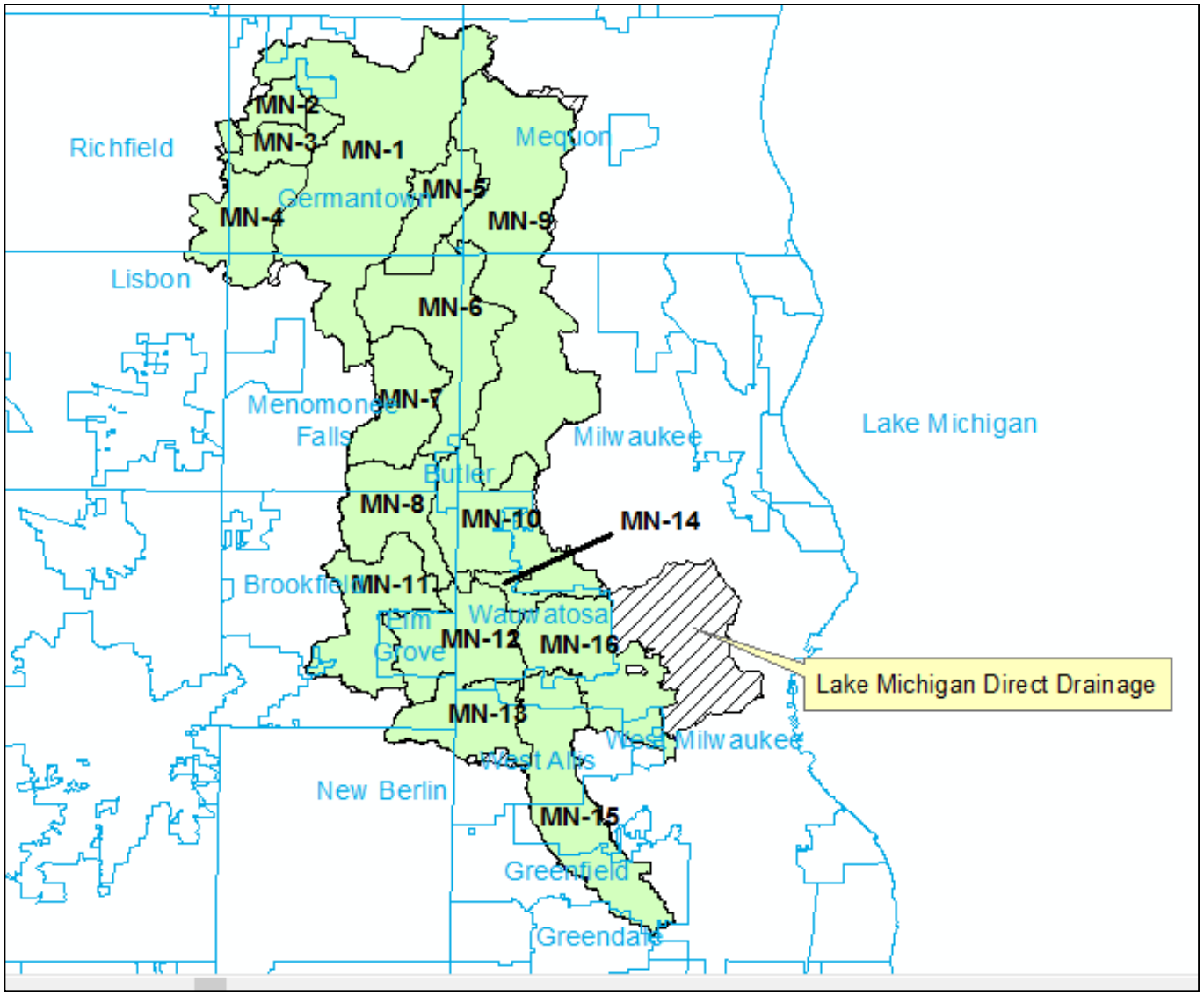


FIGURE 12. MUNICIPALITIES WITHIN THE MENOMONEE RVER WATERSHED AND TMDL REACHES.

SOURCE: MILWAUKEE RIVER TMDL

Water quality goals for the Plan for each reach, or sub-watershed in the Menomonee basin, shown above in Figure 12, were determined by pollutant load reductions calculated in the MRB TMDL (Figure 11). Table 6 provides a summary of these reductions by municipal separate storm sewer systems (MS4) and reach for TSS and TP. Pollutant loading reductions for Fecal Coliform are summarized in Table 7. A full list of TMDL allocations by source can be found in Appendix A of the Milwaukee River Basin TMDL. Appendix B has more detailed maps of reach locations.

Approximately 8% of the Menomonee River Watershed is part of the combined sewer area in the City of Milwaukee. No direct discharges of stormwater to surface waters are permitted from this area; combined sewage is conveyed to MMSD for processing under its point source permit. The

remaining 92% of the watershed area is in the following municipalities: City of Milwaukee, City of Brookfield, Village of Butler, Village of Elm Grove, Village of Germantown, City of Greenfield, Village of Menomonee Falls, Milwaukee County, City of West Allis, Village of West Milwaukee, and City of Wauwatosa. The majority of the remaining agricultural acres and non-permitted urban acres (that do not drain/discharge to MS4 drainage systems) in the Menomonee watershed are concentrated within reaches 1, 9 (see Figure 13); reaches 2-6 and 11-13 may also contain limited agricultural and non-permitted urban acres within them, but these will likely convert to urban acres in the next ten years (see pages 50-52 for land use conversion estimates in the watershed).

As described earlier in this plan, after a several year process, documented by SEWRPC in their report "Development of a Framework for a Watershed Based Municipal Stormwater Permit for the Menomonee River" (January 2013), almost all of the Menomonee River municipalities joined into the first watershed-based municipal stormwater permit in the US, with the exception of Mequon (which is part of the a separate group permit in the Milwaukee River Watershed) and the City of New Berlin (which has 430 acres in the watershed). The Village of Richfield and the Town of Germantown, which only comprise 1.1 and 0.6 percent, respectively, of the 136.1-square-mile watershed area, are the only municipalities within the watershed that do not have MS4 permits. The first group permit took effect on November 30, 2012 (WPDES Permit WI-S065404-1). This permit regulated all portions of the Municipal Separate Storm Sewer Systems (MS4s), owned or operated by the Menomonee River Watershed Permittees to waters of the state in the Menomonee River Watershed, as well as other waters that those MS4s discharge to, and expired on December 1, 2017. The second permit for this group was just issued on March 31, 2020 (WPDES Permit WI-S065404-2), and is located in Appendix F.

The Southeast Wisconsin Professional Baseball District, which operates Miller Park, and the Wisconsin State Fair Park also have MS4 permits, and are not included in the group permit. Ozaukee and Waukesha Counties have separate MS4 permits, and Washington County was granted an exemption under Section NR 216.023 of the Wisconsin Administrative Code.

Per SEWRPC, the goals of the watershed-based group permit were largely to: 1) investigate innovative approaches to improving the quality of stormwater discharges through a watershed-based permit while considering the regulatory and financial burdens on municipalities, 2) to develop cost effective permit conditions and stormwater management activities, particularly related to implementation of green infrastructure, that are tailored to threats in the watershed and that would be expected to yield the greatest improvements in water quality, 3) to consider more effective sampling requirements that are related to needs identified under recent sub-regional water quality management plans, and 4) to recognize that TMDLs were being developed for the watershed and consider how a watershed-based stormwater permit might better facilitate load reductions and allow for collaborative work to more cost-effectively achieve water quality improvements.

Current MS4 and Combined Sewer maps for each municipality are provided in Appendix G. As shown in Table 6, there are no non-permitted urban areas that were identified using the MS4 maps provided by municipalities. However, some practices that do not directly implement the terms of the MS4 permits, or sub-basin areas that do not drain to a MS4 drainage system, may be eligible for federal §319 funding to reduce nonpoint sources of pollution. For example, non-permitted areas may include county parks or similar vegetated areas which fall outside of/do not drain or discharge into Milwaukee County's MS4 drainage system.

The MRB TMDL has identified the areas in the Menomonee River Watershed that are impaired from point and non-point pollution sources. Of the point sources in the watershed, MS4 areas are the largest land use and contributor/cause of pollutant loading in the watershed. However, there are some agricultural and non-permitted urban sources (see Table 8), largely in the northern portion of the watershed in MN 1 and MN 9 (040400030401 and 040400030402 HUC12s). Over the next ten years, the Wisconsin DNR estimates approximately 42% of the remaining agricultural areas (4,110 of 9.815 acres) in this section of the watershed may convert to other urban land uses dominated by impervious surfaces. Most of these areas are located and are adjacent to or nearby to a municipality's sanitary service area boundary. See Appendix K and Figure 13. Specific pollutant loading tables for point and nonpoint sources can be found in Appendix A of the MRB TMDL report.

Due to the high prevalence of urban and suburban areas that discharge stormwater to a MS4 or Combined Sewer system within the Menomonee River Watershed, these areas will be the primary focus for adoption of practices to achieve pollutant reductions identified in this plan. Likewise, combined sewer and MS4 permits, re-issued every 5 years, will be the primary implementation and monitoring mechanism for this Plan. As MS4 permits expire and are reissued within the watershed during the Plan's ten-year schedule, the Menomonee group permit and other MS4 permits will be revised to reflect TMDL based waste load allocations per steps 1, 2, and 3 described within DNR's 2014 TMDL Guidance for MS4 Permits: http://dnr.wi.gov/topic/stormwater/documents/MS4TMDLImpGuidance.pdf

and

Addendums A and B to the 2014 TMDL guidance for MS4 permits:
http://dnr.wi.gov/topic/stormwater/standards/ms4_modeling.html

Below is a summary of the steps from DNR's TMDL MS4 guidance that describes how MS4 permits will, over one or more permit terms, be used to achieve this Plan's pollutant load reductions:

- Inclusion of TMDL reach specific waste load allocations for phosphorus, sediment and bacteria in the MS4 permit;
- Provisions for revising or creating a Storm Water Management Plan (SWMP) with a TMDL implementation analysis that demonstrates that the discharge of pollutants to the

MS4 system, over time, is progressing toward the percent reductions needed to meet the TMDL waste load allocations (see below);

- Establishing benchmarks within the SWMP to reflect what pollutant reduction practices will be employed and over what time frame the practices will be implemented to meet reductions consistent with TMDL waste load allocations;
- Tracking implementation of stormwater management practices by TMDL reach;
- Estimating pollutant load reductions from implemented practices on a percentage basis using WINSLAMM or equivalent models/methods;
- Comparing load reductions achieved on a percentage basis, to TMDL pollutant reduction goals; and
- Reporting on TMDL implementation in the MS4 annual reports to DNR and including a description of practices and pollutant load reductions achieved.

Municipal Storm Water Management Programs

The MS4 permits require municipalities to reduce polluted storm water runoff by implementing stormwater management programs with best management practices. Municipal stormwater management programs cover a wide array of activities that occur within a municipality. More detailed descriptions of the "minimum measures" of stormwater permits can be found here: https://www.epa.gov/npdes/stormwater-discharges-municipal-sources#developing. The permits contain requirements for the following:

- **Public Education and Outreach** - The MS4 permit specifies that public education and outreach programs be developed to encourage the public and businesses to modify their behaviors and procedures to reduce storm water pollution.
- **Public Involvement and Participation** - In addition to public education and outreach, the MS4 permit requires municipalities to encourage participation from individuals to prevent storm water pollution. Some examples of public involvement are volunteer stream monitoring, storm drain stenciling, presenting information to established community groups, or planting a community rain garden.
- **Illicit Discharge Detection and Elimination** - Storm sewers that carry rain water runoff are not intended for other fluids and waste material. These pollutants are illicit discharges and may have the potential to harm people, animals and aquatic life in the downstream rivers, lakes and wetlands. Municipalities are required to develop programs to identify, prevent, and eliminate illicit discharges to their storm sewer systems. The DNR has developed additional illicit discharge detection and elimination guidance to assist municipalities with this requirement.
- **Construction Site Pollutant Control** - Municipalities are required to develop a soil erosion control ordinance and enforce it on construction sites. Municipalities may use state-recommended technical standards for methods and products used to control erosion and prevent sediment-laden water from discharging into a lake, stream or wetland.

- **Post-Construction Storm Water Management** - Municipalities are required to develop a post-construction ordinance and enforce it to ensure that areas of new and redevelopment will include structural measures to control pollutants, control peak flow, maintain infiltration, and establish vegetated protective areas adjacent to waterways and wetlands. Municipalities may use state-recommended technical standards for post- construction storm water management practices.
- **Pollution Prevention Practices for the Municipality** - MS4 storm water programs are to include practices to prevent pollutants from municipally-owned transportation infrastructure, maintenance areas, storage yards, sand and salt storage areas, and waste transfer stations entering the storm sewer system.
- **Developed Urbanized Area Standard** - Municipalities are required to control the Total Suspended Solids (TSS) carried in storm water from existing urban areas as compared to no controls. Many municipalities have already achieved the state standard of 20 percent reduction in TSS. Compliance with the standard is achieved by implementing a system of practices and activities, which has been verified by a storm water computer model.
- **Storm Sewer System Maps** - Municipalities covered by a MS4 permit area are required to maintain a map of the storm sewer system. These maps identify storm sewer conveyances such as pipes and ditches, and identify roads, streams and lakes.
- **Impaired Waters** - Many streams and lakes in Wisconsin are polluted or impaired to a point that the receiving water's animal and plant communities, the fish in a local lake for example are significantly impacted. If the storm sewer system discharges a pollutant of concern to an impaired water, a municipality covered by a MS4 permit is required to develop a plan to reduce those pollutants.

MS4 permits will require permittees to identify critical areas for practices within the Menomonee watershed. Examples of stormwater best management practices used by municipalities to meet permit requirements above include, but are not limited to: detention basins, street sweeping, filter strips, porous pavement, rain barrels, water quality inlets, grassed swales/ditches, green roofs and rain gardens. Several of these practices have already been adopted within the watershed to meet NR 151 requirements. Rerouting storm water generated by MS4 areas into non-MS4 areas for infiltration and treatment is another practice that can help meet MS4 requirements.

Table 6 lists the Milwaukee Basin TMDL based annual MS4 load allocations for TSS and P, along with average percent reductions from baseline loads for each TMDL reach in the Menomonee watershed. Table 7 lists monthly TMDL Fecal Coliform wasteload allocation by municipality. Table 8 shows the MRB TMDL load allocations for non-point sources (agriculture and non-permit urban) by TMDL reach. The TMDL waste-load and load allocations will be serve as pollutant reduction goals for this plan.

TABLE 6. SUMMARY OF TMDL ALLOCATIONS FOR TOTAL SUSPENDED SOLIDS AND TOTAL PHOSPHORUS BY REACH IN THE MENOMONEE WATERSHED.

TMDL Reach	TP Target (mg/L)	Annual Allowable TP Load for Reach (lbs/year)	TSS Target (mg/L)	Annual Allowable TSS Load for Reach (lbs/year)	Municipality*	MS4 Area (acres)	Average TP Percent Reduction for MS4	Average TSS Percent Reduction for MS4
MN-01	**0.075**	**1,398**	**12**	**223,786**		**14,295**	**59%**	**58%**
					Germantown (v)	11,578	59%	58%
					Menomonee Falls (v)	2,170	59%	58%
					Mequon (c)	547	59%	58%
MN-02	**0.075**	**121**	**12**	**19,372**		**1,216**	**41%**	**54%**
					Germantown (v)	1,119	41%	54%
					Richfield (v)	98	41%	54%
MN-03	**0.075**	**213**	**12**	**34,020**		**1,692**	**55%**	**57%**
					Germantown (v)	1,664	55%	57%
					Richfield (v)	28	55%	57%
MN-04	**0.075**	**363**	**12**	**58,058**		**3,744**	**45%**	**55%**
					Germantown (v)	2,149	45%	55%
					Lisbon (t)	196	45%	55%
					Menomonee Falls (v)	539	45%	55%
					Richfield (v)	860	45%	55%
MN-05	**0.075**	**316**	**12**	**50,631**		**2,705**	**69%**	**63%**
					Germantown (v)	1,909	69%	63%
					Menomonee Falls (v)	376	69%	63%
					Mequon (c)	420	69%	63%
MN-06	**0.075**	**711**	**12**	**113,773**		**6,439**	**65%**	**67%**
					Butler (v)	58	65%	67%
					Germantown (v)	134	65%	67%
					Menomonee Falls (v)	4,031	65%	67%
					Mequon (c)	92	65%	67%
					Milwaukee (c)	2,124	65%	67%
MN-07	**0.075**	**365**	**12**	**58,344**		**3,640**	**60%**	**63%**
					Menomonee Falls (v)	3,640	60%	63%
MN-08	**0.075**	**457**	**12**	**73,067**		**3,623**	**53%**	**62%**
					Brookfield (c)	2,540	53%	62%
					Butler (v)	13	53%	62%
					Menomonee Falls (v)	1,070	53%	62%
MN-09	**0.075**	**1,627**	**12**	**260,315**		**13,954**	**60%**	**63%**
					Germantown (v)	249	60%	63%
					Mequon (c)	6,399	60%	63%
					Milwaukee (c)	7,305	60%	63%

TMDL Reach	TP Target (mg/L)	Annual Allowable TP Load for Reach (lbs/year)	TSS Target (mg/L)	Annual Allowable TSS Load for Reach (lbs/year)	Municipality*	MS4 Area (acres)	Average TP Percent Reduction for MS4	Average TSS Percent Reduction for MS4
MN-10	**0.1**	**3,036**	**12**	**222,942**		**5,750**	**23%**	**59%**
					Brookfield (c)	555	23%	59%
					Butler (v)	446	23%	59%
					Menomonee Falls (v)	13	23%	59%
					Milwaukee (c)	2,501	23%	59%
					Wauwatosa (c)	2,236	23%	59%
MN-11	**0.075**	**597**	**12**	**95,580**		**4,720**	**58%**	**65%**
					Brookfield (c)	4,172	58%	65%
					Brookfield (t)	113	58%	65%
					Elm Grove (v)	435	58%	65%
MN-12	**0.075**	**679**	**12**	**108,574**		**4,673**	**73%**	**75%**
					Brookfield (c)	526	73%	75%
					Elm Grove (v)	1,649	73%	75%
					Milwaukee (c)	53	73%	75%
					Wauwatosa (c)	2,445	73%	75%
MN-13	**0.075**	**454**	**12**	**72,671**		**3,341**	**66%**	**71%**
					Brookfield (c)	831	66%	71%
					Elm Grove (v)	15	66%	71%
					Milwaukee (c)	198	66%	71%
					New Berlin (c)	431	66%	71%
					Wauwatosa (c)	101	66%	71%
					West Allis (c)	1,766	66%	71%
MN-14	**0.1**	**718**	**12**	**53,449**		**772**	**43%**	**56%**
					Milwaukee (c)	67	43%	56%
					Wauwatosa (c)	705	43%	56%
MN-15	**0.075**	**895**	**12**	**143,161**		**6,506**	**63%**	**67%**
					Greendale (v)	73	63%	67%
					Greenfield (c)	1,840	63%	67%
					Milwaukee (c)	2,185	63%	67%
					Wauwatosa (c)	150	63%	67%
					West Allis (c)	2,258	63%	67%
MN-16	**0.1**	**3,122**	**12**	**220,942**		**5,558**	**43%**	**65%**
					Milwaukee (c)	2,002	43%	65%
					Wauwatosa (c)	2,827	43%	65%
					West Allis (c)	316	43%	65%
					West Milwaukee (v)	413	43%	65%

*Municipality Designations: (c) = City; (t) = Town; (v) = Village

Source: Milwaukee TMDL

TABLE 7. MONTHLY TMDL FECAL COLIFORM WASTELOAD ALLOCATION BY MUNICIPALITY.

Municipality	TMDL Reach	Area (acres)	Monthly Fecal Coliform Wasteload Allocation (billion cells/month)				
			Low	Dry	Mid	Moist	Wet
Brookfield, City	MN-08	2,540	250.29	565.02	932.78	1,253.21	2,213.84
	MN-10	555	80.95	141.16	233.66	340.99	697.78
	MN-11	4,172	407.23	809.27	1,265.33	1,984.80	4,383.87
	MN-12	526	58.07	121.79	182.44	280.68	578.81
	MN-13	831	89.93	180.14	277.00	430.64	895.97
Brookfield, Town	MN-11	113	10.99	21.84	34.15	53.57	118.33
Butler, Village	MN-06	58	2.68	10.74	19.57	31.85	75.48
	MN-08	13	1.24	2.80	4.61	6.20	10.95
	MN-10	446	65.11	113.54	187.94	274.27	561.25
Elm Grove, Village	MN-11	435	42.49	84.44	132.03	207.10	457.43
	MN-12	1,649	182.02	381.75	571.84	879.77	1,814.20
	MN-13	15	1.65	3.31	5.08	7.90	16.44
Germantown, Village	MN-01	11,578	389.73	1,335.98	2,586.21	3,967.69	11,566.02
	MN-02	1,119	29.39	133.62	253.02	406.26	1,152.08
	MN-03	1,664	114.01	298.17	536.15	785.34	1,850.80
	MN-04	2,149	55.82	251.39	479.39	757.77	2,141.51
	MN-05	1,909	124.63	347.61	593.68	916.94	2,213.27
	MN-06	134	6.14	24.67	44.93	73.12	173.30
	MN-09	249	13.39	40.34	71.50	113.63	219.46
Greendale, Village	MN-15	73	8.10	18.66	25.03	40.96	69.01
Greenfield, City	MN-15	1,840	204.54	471.19	632.14	1,034.65	1,743.08
Lisbon, Town	MN-04	196	5.09	22.92	43.72	69.10	195.29
Menomonee Falls, Village	MN-01	2,170	73.04	250.38	484.68	743.58	2,167.59
	MN-04	539	14.00	63.06	120.25	190.08	537.19
	MN-05	376	24.57	68.54	117.06	180.80	436.41
	MN-06	4,031	185.17	743.59	1,354.63	2,204.32	5,224.37
	MN-07	3,640	133.61	564.34	1,023.88	1,613.07	3,934.77
	MN-08	1,070	105.45	238.04	392.98	527.98	932.69
	MN-10	13	1.83	3.18	5.27	7.69	15.74
Mequon, City	MN-01	547	18.42	63.14	122.23	187.52	546.63
	MN-05	420	27.40	76.43	130.54	201.61	486.65
	MN-06	92	4.21	16.89	30.77	50.07	118.67
	MN-09	6,399	343.59	1,035.31	1,834.79	2,916.04	5,631.68
Milwaukee, City	MN-06	2,124	97.58	391.85	713.85	1,161.61	2,753.09
	MN-09	7,305	392.24	1,181.88	2,094.54	3,328.87	6,428.95
	MN-10	2,501	364.98	636.46	1,053.56	1,537.46	3,146.19

Municipality	TMDL Reach	Area (acres)	Monthly Fecal Coliform Wasteload Allocation (billion cells/month)				
			Low	Dry	Mid	Moist	Wet
	MN-12	53	5.86	12.28	18.40	28.30	58.36
	MN-13	198	21.39	42.85	65.89	102.44	213.14
	MN-14	67	16.75	28.73	39.58	60.77	133.15
	MN-15	2,185	242.92	559.60	750.75	1,228.78	2,070.14
	MN-16	2,002	535.54	834.93	1,158.88	1,647.10	3,240.78
New Berlin, City	MN-13	431	46.62	93.38	143.59	223.24	464.46
Richfield, Village	MN-02	98	2.57	11.67	22.10	35.49	100.65
	MN-03	28	1.93	5.04	9.06	13.27	31.28
	MN-04	860	22.32	100.54	191.72	303.06	856.46
Wauwatosa, City	MN-10	2,236	326.26	568.94	941.79	1,374.35	2,812.42
	MN-12	2,445	269.75	565.74	847.46	1,303.81	2,688.63
	MN-13	101	10.94	21.91	33.69	52.38	108.99
	MN-14	705	176.39	302.62	416.87	640.10	1,402.50
	MN-15	150	16.70	38.46	51.60	84.46	142.29
	MN-16	2,827	756.15	1,178.86	1,636.27	2,325.59	4,575.75
West Allis, City	MN-13	1,766	191.20	382.98	588.91	915.56	1,904.86
	MN-15	2,258	251.07	578.38	775.94	1,270.02	2,139.61
	MN-16	316	84.47	131.70	182.80	259.81	511.19
West Milwaukee, Village	MN-16	413	110.36	172.06	238.82	339.43	667.85

Source: Milwaukee TMDL

TABLE 8. REQUIRED PERCENT REDUCTION OF AGRICULTURAL AND NON-PERMITTED URBAN TP AND TSS BY REACH.

Reach	Required Average Percent Reduction of TP from Baseline Load		Required Average Percent Reduction of TSS from Baseline Load	
	Agricultural	Non-Permitted Urban	Agricultural	Non-Permitted Urban
MN-1*	46%	60%	46%	59%
MN-2	30%	43%	45%	55%
MN-3	38%	--	42%	--
MN-4	30%	--	43%	--
MN-5	58%	--	51%	--
MN-6	45%	--	42%	--
MN-7	--	--		--
MN-8	--	--		--
MN-9*	49%	--	51%	--
MN-10	--	--	--	--
MN-11	45%	--	54%	--
MN-12	53%	--	61%	--
MN-13	47%	--	58%	--
MN-14	--	--	--	--
MN-15	--	--	--	--
MN-16	38%	--	58%	--

* = TMDL Reach estimated to have significant agricultural acres that will remain active over the next ten years; other reaches shown in this table either have no ag acres or have ag acres that are expected to convert to urban land use over the next ten years.

Source: Milwaukee TMDL. See Agricultural and Non-Permitted Urban Acres in the Watershed.

Agriculture and Non-Permitted Urban Acres in the Watershed

The Milwaukee River Basin TMDL determined reaches MN 1-6, MN 9 and MN 11-13 in the watershed have some agricultural land use and corresponding agricultural TP, TSS and bacteria reduction targets. This plan recognizes meeting these agricultural reductions will require new or additional agricultural best management practices. Currently, Washington and Ozaukee Counties are working with some of the Menomonee River watershed farmers to implement soil-health based conservation or manure management practices by utilizing a variety of funding mechanisms to improve water quality and help implement the MRB TMDL. Increasing soil health-based conservation or manure management practices over the next ten years on a portion of the remaining agricultural acres in the watershed will be necessary to meet this plan's phosphorus and sediment reduction goals. Because soil health and/or manure management practices help reduce the amount or frequency of runoff from ag fields or barnyards, those efforts may also help to reduce bacteria loading to some tributary streams in the watershed.

Over the next ten years, some of the TMDL reaches in the Menomonee River Watershed will retain their agricultural acres, while others will have substantial conversion from agriculture to urban acres – and will be subject to MS4 permit requirements. After consultation with the WDNR and

County Land Conservation staff (who reviewed construction stormwater permit data from 2009-2019, existing municipal water and sanitary service areas and 2018-2020 aerial imagery) this plan estimates:

- Approximately 9,815 agricultural acres remain the watershed and are concentrated within the most northern or upstream areas of the Menomonee watershed (TMDL reaches MN 1 and MN9; 040400030401 and 040400030402 HUC12s).
- TMDL Reach MN1 resides mostly within Washington County and TMDL Reach MN9 reside mostly in Ozaukee County.
- Over the next ten years, MN1 will retain 3,340 ag acres and MN9 will retain 2,245 ag acres.
- 42% (4,101 acres) of the remaining agricultural acres in the watershed (9,815 acres) will convert to urban uses in the next ten years.
- Stormwater runoff from ag areas converted to urban land use will be addressed through existing MS4 programs.

Figure 13 shows agricultural areas in TMDL reaches MN1 and MN9 that are likely to convert to urban land use within the next ten years. Agricultural areas estimated to convert to urban land use in next ten years are shown via crosshatch areas within the yellow/high risk for development boundary line. The agricultural acreage conversion estimate methods and calculations can be found in Appendix K.

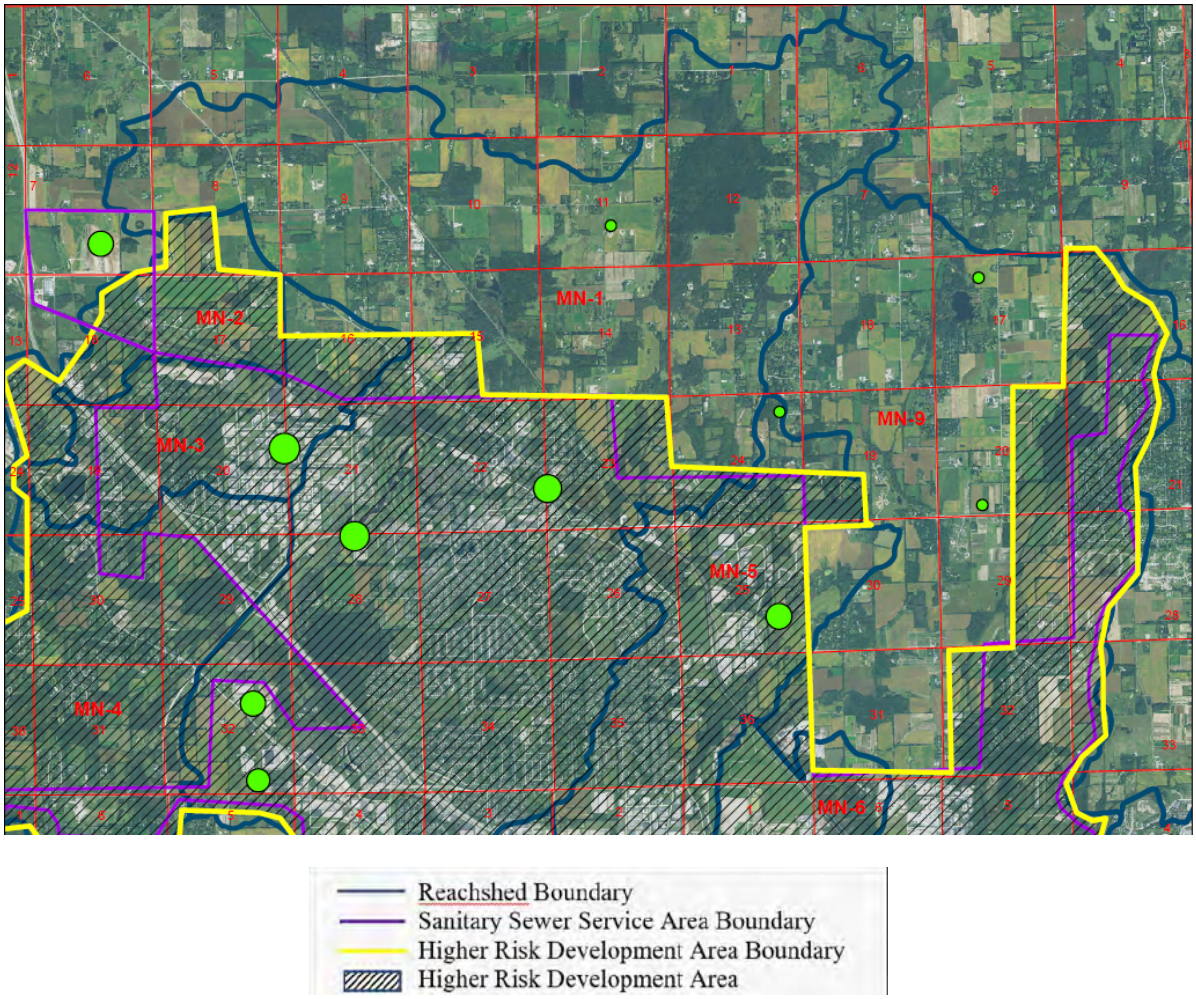


FIGURE 13. REMAINING AGRICULTURAL AREAS WITHIN TMDL REACHES MN1 AND MN9 ESTIMATED FOR CONVERSION TO URBAN LAND USE WITHIN TEN YEARS.

SOURCE: WDNR 2021.

Most agricultural acres in the watershed that receive annual tillage and are managed with little or no crop residue are vulnerable to soil erosion and phosphorus loss. To evaluate the erosion risk from the remaining agricultural acres within the Menomonee watershed (TMDL reaches MN1 and MN9) Washington County staff used WDNR's EVAAL tool. Figure 14 shows EVAAL results. The EVAAL results help identify critical agricultural areas most vulnerable to soil erosion based on topography, soils, land cover, and rainfall and will be used to prioritize fields or areas where soil health-based practices to improve water quality and meet this plan's agricultural phosphorus, sediment reduction goals.

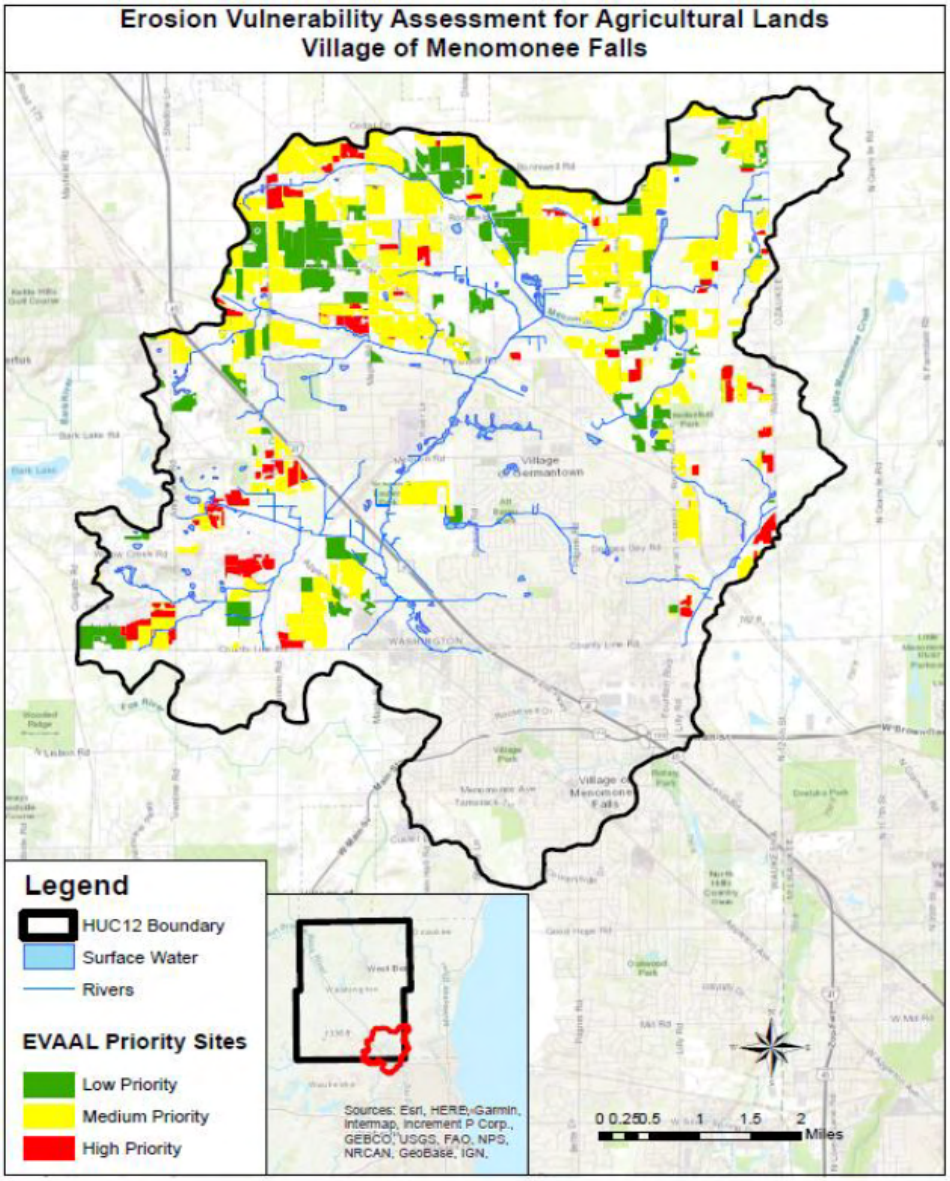


FIGURE 14. EVAAL RESULTS FOR MENOMONEE WATERSHED AGRICULTURAL LANDS - TMDL REACHES MN1 AND MN9.

SOURCE: WASHINGTON COUNTY LAND AND WATER RESOURCE MGMT PLAN – 2021

In addition to EVAAL, WDNR staff used SNAP Plus (Soil Nutrient Application Planner to estimate phosphorus and sediment loss from the remaining agricultural areas in the Menomonee watershed (Figure 14) and determined what types and extent of agricultural practices will help meet TMDL based load reduction goals. SNAP helps farmers and planners calculate soil and phosphorus runoff losses (i.e., expressed as lbs or tons/ac/yr), at a field or farm-wide scale, based on crop rotations, nutrient applications, soil P concentrations, field soil type + slope and tillage practices. SNAP Plus can help identify priority fields for high soil erosion and phosphorus losses. SNAP Plus does not estimate bacteria runoff from agricultural lands. SNAP Plus can also be used at a watershed scale to help translate agricultural TMDL reduction goals into meaningful metrics that county staff and agricultural producers can understand and implement, over time, to improve water quality.

To meet the TMDL based agricultural TP and Sediment load reduction goals in the watershed, SNAP Plus modeling results completed by WDNR were used to confirm that approximately 65% of remaining agricultural acres in MN1 (N = 2,100 acres) and 70% of remaining cropland acres in MN9 (N = 1,500 acres) need to transition from annual tillage to soil health-based practices (i.e., no-till practices and cover crops). Accordingly, the SNAP Plus modeling results, shown in Appendix L, will serve as plan implementation milestones for the remaining agricultural cropland acres within the watershed. Table 9 contains a summary of the agricultural practice milestones for the Menomonee Watershed. In addition to cropland acres, this plan recognizes there are also multiple horse and hobby farms in this section of the watershed and some of these animal operations may need new or improved manure management practices to help meet TMDL-based pollutant reductions goals.

TABLE 9. AGRICULTURAL PRACTICE MILESTONES FOR THE MENOMONEE WATERSHED

TMDL reach	HUC	Year 1-3 **Cropland Acres** with Soil Health BMPs	Year 4-6 **Cropland Acres** with Soil Health BMPs	Year 7-10 **Cropland Acres** with Soil Health BMPs	10-year Goal **Cropland Acres** with Soil Health BMPs
MN - 1	040400030401	700	700	700	2,100
MN - 9	040400030402	500	500	500	1,500

* = Soil Health BMPs reduce or eliminate tillage and increase living cover/residue

Appendix M contains cost estimates for the extent and types of agricultural BMPs (i.e., cropland acres and animal-based operations) planned for the watershed. The cost estimates reflect the number and types of cropland practices captured within the WDNR derived SNAP Plus modeling results shown in Appendix L. Cost share rates (per acre or per practice) in Appendix M are based on conversations with Washington and Ozaukee County Land and Water Management staff and reflect rates captured within the WDNR and US EPA approved Cedar, Pigeon, Ulao, and Mole Creeks Watershed Restoration Plan [PDF] .

Combined Sewer Overflows

MMSD's WPDES permit allows up to 6 Combined Sewer Overflows (CSOs) annually; in recent years, the average number of annual CSOs has been 2.3. The permit also requires MMSD to capture and treat at least 85% of combined sewage in the CSSA; since 1993, the actual amount has exceeded 98%. Appendix 10A of MMSD's 2020 Facilities Plan (FP) details the District's CSO Long Term Compliance Plan (LTCP), consistent with EPA's 1994 policy guidance for CSO compliance. In addition to implementing the nine minimum technology-based controls detailed in an MMSD 2003 document, specific measures include upgraded capacity for the Inline Storage System (ISS) pump station at the Jones Island treatment plant and operational strategies to curtail CSS discharges at an outfall north of South Shore Park. Overall, the 2020 FP adopts a watershed-based approach to reducing CSOs, in accordance with the companion RWQMPU (see also 2050 FP below).

The implementation schedule for the elements of the 2020 Facilities Plan is included in Appendix 11A, and includes both "adaptive" and "full" versions which track actual and maximum population projections, respectively. Implementation progress is reported annually to WDNR. The implementation schedule beyond 2020 will be included in the 2050 Facilities Plan. This plan will include milestones at 6-year intervals that correspond with budget timelines. It will also include 2035 and 2050 milestones, which correspond with the timeframes to achieve the goal of zero CSOs and the anticipated full buildout of the MMSD service area, respectively. The 2050 FP will include preliminary modeling of the potential contributions of various levels of GI implementation to reduce future occurrences of CSOs.

Flooding and Water Quantity Control

Water quantity and flood management are highly correlated to the water quality of a stream or river. This is perhaps especially the case in the highly urbanized Menomonee River Watershed where extreme flooding events have plagued the area throughout the last several decades. Flood events collect pollutants from streets and paved surfaces, rushing them to nearby waterways, causing sewer overflows, eroding streambanks, and discouraging recreational and stewardship opportunities. High volumes of polluted runoff also pose safety and property damage concerns. The following section will establish the flood management and water quantity baselines and determine the goals and measures of progress in the Menomonee River Watershed over the next ten years to help achieve watershed restoration as well as to support water quality improvements.

Current Conditions

As with many U.S. cities, the increased variability and intensity in rainfall has led to a more focused approached on how to manage flooding in urban communities. The Menomonee River has experienced amplified flood events as a result of increased rainfall in the highly urbanized context of the watershed, particularly during the last ten years. Extensive portions of the watershed were channelized with concrete as a flood management measures in the 1960s and 1970s.

Approximately 8 percent of stream miles in the watershed are concrete lined channels and 2 percent enclosed culverts, both of which amplify the speed and volume of runoff (i.e., increase "flashiness") compared to natural stream conditions. Although concrete channels were meant to reduce flooding, the continued upstream development of the watershed has led to more impervious surface, increased runoff, and increased flooding. The high level of "flashiness" in the watershed also leads to increased erosion and streambank failure, and in some sub-watersheds, excessive levels of woody debris that can become barriers to fish passage.

By the 1990s, flooding from the Menomonee River and Underwood Creek began to occur regularly, and to address this, MMSD began work on a large flood retention facility on the Milwaukee County Grounds, which was completed in 2011. This facility included a 3,000-foot-long diversion tunnel and a 315 million-gallon floodwater detention basin. Since the facility's installation, floodplain impacts (100-year or 1 percent chance event) have been reduced within the project area between one to two feet, and that allowed MMSD to remove approximately 6,600 feet of concrete channel on Underwood Creek (see aquatic habitat section) and replace that with a more natural, meandering stream.

Historically, MMSD and partners completed several other flood management projects to protect the Valley Park neighborhood, as well as the western portion of Milwaukee County including Wauwatosa and Milwaukee in Hart Park. These projects began in the late 1990s after many homes in the Valley Park and Hart Park neighborhoods were ravaged by floods. The Valley Park project was completed in 2001 and was soon followed by work in Hart Park that was completed in 2007. These projects involved increasing storage in the floodplains, purchasing and demolishing homes, removing concrete channel, and building flood walls, and projects completed on and planned for adjacent tributaries and river segments add to these flood management efforts. However, even though much progress has been made through these efforts, increasing development in areas upstream and large amounts of impervious surface in the watershed still remain as large barriers to achieving water quality as well as water quantity goals.". These projects involved increasing storage in the floodplains, purchasing and demolishing homes, removing concrete channel, and building flood walls. Even though large gains have been made on flood management efforts in the watershed, increasing development in areas upstream and large amounts of impervious surface in the watershed still remain as large barriers to achieving water quality as well as water quantity goals.

Flooding and Water Quantity Control Goals and Metrics

The following goals and metrics were formulated by combining the flood management goals of multiple organizations in the watershed, through numerous conversations with environmental non-profit groups, and by gathering feedback from government agencies responsible for regulation and flood management. These goals were then vetted with key stakeholders in the watershed.

Goals	Metrics
1. Reduce flooding occurrences in the Menomonee River Watershed to maintain a safe and dry community to the 1% probability storm 2. Reduce flashiness of streams 3. Return streams to a more stable state by improving from current conditions*	1. Linear feet of concrete removed 2. Number of properties flood-proofed 3. Acre feet of flood storage added 4. Modeling results 5. Number of bridges and culverts improved or replaced 6. Number of properties acquired and removed from the floodplain

* = Figure 15 shows a 2009 inventory of streambank and stream channel conditions in the watershed

Western Milwaukee Flood Management Project

MMSD has several current and future flood management activities in the watershed as part of their Western Milwaukee Flood Management Project. There is an ongoing $6 million project to daylight a 500-foot portion of Schoonmaker Creek from a concrete culvert underground at its confluence with the Menomonee River. This project creates more storage for floodwater along the Menomonee River, constructs a wetland adjacent to the new creek channel, and provides environmental and habitat improvements for both waterways. This project is part of the Western Milwaukee Flood Management Project that will reduce the risk of flooding for 65 homes and businesses in Wauwatosa and Milwaukee. The Western Milwaukee Project, in combination with other Menomonee River projects mentioned above--the Milwaukee County Grounds flood detention, Hart Park, and Valley Park projects—is providing protection from the one-percent probability flood (a storm with a one percent chance every year) or 100-year flood to over 363 homes and businesses. To learn more, visit: https://www.mmsd.com/what-we-do/flood-management/western-milwaukee

AQUATIC AND TERRESTRIAL HABITAT

Stable and diverse habitat is a key component to watershed restoration and highly correlates with the water quality of a system. As water quality improves, better quality habitat for fish and aquatic life can result, and vice versa, creating a positive feedback loop. Without healthy habitat, water quality improvements are unlikely to have a major impact on fish and aquatic life. A healthy watershed requires good water quality and high-quality habitat. Portions of the Menomonee have decent water quality but are concrete channelized, and so unlikely to achieve goals for healthy habitat. Conversely, high quality habitat will also not support fish and aquatic life if water quality and conditions are poor.

CURRENT CONDITIONS

The majority of the Menomonee River Watershed lies within the Southern Lake Michigan Coastal Landscape where the landscape was influenced by glacial lake features, with the upper northwest quarter of the watershed located within the Southeast Glacial Plain Ecological Landscape containing lime-rich soils frequently overlain by silt-loam.

Historically the watershed was predominantly dominated by forests of sugar maple, basswood-beech and some oak in the lower three quarters of the watershed with oak forest, oak savanna, and prairies dominating the landscape. Numerous black ash and relict cedar and tamarack swamps were found across the landscape, with oak savannah dominating the upper one quarter of the watershed.

Today, however, only about 8% of the Southern Lake Michigan Coastal Landscape and 10% of the Southeast Glacial Plain Ecological Landscape remains forested having been replaced with urban and agricultural landscapes, respectively. Some remnant tamarack swamps and large wetland complexes still exist in the northern half of the watershed. However, SEWRPC estimates that the population in the watershed will grow between 30-35% by 2050, and this will likely result in even more urbanization or sub-urbanization of areas within Ozaukee and Washington Counties.

Milwaukee County is classified as a humid continental climate, in which large seasonal temperature differences between summer and winter months are seen. Precipitation is typically well distributed throughout the year, with rainy and humid summers and snowy winters. An upward trend in average annual temperatures has occurred in the last 150 years, however, which may have great influence on habitat restoration goals and plans. As temperatures continue to rise, the Milwaukee area should expect to see a shift towards warmer climate species, will be at greater risk for invasive and exotic species to colonize, and will experience an increase in large, drastic storm events.

The Menomonee River Watershed contains 96 miles of streams and 4,537 square miles of wetlands but has been severely altered historically with the addition of 36 dams and/or concrete drop structures, and 269 culverts and bridges (DNR, 2010; SEWRPC, 2010). The fishery in the watershed has been and continues to be dominated by pollution tolerant fish species. Populations of carp have increased and are likely having a negative effect by destroying habitat and competing with native fish species. After removal of the Falk Dam, brook trout, brown trout, smallmouth bass, black crappie, walleye, and greater redhorse were identified in the watershed. Since removal of other impediments, we are now seeing young of year Northern pike in portions of the Little Menomonee River in Ozaukee County. There have been notable losses of other pollution intolerant species including the blacknose shiner, spottail shiner, the least darter and reside dace, which are species of special concern in the State of Wisconsin. Additional species that have not been observed since 1975 include the southern redbelly dace, northern redbelly dace, and grass pickerel (SEWRPC 2007a; WDNR 2010).

The 2010 Watershed Restoration Plan and Implementation Plan recommended extensive fish passage surveys and removal of barriers in the watershed, starting from downstream and moving upstream along the mainstem, and then reconnecting tributaries, and high-quality habitat areas (SEWRPC 2010). Milwaukee Riverkeeper completed a Fish Passage Impediment Survey in 2011 that identified partial and complete stream impediments along the natural main stem reaches of the Menomonee and Little Menomonee Rivers, as well as 10 major tributaries that are not concrete

channelized or enclosed, and that provide access to higher quality natural areas that could be used for fish spawning or rearing. One of the major goals identified in the 2010 Watershed Restoration Plan and Implementation Plan for the watershed was to remove obstructions to fish passage and restore access to high quality natural areas is the most cost-effective way to increase aquatic life diversity and productivity in the Menomonee River Watershed. Over 382 potential barriers were identified and assessed, with 126 of those found to be significant. In addition, 75 areas of potential spawning habitat for northern pike and other native fish were identified. This plan incorporates and these prior surveys of fish passage and barriers. The prior surveys will be used to establish milestones for each municipality and other stakeholders in the watershed to improve fish and aquatic habitat.

Large portions of the Menomonee River and its tributaries were historically lined with concrete and straightened or channelized for flood management or agricultural purposes. Concrete lining is largely localized within Underwood and Honey Creek (Figure 15), and much of the area does not have adequate riparian buffers, or plants that border the stream to filter pollutants or provide habitat (Figure 16). A large portion of the Nor-X-Way Channel is lined with concrete and channelized upstream of its confluence with the Menomonee River. In the locations where channels are not present, stream bank stability is very poor and erosion poses a large threat to aquatic and terrestrial habitat (Figure 15). For example, Lily Creek remains unstable with over 70% eroded stream banks posing a large threat to aquatic and terrestrial habitat.

Progress is being made in the watershed to improve habitat and remove impediments to fish passage. Over the last few decades, several dams have been removed from the Menomonee River including the Falk Dam (at 27th Street), and a small dam adjacent to Miller Brewery (at 45th Street) in the early 2000s. In late 2015/early 2016, MMSD removed 4 low flow dams from the Menomonee River mainstem in Hoyt Park (downstream of Swan Boulevard), and constructed a rock ramp to bridge another elevation drop from an active sewer pipe crossing serving the Hoyt Park pool. Milwaukee Riverkeeper removed 19 debris jams from the Little Menomonee River (largely downstream of Fond du Lac Avenue) and 7 barriers from the mainstem of the Menomonee River (mostly north of Mill Road) as identified in the fish passage impediment report.

Since 1999, approximately, 4,700 feet of concrete has been removed from the lower Menomonee River by MMSD and the US Army Corps of Engineers, with in-kind support from WDNR, Trout Unlimited and Milwaukee Riverkeeper. The Menomonee River in Milwaukee was deepened and lined with concrete in 1965 for nearly one mile from 400 feet upstream of N. 45th Street downstream to 500 feet south of Interstate Highway 94 (I-94). The concrete channel began near Miller Park just 3.8-miles upstream of the Milwaukee River Estuary and the confluence with Lake Michigan. These modifications to the Menomonee River streambed and banks were a local flood management solution that resulted in a barrier to fish and wildlife movement along with a hazard to navigation and recreational uses of the river. The concrete channel was also beginning to fail.

In 1999, MMSD began the incremental removal of the concrete starting with the first of three projects. Approximately 1,000 feet of the upstream concrete lining was removed from approximately 400 feet upstream of N. 45th Street Bridge to the Canadian Railroad Bridge located at River Mile 4.26. A 4.5 feet high concrete drop structure that acted like a dam was also removed. The concrete lining was replaced with a rock-lined pool and riffle stream design. The total project cost was nearly $4.8 million and the project was completed in 2000.

In the summer of 2013, the second project began by removing approximately 1,000 feet of the steepest section of concrete channel downstream of the Canadian Pacific Railroad Bridge to the Bluemound Road Bridge. Thirteen pools were constructed to assist with fish passage along this rock-lined stretch. This project was completed in 2017 at a cost of approximately $5.7 million.

The third project began in the fall of 2014 and removed the remaining 2,700 feet of concrete lining from the Bluemound Road Bridge to 500 feet south of I-94. This section was not as steep as the other sections and did not have any drop structures. The U.S. Army Corps of Engineers partnered with MMSD by designing and managing the construction. The project was finished in 2016 at a cost of $7.5 million with the Army Corps paying approximately $5 million. Concrete lining was removed from the streambed, and a series of pools and riffles were created.

During the 1960s and 1970s, Underwood Creek was altered for flood management purposes including concrete lining, channel widening, and installation of concrete drop structures. While these modifications successfully reduced peak water surface elevations, in-stream habitat was virtually eliminated as well as aquatic species connectivity to upstream reaches. In 2011, MMSD began removing concrete from the channel bottom and removing drop structures to enhance connectivity from the confluence of Underwood Creek with the Menomonee River to approximately Mayfair Road. Concrete channel was removed, the stream was re-meandered where possible, pools and riffles constructed, in-stream habitat improved for macroinvertebrates and other aquatic life, and floodplain habitat restored with native plants. In total, MMSD has removed approximately 6,600 linear feet of concrete in two phases, with 4,400 feet of that concrete removed largely in 2017. Some restoration and maintenance is still ongoing. As mentioned in the flood management section, there have also been habitat improvements made to Schoonmaker Creek and the lower Menomonee River as part of flood management activities.

These existing projects in the watershed collectively help to address restoration of fish passage, sustainable fish populations, in-stream habitat, riparian plant communities and water-based recreational uses in one of Wisconsin's most urbanized, populated and demographically diverse watersheds. The fish passage work completed, thus far, has helped to restore some fisheries present in the watershed, such as greater redhorse, common white suckers, and northern pike. This work has also enhanced movement of salmon and trout species, which have become a popular fishery in the lower Menomonee River and which are now migrating well past Pilgrim Road in Menomonee Falls. With that said, many sport and recreational fish such as walleye and smallmouth bass still do not have access to their historical spawning and rearing habitat in the

watershed, including over 1,000 acres of upstream riparian wetlands. More work still needs to be done to remove smaller fish passage barriers; to better connect streams with floodplain and wetland habitat that no longer connects to streams due to down-cutting of streams; and to continue to improve fish passage and habitat and create new fishing opportunities along the 37 additional miles of river, tributaries and corridor habitat that exist downstream of the Lepper Dam in the Village of Menomonee Falls (the last "major" barrier). There is also potential work to improve resident fish populations in streams upstream of the Lepper Dam in Menomonee Falls.

Goals	Metrics
1. Remove Fish Passage Barriers	Number and types of fish barriers removed
2. Restore access to historical spawning and rearing habitat in the watershed, including over 1,000 acres of upstream riparian wetlands	Number of stream segments reconnected with floodplain and wetland habitat Acres of historic spawning and rearing habitat reconnected to downstream waters
3. Create new fishing opportunities along the 37 additional miles of river, tributaries and corridor habitat that exist downstream of the Lepper Dam in the Village of Menomonee Falls	Number of new fishing areas downstream of the Lepper Dam in the Village of Menomonee Falls Number of properties acquired and restored to improve fish habitat/populations
4. Restore/Improve resident fish populations in streams upstream of the Lepper Dam in Menomonee Falls	Fish and Habitat Assessments of specific streams in watershed by DNR or equivalent biologists

While stream bank erosion is not a major issue in all streams of the Menomonee River Watershed, new construction in the watershed is a major source of sediment in Menomonee streams and rivers that can impair fish and aquatic life habitat. Sediment can impair water quality, destroy macroinvertebrate habitat, fill in stream segments, create fish passage barriers, and also harm or kill fish and other aquatic life at very high levels, or even moderate levels over extended periods of time. Improperly managed construction sites can contribute significant amounts of sediment to local waterways; up to 10-20 times greater than that of agricultural lands per the US EPA. Construction activities that disturb an acre or more of land are subject to state construction site regulations to limit the amount of sediment that is permitted to leave a site. MMSD also has Chapter 13 rules that will regulate runoff from new development and re-development of over a half-acre or more in their service area to reduce flood risk. Other significant sources of sediment may come from some of the remaining farming operations that allow over-graving and/or and livestock trampling streambanks. Streambank restoration projects within the watershed to address agricultural sources of sediment and implementation of MS4 permits to meet the Milwaukee River TMDL TSS reduction goals will help reduce sediment pollutants that can impair water quality and aquatic habitat throughout the watershed.

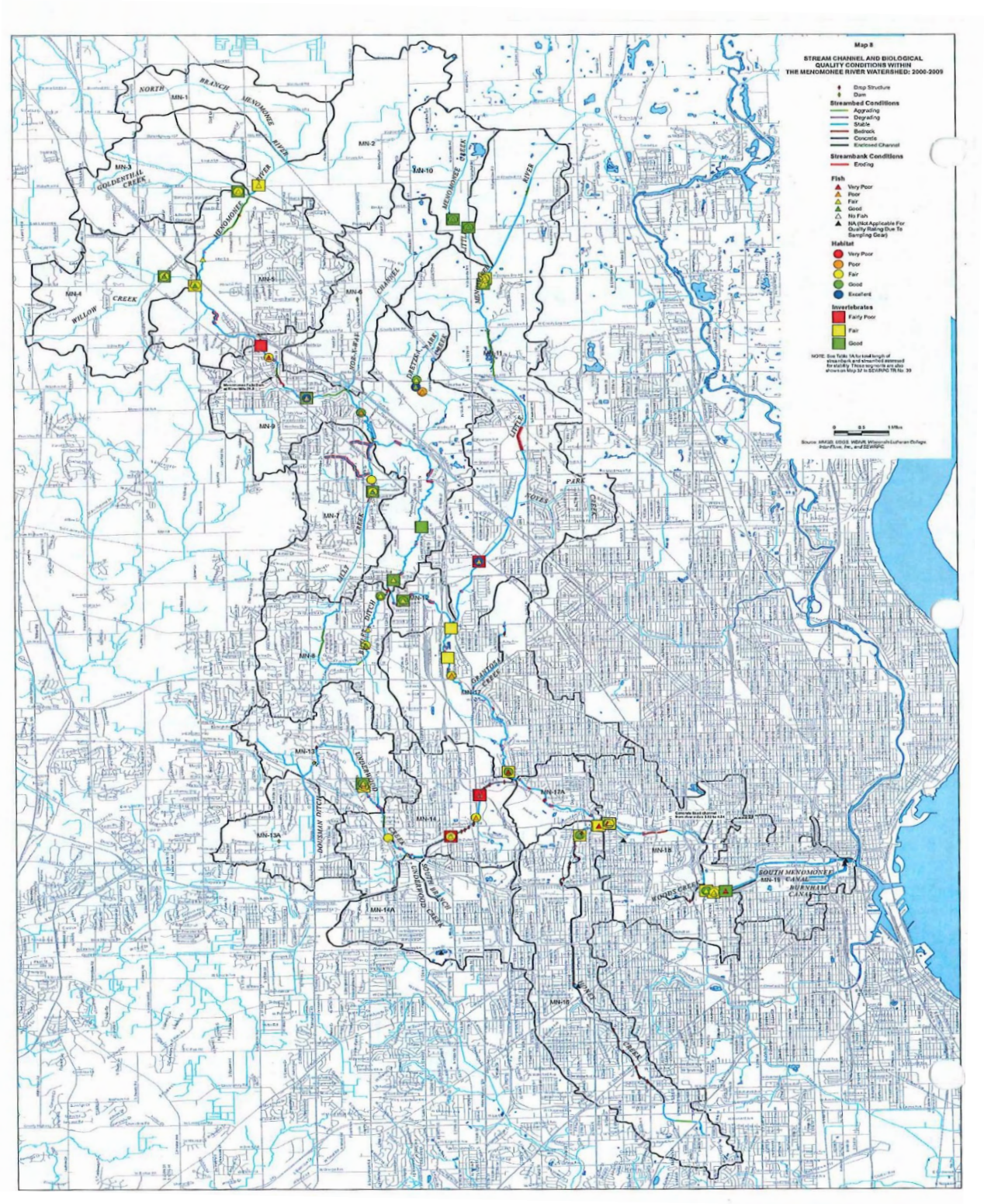


FIGURE 15. STREAM CHANNEL AND BIOLOGICAL QUALITY CONDITIONS WITHIN THE MENOMONEE RIVER WATERSHED: 2000-2009.

Source: SEWRPC, 2010

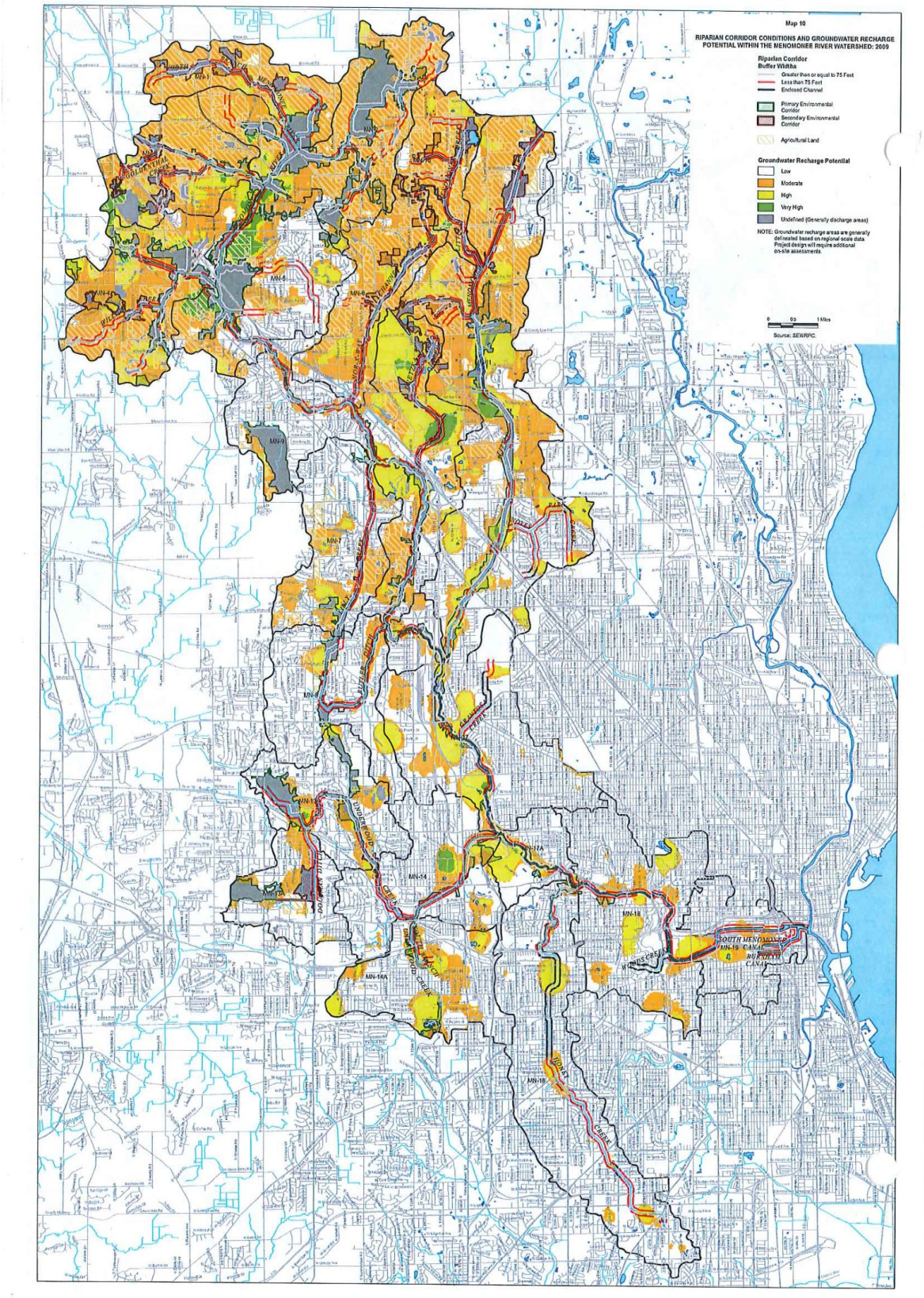


FIGURE 16. RIPARIAN CONDITIONS AND GROUNDWATER RECHARGE POTENTIAL WITHIN THE MENOMONEE RIVER WATERSHED: 2000-2009.

Source: SEWRPC 2010

AQUATIC AND TERRESTRIAL HABITAT GOALS AND METRICS

The following goals and metrics were formulated by combining habitat goals and metrics of multiple organizations in the region, through numerous conversations with environmental non-profit groups, consulting with government agencies responsible for regulation, and vetting with key stakeholders in the watershed. These goals and metrics align with the existing habitat restorations projects and corresponding goals and metrics described above.

Goals	Metrics
1. Meet, maintain, or improve the natural community classifications of the Menomonee River waterways 2. Remove concrete lining 3. Expand riparian buffers to 75 feet wherever possible 4. Improve connectivity of riparian zones for wildlife habitat and restore buffers 5. Protect high quality areas and sensitive lands 6. Restore fish and aquatic organism passage and improve stream connectivity 7. Remove trash and debris from aquatic habitat	1. Biological Index 2. Acres of riparian habitat and/or river buffers 3. Acres of connected riparian habitat and or/river buffers 4. Linear feet of stream bank restoration and stabilization 5. Linear feet of streams connected via removal of barriers 6. Acres of exotic invasive species removed 7. Linear feet of concrete channel removed 8. Number of barriers to organism passage removed

POLICY IMPLICATIONS

Policies and regulations often lag behind innovative solutions to watershed problems and it is often the case that they unknowingly hinder progress. Without updated policies in the watershed that accurately reflect and support the goals and objectives of the Plan, watershed restoration will occur at a slower and costlier pace.

CURRENT CONDITIONS

Despite the growing popularity of green infrastructure practices to address stormwater runoff into our watersheds, many local policies and regulations make implementation difficult and costly, both for municipalities and the private sector working within those municipalities.

Green Infrastructure Codes and Ordinances

In 2005, MMSD created an audit of codes and ordinances relating to Green Infrastructure for municipalities within its service area. In a recent effort conducted by SWWT and the non-profit Clean Wisconsin, approximately 70 local professionals were polled in a series of roundtable meetings throughout 2016 to identify barriers to green infrastructure. The major barriers identified included: cost, operation and maintenance, and lack of regulation *requiring* green infrastructure.

These findings were supported by an earlier study conducted by the non-profit organization 1,000 Friends of Wisconsin in 2013-2014, which examined the codes and ordinances of all Menomonee River Watershed Based Stormwater Permit municipalities, and made recommendations to improve these ordinances. The audit found that despite the fact that all of the municipalities in the Menomonee River Watershed have either group or specific stormwater permits that would open up the possibility of green infrastructure, several policy barriers remain that either impede implementation of green infrastructure or are not strong enough to encourage green infrastructure.

In 2018-2019, Clean Wisconsin and Sweet Water conducted additional briefings for West Milwaukee and West Allis along with copies of the recommended code and ordinance changes for their jurisdictions. Five municipalities in the Menomonee group have already adopted most of the recommended ordinance changes over the last several years (Milwaukee, Wauwatosa, Greenfield, Menomonee Falls, and Germantown). The last two municipalities, Butler and Brookfield, both opted out of MMSD's Green Solutions program, which historically gave grants back to participating municipalities for green infrastructure as part of their sewer fees. Most municipalities outside of Milwaukee County opted out of that program, which removes a funding source for GI. Brookfield has adopted several ordinance changes, but Butler had not adopted any. All Milwaukee County municipalities are still eligible for MMSD Green Solutions grants for green infrastructure.

Watershed-Based Municipal Stormwater Permit

One of the biggest policy efforts in the Menomonee River Watershed was the creation of a Watershed-Based Municipal Stormwater Permit for 10 municipalities and Milwaukee County that went into effect November 30, 2012 (and expired in December 2017). This watershed-based stormwater permit was the first such permit in the United States and was a priority action identified in the Menomonee River Watershed Restoration Plan and Implementation Plan (2010). The permit builds on the existing Wisconsin Pollutant Discharge Elimination System (WPDES) municipal separate storm sewer system (MS4) permit for the Menomonee River watershed municipalities, and includes both individual and group permit requirements that are customized to watershed issues and opportunities. In particular, this permit was focused on watershed-specific pollutants of concern, such as bacteria, TSS, and phosphorus that were identified in the MRB TMDL, and facilitated collaboration of municipalities in watershed education efforts as well as restoration efforts such as green infrastructure and streambank stabilization projects.

The City of Mequon, Village of Richfield and Town of Germantown were not included due to their small amount of land in the watershed, and other counties such as Washington, Waukesha, and Ozaukee County did not participate, and neither did Miller Park nor the Wisconsin State Fair Park, which also have individual stormwater permits. More information on the framework for this permit can be found here: http://www.sewrpc.org/SEWRPCFiles/Publications/mr/mr-204-framework-for-stormwater-permit-men-river-wshed.pdf.

The group watershed-based stormwater permit included a provision requiring group projects, with the intent to facilitate larger and more cost-effective projects to achieve larger pollutant reductions. Approximately half of the municipalities partnered to repair an eroding streambank at Rotary Park in Menomonee Falls; Butler repaired an eroding streambank in Frontier Park and Germantown constructed a treatment wetland; and a second group of municipalities partnered on creating and funding 22 stormwater treatment bioswales along the lower Menomonee River Parkway (35,907.6 square feet). This latter project also included restoration of a wetland for stormwater treatment (93,785.8 square feet). In addition, dozens of additional green infrastructure practices were installed individually by Menomonee municipalities.

The group also worked together to create a prioritization spreadsheet or matrix to identify areas of their sewer systems with potential for discharge of human sewage or bacteria to area waterways. The goal was to identify areas of each municipal storm sewer system for more illicit discharge detection and elimination work to address high bacteria levels in the watershed that are suspected to be coming, in part, from failing storm sewers that are contaminated with human waste. This spreadsheet looked at age of development, pipe condition, water quality conditions, other crossing or adjacent utilities, etc. The municipalities also were required to tests all sizes of sewers for illicit discharges and to test "clean" stormwater outfalls once in the 5-year permit term. This was a new requirement to encourage testing of both minor and major outfalls that are sources of pollution to the watershed.

In April of 2020, the second iteration of this watershed-based stormwater permit was issued incorporating TMDL load reductions and enhanced requirements relating to municipal ordinance updates to facilitate green infrastructure as well as increased efforts required for addressing bacteria through monitoring and illicit discharge detection and elimination programs (Appendix F). The permit also includes a framework to better identify and respond to sources of bacteria into area waterways, given that many area waterways are impaired for bacteria and now governed by a bacteria TMDL. Additionally, the permittees are encouraged to continue to collaborate on educational efforts such as Sweet Water's Respect Our Waters Program, as well as to meet regularly to discuss issues affecting the watershed, such as chloride and implementation of the new watershed TMDLs, as well as to identify opportunities for collaboration.

In addition, the 2010 watershed restoration plan and subsequent implementation plan for the Menomonee River also identified implementation of the TMDLs as a main priority, as well as identification of opportunities for implementing policy tools such as using adaptive management and water quality trading projects as additional goals/priority. Given delays in drafting and approval of the watershed TMDLs, which were approved in summer of 2018, there has been little progress on these policy items. The Watershed Based Permit structure would allow for easier collaboration and an adaptive management approach. More information on these policy tools and municipal implementation of TMDLs can be found in this WDNR guidance document: http://dnr.wi.gov/news/input/documents/guidance/ms4guidancefinal.pdf

Other policy items identified in the 2010 Plans included working with municipalities to help implement the State's new phosphorus regulations as well as existing TSS regulations through NR151 in a cost-effective manner. Implementation of the state phosphorus standards has been slow as permits come up for review, but implementation should be enhanced by the new TMDL for total phosphorus. The state also approved a multi-discharger variance for phosphorus in 2019 that allows a point source to request a variance if the discharger can reduce effluent phosphorus, implement a watershed project directly, by working with a third party, or by making payments to county Land Conservation Districts for pollution reduction efforts. More information on this program can be found here: https://dnr.wi.gov/topic/wastewater/phosphorus/implementation.html

The 2010 Plans also suggested making changes to the chemical additives used by municipal drinking water systems as anti-corrosion inhibitors, which are in the form of ortho-phosphate. These inhibitors are a significant source of phosphorus loading to area watersheds via cooling water discharges (largely via individual permits) from industry, and from other activities such as lawn watering and car washing. The lower Menomonee River has significant non-contact cooling water discharges. SEWRPC's Regional Water Quality Management Plan Update showed that phosphorus levels in streams increased in different areas of the Milwaukee River Basin when phosphorus-based corrosion inhibitors were used, and this did not occur in other watershed that do not use these inhibitors (SEWRPC 2007). This issue has been complicated by recent events pertaining to concern over lead pipes in the Greater Milwaukee Area; however, there has been some good progress made, and MMSD is partnering with some industrial discharges on whether they can collect and treat non-contact cooling water discharges from several facilities discharging to the Menomonee River as part of its 2050 planning efforts.

Policy Goals and Metrics

The following list of goals is informed by a summary of the strategic outcomes of the green infrastructure roundtables for the Greater Milwaukee Area, implementation of which could have significant influence on the Menomonee River Watershed. Due to the multiplicity of civil divisions in the Menomonee River Watershed, Green Infrastructure (GI) policies adopted by the various municipalities in the watershed over the next ten years will have consequences that reach beyond individual municipal borders. In addition, other policy goals relate to continuing watershed collaboration in the form of implementation of the group stormwater permit for watershed municipalities, implementation of TMDL derived TP, TSS and bacterial reductions via MS4 permits, and associated compliance tools for point source dischargers, such as adaptive management and water quality trading.

Goals	Metrics
1. Strengthen regulations requiring green infrastructure. 2. Incentivize and help fund green infrastructure implementation.	1. Number, extent, and effectiveness of stormwater management plans that include green infrastructure practices 2. Number of codes and ordinances updates adopted

3. Accurately reflect recommendations of the Plan in local regulations. 4. Strengthen watershed collaboration and implementation of cost-effective water quality improvement projects through watershed-based stormwater permit and other measures. 5. Implement TMDL measures to address TP, TSS, and bacteria issues that lead to waterway impairments.	3. Compliance with requirements from watershed-based stormwater permit for the Menomonee municipalities and Milwaukee County 4. Number of group and individual projects implemented 5. Progress by MS4 municipalities toward achieving TMDLMS4 waste load reductions in the watershed

Recreation and Public Access

Recreational opportunity and access are crucial to the ideals of watershed restoration. Bringing the community to the riverside and getting people on the Menomonee river can help to develop a sense of stewardship for the watershed. This stewardship is crucial to citizen safety around water, citizen enjoyment of the water, proper maintenance of watershed restoration projects, citizen monitoring efforts, and establishing the political support needed for restoration projects.

Current Conditions

During the development of the 2010 Menomonee River Watershed Restoration Plan and Implementation Plan, it was clear that watershed stakeholders valued improvements in public access to the Menomonee River as well as improvements to aesthetics. In addition, there was much emphasis on encouraging protection of riparian corridors to enhance wildlife habitat and water quality protection as well as to improve connectivity and river access for humans and wildlife alike. Many of the foundation and priority actions identified during public meetings and design workshops related to making improvements to riverfront properties and acquiring properties where possible.

Butler stabilized a failing streambank and put in stairs to provide better riverfront access in Frontier Park in 2014. In 2012, Menomonee Falls partnered with Milwaukee Riverkeeper to improve an existing pedestrian bridge in Rotary Park and stabilize several hundred feet of streambank. In 2016/2017, these efforts were expanded upstream and a river access/fishing access added just south of Pilgrim Road. Planning new pedestrian crossing upstream of village in 2016. MMSD's removal of concrete channel and habitat restoration work in the lower Menomonee River and Underwood Creek have provided improved access as well as major aesthetic improvements. Similarly, removal of low-flow fish passage barriers in Hoyt Park has improved the recreational experience there. Milwaukee County also refurbished the Hoyt Park pedestrian bridge in 2016. Three Bridges Park in the Menomonee Valley added two new pedestrian crossings over the Menomonee River and added several new river access points in 2015!

Several Menomonee River access locations in downtown Milwaukee and the Menomonee Valley are included in the new 2016 version of the Milwaukee Urban Water Trail managed by Milwaukee

Riverkeeper, as well as access points managed by several local businesses. Upstream access points in the watershed are not currently included in the Water Trail because stream flashiness and excessive amounts of woody debris make paddling in most of the watershed a very frustrating experience for most people. In order to facilitate paddling in the watershed, more active management of debris would have to be taken on by riparian landowners, government, and/or non-government organizations.

Removal of concrete channel, dams, and woody debris barriers have resulted in improved fisheries, and in particular, increased presence of migrating salmonids in the watershed. Spring and fall fishing opportunities have continued to grow over the last decade. Historically, many fishermen and women could be found at Miller Park during steelhead season, but now fishing enthusiasts can be found further and further upstream. Fishing in the watershed is also common at many riverside parks including Frontier Park in Butler, Lime Kiln Park in Menomonee Falls, and Schoen Laufen Park in Germantown.

Improving paddling conditions, fishing opportunities (see also aquatic habitat section), and river access will remain a long-term goal for this plan, especially given the population growth that is being experienced and that is projected to occur in the next 20 years. Success in achieving these recreation and public access goals will be closely linked to water quality protection work and implementation of green infrastructure and other stormwater and flood management measures adopted in the watershed.

Recreation and Public Access Goals and Metrics

The following list was formulated by combining goals various recreational goals identified in watershed and vetted with stakeholders in the Menomonee River Watershed

Goals	Metrics
1. Improve the livability of the Menomonee River Watershed through increased green space and outdoor recreational opportunities. 2. Maintain and improve connections between the Menomonee River waterways and local communities. 3. Improve riparian buffers for water quality, habitat, and recreational purposes. 4. Improve access and aesthetics of riverside locations. 5. Improve conditions for paddling, fishing, and other recreational activities.	1. Acres of green space added 2. Miles of trail created and improved 3. Number of recreational programs added 4. Number of safe access points in watershed added or improved 5. Increase in recreational use (e.g. number of visits) 6. Miles or linear feet of riparian corridor improved/connected 7. Improved aesthetic condition as measured by trash removed, visitor use, etc.

PART 3. IMPLEMENTATION AND EVALUATION

The following sections describe this plan's implementation tools to make the water quality, quantity, habitat and recreational goals of the Menomonee River Watershed a reality. Plan implementation is an adaptive process. It builds from prior successes in the watershed, provides solutions to identified problems in the watershed, and incorporates the decades of restoration work and planning that was conducted in the Menomonee into a cohesive watershed restoration plan.

PRIORITY PROJECTS

The priority projects identified in this Plan reflect numerous existing initiatives in the watershed and will help provide cost effective solutions to watershed-related problems. Watersheds are complex systems in which one action can have multiple reactions. For example, water quality improvements can be both a result of and a cause of other watershed improvements such as flood management, habitat restoration, and recreational opportunities. Truly comprehensive planning identifies and supports projects that will result in achieving multiple and synergistic objectives in a cost-effective manner.

Table 10 serves as a starting point for identifying priority projects for this watershed-based plan, which include priority projects identified in the 2010 Watershed Restoration and Implementation Plans, as well as current/future planned projects in the watershed. High Priority will be given to projects that address multiple components of watershed restoration and practices that provide co-benefits across multiple components. The vast majority of these projects were identified as "Foundation Actions" or "Priority Projects" in the existing 2010 Menomonee River Watershed Restoration Plan and accompanying Implementation Plan. Other projects reflect or build upon MS4 permit requirements or agricultural-based practices.

TABLE 10. PRIORITY PROJECTS.

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
Data Collection and Mapping								
Continue water quality monitoring activities to support policy adjustments and management actions, including bacteria testing.	All	Ongoing. In 2018, Milwaukee Riverkeeper tested 24 sites, MMSD monitored 31 sites. Ozaukee County monitored 8 sites.	X				**Milwaukee Riverkeeper, MMSD**, WDNR, Ozaukee County, USGS, UWM, Municipalities	Water quality monitoring continues annually for the next 10 years; Sampling data reviewed every other year to ID critical areas and pollution sources; Year 10 - Complete trend analysis for priority pollutants with monitoring partners
Better prioritize water quality monitoring locations (see monitoring section) to assist with TMDL implementation.	All	New project.	X				**Milwaukee Riverkeeper, MMSD, WDNR,** Municipalities, counties	Year 5 - Review and adjust existing water quality monitoring efforts, with all monitoring partners; prioritize TMDL reaches that make progress towards meeting plan milestones.
Work with public agencies to collect stormwater catchment area maps and public/private outfall information; and integrate data into GIS. This is to assist with IDDE work and identification of priority areas for GI.	All	MMSD has hosted SWWT GIS work in the past including mapping and prioritization efforts (Appendix C). Menom MS4s have submitted maps to WDNR, and have GIS/CAD based systems to identify parts of MS4 most likely to be discharging bacteria/human sewage.	X				**Municipalities, WDNR,** MMSD, Milwaukee Riverkeeper, UWM-SFS, SEWRPC	Assist MS4s permittees in watershed with updating existing stormwater catchment area maps for current 5-year permit (2020-2025).

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
Identify and integrate parcel, property owner and land use/occupancy data into SWWT GIS platform.	All	Complete as part of MMSD hosted GIS platform. Many online mapping tools now exist too.	X				**SWWT, MMSD DNR**	Within 1 year, SWWT and MMSD review MMSD hosted GIS platform with MS4 permittees in watershed to identify how to best use the GIS platform to track completed projects and measurable goals, by TMDL Reach
Implement comprehensive and collaborative projects with stakeholders to implement this plan and make progress towards meeting TMDL reduction goals; track these projects.	All	New project to document progress with TMDL implementation by coordinating and tracking projects.	X				**SWWT, MMSD, DNR** and others	Within 2 years, SWWT, MMSD and DNR staff review municipalities MS4 permit annual reports/measurable goals from last three years and begin tracking, by TMDL Reach, completed projects using MMSD hosted GIS platform.
Pollutant Loading Reduction/Bacteria Reduction Projects								
Reduce bacterial loading in the Menomonee River; finish testing all stormwater outfalls in pilot area between Burleigh and Hawley Ave (3 wet weather tests minimum/pipe and dry weather tests if appropriate).	MN 15, MN 16	Jan 2008-Dec 2016 all outfalls were tested in pilot area. Some follow up work after pipe replacement is warranted but unfunded. MS4s will now be required to take on bacteria source reduction per MS4 permit and TMDLs.	X				**Milwaukee Riverkeeper, UWM-SFS**, **WDNR** MMSD, City of Milwaukee, City of Wauwatosa	Menomonee MS4 permittees develop bacteria monitoring and source reduction plans, for selected stormwater outfalls, to help meet their IDDE MS4 permit requirements/measurable goals across the watershed. Every 2 years, verify all Menomonee MS4 permittees have and are implementing their bacteria IDDE plans.

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
								Evaluate IDDE implementation via water quality monitoring and/or other assessments (e.g., surveys, inventories, modeling, pilot projects)
Find and fix pipes in the Menomonee River Watershed that are contaminated with human sewage based on results of outfall testing. Continue post-fix monitoring to assess bacteria load reductions.	All	Approximately 12 problem pipes have been fixed, but dozens remain. More work and funding needed. Strong emphasis on IDDE in new watershed-based permit.	X				**Municipalities, Counties, WDNR,** Milwaukee Riverkeeper, UWM-SFS, MMSD,	MS4s permittees in watershed test for bacteria at selected outfalls/TMDL reaches as part of 5-year permit term. Within 5 years, examine progress of MS4s in reducing bacteria sources to meet IDDE requirements and TMDL reduction goals. Repeat MS4 bacteria reduction efforts in watershed every 3-5 years.
Work with DNR and municipalities to include bacteria monitoring and find/fix sources of bacteria in stormwater permit requirements. Finish desktop analysis prioritizing storm sewersheds that are contributing human bacteria load.	All	Complete. Bacteria source reduction is included in new watershed-based permit. Bacteria monitoring is required in Appendix B of permit. MS4s have finished desktop analysis from 2012 permit, but should update with TMDL pollutant reductions/allocations. More IDDE needed and required in 2018 permit. Bacteria TMDL completed.	X				**MN Municipalities, WDNR, SWWT, Milwaukee Riverkeeper**	All MS4s update their human bacteria illicit discharge potential spreadsheets based on monitoring results and incorporate TMDL based bacteria reductions as IDDE performance goals**.** Annually collect and review MS4 annual reports submitted by municipalities to DNR to verify types and extent of IDDE efforts in the watershed, by TMDL reach.

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
Conducted Find/Fix Monitoring with Sewage Sniffing Dogs in 8 sewersheds	MN 15, MN 16	Complete 2012/2014	X				**Milwaukee Riverkeeper, UWM-SFS,** MMSD, City of Milwaukee, City of Wauwatosa, DNR	Within 5 years, evaluate if canine detection of bacteria sources can be completed in other TMDL reaches.
Hartung area residential neighborhood needs attention for bacterial sources per Wauwatosa.	MN 16	Done. Diagnostic work done and stormwater pond restoration project complete in 2017 to improve stormwater treatment and aesthetics.	X				**City of Milwaukee, Milwaukee County, Wauwatosa**	Ongoing education/outreach work needed watershed wide to address pet waste. Monitoring should occur in 2022 to determine success of restoration efforts.
Support bacteria treatment and source reduction through stormwater pilot projects.	All	Two pilot projects were selected in 2021. One will treat stormwater at State Fair Park, and another will focus on stormwater outfalls to Underwood Creek and lower Menomonee River.	X				**WDNR, Milwaukee Riverkeeper, Water Council, State Fair, Wauwatosa,** municipalities	Within 3 years, implement both pilot projects and report project findings to MS4 permittees in watershed.
Complete inventory agricultural runoff problem areas or operations in upstream portions of the Menomonee River Watershed for targeting of federal farm bill and state funds Use EVAAL results to focus/target inventory efforts.	MN 1, MN 9	In 2011, we held small group meetings to focus on this issue. Washington County sent out letter to all farmers in watershed advertising farm bill programs and funding sources. Ozaukee County also conducted farmer outreach. In addition, Washington County	X		X		**SWWT, Ozaukee County, Washington County**, **DNR,** Milwaukee Riverkeeper, MMSD Greenseams, NRCS, MN Municipalities	In five and 10 years, re-evaluate ag land use and operations within reaches 1 and 9. Confirm how much agricultural land has been converted to urban land use and how much remains; re-assess number of animal farm operations with manure management problems.

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
		completed one successful barnyard runoff control project on the West Branch of the Menomonee River in 2017 that estimated. removal of 45 pounds of phosphorus annually. SNAP analysis complete in 2021. EVAAL analysis complete in 2019.						Every 2 years, check in and review progress made by Counties to identify and reduce agricultural pollution sources in the watershed; revise SNAP or other pollutant reduction modeling analysis, as needed, to determine if this plan's agricultural milestones are met or not met.
Continue to enroll remaining farmland in farm bill programs, secure easements, improve riparian buffers, increase harvestable buffers.	MN 1, MN 9	Ongoing.	X		X		**Ozaukee County, Washington County, NRCS, MMSD Greenseams,** SWWT, others	Within 5 years, assess remaining agricultural land and prioritize farms for farm bill funding with Counties.
Identify areas of farmland that have been converted to horse or hobby farms, and develop outreach/education and funding plan to address these pollution sources.	MN 1, MN 9	New project. As part of SNAP analysis for this plan, counties identified that many former agricultural fields are becoming horse or hobby farms, and that this source of pollution needs to be better addressed.	X		X		**Ozaukee County, Washington County,** NRCS, Milwaukee Riverkeeper, SWWT	Complete inventory of horse farms/hobby farms in MN1 and 9 within 2 years; and develop outreach/education/funding plans within 3 years to help clean up farms with manure runoff pollution problems.

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
Convene small technical group to develop a strategy to prioritize "find and fix" failing septic systems, based on results of recreational use surveys, data collection/mapping work and existing bacteria loading data.	MN-1 and 9	Complete. The Menomonee Watershed Based Stormwater Group convened a bacteria subcommittee from 2014-2016 or thereabouts. Sweet Water convened a separate Science Working Group on this issue in 2018, and released a white paper in 2020. Looking to start several pilot projects to test white paper procedures in urban and rural area with septic system.	X			X	**SWWT Science Committee**, **MN Municipalities, WDNR**, **SEWRPC, Ozaukee and Washington LC Departments** Milwaukee Riverkeeper, UWM-SFS, MMSD	Within 2 years, complete septic system inventory within TMDL reaches MN 1 and MN 9 to define number and status of septic systems. Using inventory, prioritize areas to allocate or apply for grant funding to help repair failing septic systems. Develop a more refined map of un-sewered areas of watershed within 2 years. Work with MS4 permittees to identify known or suspected leaking septic systems as part of their IDDE efforts.
Conduct pet waste education efforts in the watershed.	All	Pet Waste Education efforts included establishment of annual pet owner fairs in MN Falls and Brookfield; new partnerships with humane societies, UW-Extension, and other partners; establishment of "Paws Pledge for Clean Water Program"; 5 new pet waste stations established. Ongoing education since 2011 through Respect Our Waters. In 2020, will start focus on bacteria.	X			X	**SWWT**, WDNR, Municipalities, NGOs	Within 2 years, work with Menomonee MS4 permittee group to confirm existing and planned pet waste projects and educational priorities, by TMDL reach. Verify ongoing pet waste education efforts in watershed, by TMDL reach every two years. **Evaluate selected areas with and without pet waste education efforts**

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
Convene small group to develop new strategy after release of Bacteria TMDL and to create Implementation Plan for that TMDL that is in line with Watershed Plans and goals.	All	SWWT convened a Bacteria working group, a subset of the Science and Policy Group, to focus on addressing illicit sources of bacteria in urban and rural areas.	X				**SWWT Science Committee, WDNR,** Municipalities, Counties, Milwaukee Riverkeeper, UWM-SFS, MMSD	Continue existing science and policy workgroup meetings for next two years. Evaluate existing bacteria source reduction strategies using monitoring and education/outreach and IDDE efforts by MS4 permittees in selected TMDL reaches every 2 years.
Stormwater Management & Green Infrastructure Projects								
Determine priority stormwater catchment areas for clustered green infrastructure applications to manage stormwater quantity *and* quality on commercial and industrial properties, which contribute heavy loading of pollutants.	All	This analysis work was completed from November 2010-May 2014 (Appendix C). Implementation is still required. Some GI outreach conducted, and retrofits implemented at P&H Mining (now Komatsu), Burleigh Triangle, and other commercial properties.	X				**SWWT**, **MMSD**, WDNR, Municipalities, Clean Wisconsin, Milwaukee Riverkeeper, Menomonee Valley Partners, Harbor District	Apply for additional grant funding and resources to help implement GI projects within heavy pollutant loading TMDL reaches. Within 3-5 years, MMSD installs large, green infrastructure practices within their region, using previously identified parcels. Complete modeling/and or monitoring for GI projects to evaluate pollutant reductions.
Evaluate MS4 permit performance across the watershed and identify ways to support continual environmental	All	Assessment done 2014, and many MS4s have adopted suggested ordinance changes. More work needed.	X				**SWWT, MN Municipalities, Clean Wisconsin**, **WDNR**,	Conduct code and ordinance review/update and audit within 5 years.

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
improvement by permit holders.		Requirement to review and update ordinances in new watershed-based permit. Implementation is ongoing.					Milwaukee Riverkeeper	Review TMDL implementation plans and annual MS4 reports/measurable goals submitted to DNR to determine implementation efforts and corresponding pollutant reductions, by TMDL reach. Determine progress made towards meeting planned actions/measurable goals over the 5-year permit term. Review/compare stormwater outfall monitoring data in areas with significant MS4 permit implementation and/or GI projects.
Work with Milwaukee County and Menomonee municipalities to define and implement projects that help meet countywide NR 216 stormwater management requirements and TSS TMDL.	All	Since 2010, MN municipalities have worked on this as part of individual permit requirements; with most meeting 20% reduction requirements. TMDL for TSS will build on this work. MN municipalities have partnered on group GI projects such as bioswale construction along the MN parkway. More work needed.	X				**Milwaukee County, SWWT, MN Municipalities**, **WDNR**, Milwaukee Riverkeeper, other counties and permittees	All MS4s complete their TMDL implementation plans within 3 years. Review plans and annual MS4 reports/measurable goals submitted to DNR to determine implementation efforts and corresponding pollutant reductions, by TMDL reach. Determine actions taken to meet measurable goals over the 5-year permit term.

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
Identify and implement two capital projects per municipality that could be retrofitted to provide greater stormwater management and pollution loading reductions.	All	Plan completed in 2015 by Jacobs/CH2M (Appendix D); Implementation of these projects is needed.	X				**MMSD, MN Municipalities, WDNR,** Clean Wisconsin, Milwaukee Riverkeeper, Counties, SWWT	Every two years, review progress made by MS4 permittees towards meeting measurable goals and if those efforts align with the 2015 Jacobs/CH2M projects/plan.
Implement coordinated Green Infrastructure reporting and metrics to address quantity and quality objectives of Updated Implementation Plan	All	New Project, which builds on past MMSD and SWWT efforts to document GI practices in writing and on maps in watershed. Could also utilize/build on Reflo community mapping efforts.	X				**SWWT, MMSD**, Clean Wisconsin, Reflo, Milwaukee Riverkeeper	Work with MMSD, MS4s and Reflo to document existing/implemented stormwater BMPs in the watershed, by TMDL reach, within 5 years. Every two years, compare implemented GI projects to the GI hot spots identified in this plan. Within 10 years, implement GI projects on 50% of the GI hotspots identified in this plan.
Road Salt Reduction								
Convene multi-jurisdictional task force to compile local salt use best management practices (as outlined in salt use plans) and build capacity to coordinate efforts resulting	All	June 2011 – ongoing. Some great monitoring work by Milwaukee Riverkeeper since winter of 2010/2011 as well as by MMSD who added winter months as part of their baseline monitoring	X				**SEWRPC, Milwaukee Riverkeeper**, SWWT, **WDNR**, Municipalities, WisDOT, Milwaukee County	SEWRPC to finish their road salt pilot studies and recommendations report by 2022. Confirm, each MS4 permittee is calibrating salt equipment and completing training on each

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
in reduced chloride in runoff.		several years ago. USGS has also done extensive monitoring. SEWRPC has convened task force/advisory committee on Road Salt Reduction and funded study commenced in 2017 and ongoing.						permittee's salt reduction strategy
Reduce chloride through watershed wide utilization of salt application best management practices for municipalities, industry, residents and other property owners.	All	June 2011 – ongoing. Some training of public road salt contractors by Milwaukee County and UW-Extension; Milwaukee Riverkeeper has funded private and public contractor training sessions from 2017-2021. Many MS4s and Counties also hosting trainings. Respect Our Waters also working on public education. More work needed.	X				**MS4s, SWWT, Neighborhood Associations, WDNR,** SEWRPC, Menomonee Municipal Group, Milwaukee Riverkeeper, others	Collaborate with Wisconsin Salt Wise statewide coalition to develop/ coordinate educational efforts and develop a statewide training certification on salt usage/mgmt by MS4 permittees in the watershed. Continue salt education and BMPs annually. Complete progress report within 5 years.
Monitor effectiveness of road salt education efforts in the Menomonee River Watershed	All	New project	X				**Milwaukee Riverkeeper, WDNR, SEWRPC, MMSD**, Others	Within 10 years, revisit past monitored sites for chloride and document changes in water quality.

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
Riparian Buffer Restoration and Enhancement Projects								
Develop a strategy for near-term projects that focus on areas experiencing erosion, where turf grass can be replaced with native vegetation, and where invasive species have encroached into natural areas, with overall emphasis of "do no harm."	All	Originally, this item envisioned a more comprehensive plant and wildlife survey to help identify sensitive areas that needed more consideration prior to streambank or riparian restoration efforts, and to identify "easier" areas to restore. Fundraising was unsuccessful but this information exists in part in SEWRPC documents (Figures 15 and 16).	X		X		SWWT, Milwaukee Riverkeeper, WDNR, MMSD, MN Municipalities, others	Within 5 years, complete inventory of streambanks and riparian areas within selected TMDL reaches for sensitive or priority areas, building on past efforts and documenting watershed streambank improvements. Every two years, assess how many priority streambank areas identified in the inventory have been restored/stabilized
Implement riparian buffer improvements throughout watershed at sites identified in Implementation Plan.	MN 10, MN 14, MN 15, MN 16	Ongoing. Streambank/riparian Work done in Doyne Park in Milwaukee; Jacobus, Hart, and Hoyt Parks in Wauwatosa, and at Hanson Golf Course; Frontier Park in Butler; Rivers Edge, Rotary, and Lime Kiln Parks in Menomonee Falls as well as at Lilly Creek Industrial Park. Major restoration work occurring along Honey Creek Parkway, in Hart	X		X	X	**Milwaukee County Parks**, private landowners, MMSD, RRF, Milwaukee Riverkeeper, Park People, Other NGOs	Every 2 years, document stream restoration sites/AOC projects implemented within these TMDL reaches and along mainstem of Menomonee and Little Menomonee Rivers. Estimate water quality improvements including new habitat restoration projects planned as part of the Milwaukee AOC, and work with partners to prioritize remaining projects for implementation.

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
		Park, and in Milwaukee County Ground Park as part of Friends group activities. Some future work funded as part of AOC projects along mainstem of Menomonee and Little Menomonee Rivers.						
Menomonee River Watershed Biodiversity Inventory and Habitat Restoration Plan	MN 6, MN 9, MN 10, MN 14, MN 16	Much of this assessment work is being funded by the Milwaukee AOC Program for Milwaukee County; wildlife assessments and plan substantially complete in 2017. No funding for upstream areas but some information provided in SEWRPC Plan 42/Natural Areas Plan. SEWRPC also developing aquatic habitat plan for region.			X		**WDNR AOC, Milwaukee County Parks**, Gary Casper, Fish and Wildlife TAC for Milwaukee River Estuary AOC, Milwaukee Riverkeeper, others	Within 5 years, complete an updated assessment of the effectiveness of AOC restoration efforts in achieving fish/wildlife population and habitat goals.
Create plan to reduce polluted runoff from MN golf courses--both public and private	MN 10, MN 12, MN 14, MN 16	This was included as part of Milwaukee County Parks' internal planning process in 2018, but not much progress made.	X		X		**Milwaukee County**, Milwaukee Riverkeeper, SWWT, Others	Within 2 years, identify public or private golf courses located in the four TMDL reaches and make contact to discuss their interest in completing riparian buffers or other runoff reduction projects.

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
								Within 5 years. apply for and obtain funding to complete water quality or riparian restoration projects/buffers on selected golf courses
Enhancement and Maintenance of Little Menomonee River from Silver Spring Drive to Brown Deer Road (Former Moss American/Kerr McGee/Tronox Superfund Site)	MN 9	Superfund project substantially complete. Milwaukee County completed grassland restoration project in 2018 as part of AOC. Future riparian restoration work planned as part of AOC fish and wildlife population work.	X		X		**Milwaukee County, WDNR**, Milwaukee Riverkeeper, GL CCC, others	Within 5 years, complete AOC habitat restoration and in-stream work to benefit fish and wildlife populations along Little Menomonee River.
Fish Passage and Aquatic Habitat Improvement Projects (including Flood Management Projects)								
Identify stream passage impediments and opportunities to address aquatic habitat fragmentation in the Menomonee River Watershed	All	Assessment completed by Milwaukee Riverkeeper with staff and volunteers from July 1, 2011-June, 30, 2013, with assistance from WDNR (Matt Diebel) and others. SEWRPC working on aquatic habitat plan for region (2019 to present).			X		**Milwaukee Riverkeeper**, Volunteers, WDNR, US FWS	Updated fish passage assessment, as well as documentation of restoration efforts (e.g., concrete removal, etc.) to be completed in 5 years.

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
Restore fish passage within a 1,000-foot concrete-lined reach of the Menomonee River from Bluemound Road to Miller Brewery by removing concrete from the bottom, replacing with cobbles/boulders, and constructing riffles and pools.	MN 16	This work was completed from 2013-2015 with funding from GLRI and other sources. Milwaukee Riverkeeper and TU assisted with cleanups and monitoring.	X	X	X	X	**MMSD**, WDNR, SEWRPC, Milwaukee, Milwaukee Riverkeeper, Trout Unlimited	Complete similar fish passage projects within the watershed over the next five years.
Restore fish passage within a 2,700-foot concrete lined reach of the lower Menomonee from Bluemound Road to downstream I94.	MN 16	This work completed by US ACE and MMSD 2015-2016.	X	X	X	X	US ACE, **MMSD**, EPA, WDNR, others	Complete similar fish passage projects within the watershed over the next five years.
Remove 5 low flow structures in Wauwatosa causing fish passage issues between Swan Boulevard and Harmonee Avenue during low water levels.	MN 16	Milwaukee Riverkeeper hired Interfluve to create a conceptual plan for removal. MMSD procured funding to remove 4 barriers from July 1, 2011-December 2015, and one barrier was retrofitted with rock ramp.	X		X	X	**MMSD**, SEWRPC, Wauwatosa, Milwaukee Riverkeeper	Complete similar fish passage projects within the watershed over the next five years.
Remove woody debris barriers that are impeding flow/fish passage or causing drop in elevation.	MN 9, MN 10, MN 14, MN 16	Approximately 26 barriers removed by Milwaukee Riverkeeper and volunteers in 2014-2017. Great Lakes CCC has removed barriers the last few years as	X		X		**Milwaukee Riverkeeper, Great Lakes CCC,** Milwaukee County, Trout Unlimited, WDNR, others	Complete similar woody debris barrier projects within these TMDL reaches over the next five years. Within five years, create updated fish passage assessment within 5 years.

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
		problems present. Work is ongoing and sporadic.						
Implement Schoonmaker Creek restoration and flood management project.	MN 16	MMSD has finished this $6 million effort, part of the larger Western Milwaukee Flood Management Project. This project removes 500 feet of Schoonmaker Creek from a concrete culvert underground, creates more storage for floodwater along the Menomonee River, and provides environmental and habitat improvements for both waterways.	X	X	X		**MMSD, Milwaukee, Wauwatosa, Others**	Assess success of this restoration project within 5 years
Implement Underwood Creek concrete channel removal from confluence to Mayfair Road.	MN 12	First phase complete in 2011/2012; second phase complete in 2017-2018 with a total of 6,600 feet of linear concrete removed from the bed of the river. Stream was re-meandered and riffle/run features installed.	X	X	X	X	MMSD, US ACE, WDNR, SEWRPC, Others	USGS completed a fisheries assessment of this reach in 2020, showing that fish having difficulty passing concrete sections left under bridges. Future assessment work is needed, as well as study of potential retrofits.
Construct Underwood Creek floodplain/wetland restoration and stormwater infiltration project.	MN 12	In 2019, this project restored 22,585 square feet of floodplain, which was largely denuded of trees due to emerald ash borer. An existing	X	X	X	X	**Elm Grove**, Milwaukee Riverkeeper, WDNR	Assess effectiveness of restoration efforts and identify any additional work needed by 2024.

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
		wetland adjacent to Tonawanda Elementary was deepened and enhanced (1.05 acres); and several other wetland scrapes or depressions (0.17 acres) were constructed on the north side of the site On village property. Stormwater swales were constructed to filter and infiltrate polluted runoff from the school and Underwood Parkway. Ongoing maintenance needed.						
Removal of pedestrian bridge at Curry Park Golf Course, which is impeding fish passage in low flows.	MN 10	This project has been identified as a priority fish and wildlife population project for the AOC. Design/engineering ongoing and removal anticipated by 2022.	X		X		**WDNR, AOC,** Milwaukee County, Milwaukee Riverkeeper	WDNR funding for this project is secured, but there have been some permitting setbacks. Construction anticipated by 2022.
Restoration of the Little Menomonee River in Ozaukee County.	MN 9	Ozaukee County is restoring 3.7 miles of the Little Menomonee River and Creek, primarily on land owned by MMSD to improve aquatic connectivity and enhance the channel, riparian corridor, and floodplain system within the project	X	X	X	X	**Ozaukee County**, WDNR, Mequon, Others	First phase of this work is complete by Ozaukee County. Future work planned as part of AOC funded work, and anticipated to be complete within next 5 years.

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
		area. Design and engineering is complete and construction complete at first of 3 sites.						
Restore approximately 2000 linear feet of Underwood Creek from Underwood Parkway to the Village Park Bridge (near Juneau).	MN 12	The Village of Elm Grove is planning on stabilizing failing streambank and protecting a nearby sanitary sewer through re-meandering of this section of stream and associated riparian restoration. Improvements for fish habitat will also be added.	X		X	X	**Elm Grove,** Milwaukee Riverkeeper, Others	**Design of this project is ongoing, and some project funding has been secured. Construction anticipated in next few years.**
Daylighting and restoring Underwood Creek in downtown Elm Grove	MN 12	This project would daylight an underground stream, construct 1,600 linear feet of natural channel (with a low-flow stream channel length of 1,900 feet), including meanders. This project would also create pools and riffles, and provide some underground stormwater detention and convert 800 feet of existing channel into a backwater wetland for	X	X	X	X	**Elm Grove,** MMSD, Milwaukee Riverkeeper, Others	Funding for this project has been secured; construction should occur within next 2 years. Complete similar daylight creek projects within other TMDL reaches over the next five years.

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
		both stormwater and floodwater storage.						
Remove concrete channel, restore stream floodplains, and address failing infrastructure in Honey Creek from I94 to confluence	MN 15	US Army Corps of Engineers has finished preliminary design to remove concrete from a utility ROW south of Bluemound Rd to the confluence with the Menomonee River	X	X	X	X	**US Army Corps of Engineers, MMSD, Wauwatosa,** Friends of Honey Creek Parkway, Milwaukee Riverkeeper, Others	Design/engineering to be complete in next 2 years, with construction anticipated within 5 years. Complete similar channel and floodplain projects within other TMDL reaches over the next five years.
Remove concrete channel on the lower Nor-X-Way Channel and address fish passage barrier at confluence with natural creek.	MN 6	This project would remove concrete channel on the lower section of the Nor-X-Way channel. A feasibility study and design/engineering is needed.	X	X	X		**Menomonee Falls,** Milwaukee Riverkeeper, Others	There are no plans to advance this project currently after some staff changes.
Nutrient/Phosphorus Loading Reduction Projects								
Monitor implementation of statewide phosphorus rules and phosphorus ban in fertilizers and detergents, and quantify impacts to local rivers. Assess phosphorus loading areas having the biggest impact on algal growth.	All	TP TMDL approved in 2018, and identifies sub-watershed/reach areas with greatest needed TP reductions. NGOs are continuing to monitor implementation of phosphorus and MS4 permit driven regulations within the watershed	X		X		**SWWT, WDNR, Clean Wisconsin**, **Milwaukee Riverkeeper**, MS4 Municipalities SWWT Policy Committee, others	Every 3-5 years, complete inventory of TMDL implementation efforts and MDV funded projects, by TMDL reach. Assess water quality changes in TMDL reaches with significant MS4 and GI implementation within 10 years. Obtain and evaluate MS4 pollutant load reductions,

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
		including Multi-Discharger Variance for TP, which could be source of funding for agricultural-based project implementation. Algae study has not been conducted.						determined by modeling, for all TMDL reaches.
Commission Task Force to analyze and implement orthophosphate alternatives for drinking water.	MN 9-MN 16	Milwaukee Water Works did convene a group around 2015/2016 to look at the dosing of ortho-P in different municipalities. Changes never proposed due to lead pipe issues. Separate task force on lead pipes created in 2016/2017. MMSD is working to take some NCCW from Menomonee Valley businesses to reduce discharge in lower Menomonee.	X				SWWT Policy Committee, Milwaukee Water Works, MMSD, WDNR, SEWRPC, Milwaukee Riverkeeper, others	Based on Milwaukee's current plans to address lead pipes, determine whether changes can be made to orthophosphate use and application rates within 5 years. Identify priority areas where industrial discharge could be re-rerouted to MMSD instead of rivers within next 5 years.
Implement erosion control, stabilization of banks, and restoration of native vegetation along the Menomonee River to minimize nutrient loading.	All	See Riparian Improvement and Aquatic Habitat sections above. Extensive work has already occurred.	X		X	X	Milwaukee County Parks, MN Municipalities, Milwaukee Riverkeeper, Friends groups, SWWT	Document past projects and prioritize future projects within 5 years.

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
Recreational Access Improvements								
Identify and implement recreation access improvement project opportunities in the watershed.	All	Recreation improvements made in Three Bridges Park and Stormwater Park in the Menomonee Valley including 3 pedestrian bridges over the river and 3 access points; Access stairs built in Frontier Park in Butler; Pedestrian bridge stabilized and new access constructed in Rotary Park (and upstream) in Menomonee Falls. Access improved along many areas where concrete channel has been removed. Menomonee River Walk approved.			X	X	**SWWT, Milwaukee Riverkeeper**, MVP, Counties, Municipalities, Neighborhood and Community Organizations, MMSD, Friends Groups	Complete similar recreation access projects within selected TMDL reaches over the next five years. Include recreation access within other stream or river restoration projects designed and implemented in the watershed.
Increase access to the Menomonee River in conjunction with the Milwaukee Urban Water Trail, existing and proposed Menomonee River Walk, City of Milwaukee Menomonee Valley trails, the Hank Aaron State Trail, and other riparian corridor improvement.	All	The Milwaukee Urban Water Trail was updated in 2018, but only includes the Menomonee Valley and downstream. Upstream paddling opportunities are limited to a short window of ideal flow conditions and woody debris jams are excessive in many areas. Great improvements			X	X	**Milwaukee Riverkeeper, MVP, FoHAST, WDNR**, Municipalities, Counties	Continue to work with the Milwaukee County trails coordinator and public/private landowners to install signage at river access sites, to improve existing access sites, and add new sites as possible throughout the watershed.

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
Activities.		being made at the local level, including a newly approved RiverWalk system for the lower Menomonee River.						
Educational Projects								
Facilitate development of community action leaders in communities to encourage participation in local area river cleanups and other river stewardship activities.	All	Milwaukee Riverkeeper and others continue to run river cleanup and Adopt-a-River programs to deal with nuisance trash. Friends groups are engaging community members in Weed Out events. Municipalities and Counties support these events. UW-Extension had initiated database in 2012; but lost funding locally.	X		X	X	SWWT, **Milwaukee Riverkeeper and volunteers,** MVP, Community and Neighborhood Organizations, Milwaukee AOC Blue Crew, Faith-based organizations, Municipalities, Counties, Reflo	Coordinate with the AOC Community Advisory Committee to increase stewards/volunteers/community leaders within next 5 years.
Develop a watershed-wide educational outreach program that increases awareness of pet waste contributions to pollution loading.	All	In Spring 2011 – Spring 2013, several municipalities and NGOs partnered on an initiative to increase "doggy pots" and improve education around pet waste that culminated in several pet fairs and 5 new doggy pots. Respect Our Waters is conducting ongoing	X				**MS4s, SWWT**, Milwaukee Riverkeeper, Veterinarians, ROMP (Residents for Off-leash Milwaukee Parks), MADACC (Milwaukee Area Domestic Animal Control	SWWT to assess Respect Our Waters campaign within 5 years, consulting MS4 permittees in watershed to ensure their priorities are being addressed. MS4 permittees must conduct education and outreach as part of MS4 program. Every five years, Education and Outreach efforts are inventoried and summarized to identify gap

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
		outreach regarding pet waste pick-up.					Commission), Doggy Day Care providers, Dog Training providers, the Wisconsin Humane Society, etc.	areas and priorities for future education**.**
Evaluate the results of SWWT Household Surveys and develop public education programming that responds to the identified needs.	All	Sweet conducted initial survey from November 2010 – May 2012, with a follow up survey in 2016-2017 as part of the Respect Our Waters Campaign. SWWT work to respond to MS4 needs is ongoing.	X				SWWT, Municipalities, NGOs	SWWT to assess Respect Our Waters campaign within 5 years, consulting MS4s to ensure their priorities are being addressed. MS4s must conduct education and outreach as part of MS4 program. These efforts should be summarized every 5 years, to identify gap areas and priorities for future education**.**
Conduct stormwater outreach and education; ensure municipalities with are implementing educational and outreach requirements in their Stormwater Permits.	All	Implementation is ongoing as part of Respect Our Waters and Menomonee Watershed Based Stormwater Permit requirements. NGOs will assist with identifying needs of MS4s and helping to fulfill those needs, with SWWT playing a leading role as part of Respect Our Waters.	X				**MS4s, SWWT**, WDNR, Milwaukee Riverkeeper, Clean Wisconsin, others	SWWT to assess Respect Our Waters campaign within 5 years, consulting MS4s to ensure their priorities are being addressed. MS4s must conduct education and outreach as part of MS4 program. These efforts should be summarized every 5 years, to identify gap areas and priorities for future education**.**

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
Create a resource center for green infrastructure for the Greater Milwaukee Area, and finalize and widely circulate the "Tackling Barriers to Green Infrastructure" Guidebook.	All	MMSD has created their Fresh Coast Resource Center to provide assistance with GI implementation efforts in their service area. The Guidebook was finished by Wisconsin Sea Grant, but has not been widely distributed.	X				**MMSD, Clean Wisconsin, SWWT,** Wisconsin Sea Grant, Others	Work with MMSD to continue green infrastructure education and recruitment efforts within 5 years, to identify gaps, and devise strategies for filling those gaps.
Policy Initiatives and Projects								
Engage stakeholders, as part of MMSD and WDNR processes, to create and provide input on TMDLs and implementation plans for bacteria, phosphorus, and sediment in the Menomonee River watershed.	All	The TMDL creation process progressed from 2011 through 2018, and stakeholders were involved at key points in the process, including members of the Menomonee Watershed Action Team. One goal is to ensure that TMDL implementation efforts work in parallel with Watershed Restoration Plan implementation efforts. This Plan aims to help implement this goal, in part.	X		X		**SWWT, MMSD, MS4 Group Permittees. WDNR, hired consultants, NGOs,**	Create a TMDL implementation status report within 5 years; document policies and projects that have been completed to meet MS4 permit requirements/measurable goals, and where work still needs to occur to meet TMDL-based pollutant load reductions.

Project	TMDL Reaches	Status	Water Quality	Flood Management	Habitat	Recreation & Public Access	Responsible Implementers (Lead Entities in Bold)	Future Practices, Programs, and Milestones with Timelines
Pursue opportunities to further municipal progress toward meeting their NR 151/216 mandate to reduce total suspended solids (TSS) inputs to the Menomonee River system via trading of TSS reduction credits *between* municipalities.		Opportunities exist for watershed-based trades for TP and TSS, and the watershed-based permit may help facilitate this. TMDL for TSS was approved in 2018. TMDL findings can be used to help incentivize trading and/or adaptive management.	X				**Municipalities,** WDNR**,** County Land Conservation Depts, NGOs	
Evaluate opportunities for water pollution credit trading between point sources and/or between point and non-point sources of phosphorus, and seek specific opportunities to implement a pilot project on trading or adaptive management in the Menomonee River Watershed.	MN-1 MN-9	This work was delayed by the long TMDL process. However, opportunities exist for water quality trades or adaptive management within the north section of the watershed that retains agricultural crop acres. SWWT could facilitate this, with help from NGOs and Agencies.	X				**Municipalities, WDNR**, SWWT, County Land and Conservation Departments, NGOs.	

EXPECTED REDUCTIONS FOR GREEN INFRASTRUCTURE PLANS

Since the Menomonee River Watershed is highly urbanized, the vast majority of non-point source runoff is from impervious surfaces, with a small portion coming from agricultural sources. Green infrastructure (GI) may become a major component of non-point source control both inside and outside of MS4 boundaries. A number of current GI plans for the Southeast Wisconsin Region that encompass the watershed detail some of the scope of GI implementation and the expected resulting pollutant reductions. GI practices are listed as priority projects in this Plan and the reduction estimates will inform implementation and evaluation of the Plan. Below is a summary of the calculated reductions for MMSD's Regional Green Infrastructure Plan of 2013, which has projections through 2035, with an overall goal of capturing 740 million gallons of polluted runoff through GI practices during each storm (the first half inch of rainfall) throughout their service area, including 249.4 million gallons from the Menomonee River Watershed's 28.7 square miles of imperviousness (MMSD 2013).

Full implementation encompasses the following GI practices, estimated at $410 million:

- Porous Pavement: 3,300 average city blocks converted to porous pavement
- Bioretention / Rain Gardens: 59,000 10-foot by 15-foot rain gardens
- Stormwater Trees: 9 new trees per average city block
- Green Roofs: 4,000 buildings with green roofs (5,000 square foot average)
- Cisterns: 680 new cisterns on large buildings (with roofs greater than 6,500 square feet)
- Native Landscaping: 500 average city blocks converted to native landscaping
- Rain Barrels: 45,100 homes with one rain barrel installed
- Soil Amendments: 900 average city blocks with soil amendments

Green infrastructure implementation will help MS4 municipalities and other permittees in the Menomonee watershed to meet TMDL based reductions. It is estimated that implementation of the GI Plan would capture 14.8 billion gallons of stormwater per year, with annual reductions of up to 15 million pounds of TSS and 54,000 pounds of total phosphorus throughout the MMSD service area, as well as provide other social and economic benefits. The triple bottom line analysis from the GI Plan estimates that GI may reduce TSS and TP pollution from stormwater runoff by 15 to. 25 percent. Such reductions will help meet TMDL-based pollutant reductions (MMSD 2013). In addition to the MMSD GI Plan, an additional resource that provides designs and proposed pollutant reductions for a selection of municipal GI projects in the Menomonee River Watershed can be found in Appendix D.

Additional measures beyond GI will be needed to meet TMDL requirements. Because the vast majority of the Menomonee Watershed is covered by MS4 permits, these permits will be the primary method for meeting this plan's pollutant load reductions over time. MS4 permits, including the Menomonee Group Permit issued in 2020 (Appendix F) and several other individual permits, will require each permittee to use WINSLAM to model the amounts, types and locations of practices that need to be implemented within MS4 permitted areas to achieve MS4 TMDL waste load allocations for TP, TSS and bacteria over time. Road salt usage and reductions from prior

levels will also be tracked via MS4 permit annual reports/measurable goals. MS4 pollutant load reduction estimates will be generated and annually reported to WDNR during each MS4 five-year permit term. Each MS4 permittee's load reduction estimates and other annual report/measurable goal information will be included in this plan and compared to TMDL reach specific reduction goals for specific pollutants. This Plan also contains milestones for annual tracking efforts and practices implemented in the watershed by MS4 permittees. With respect to other pollutants (e.g., chlorides), the metrics in plan (gallons infiltrated, reduction in salt use from previous use levels) will be used for pollutant reduction estimates.

UPDATED IMPLEMENTATION PLAN FRAMEWORK

The framework for this Plan follows a cycle of four main steps: Plan, Do, Check, Act (Figure 17). This framework was first suggested in the Menomonee River Watershed Restoration Plan of 2010 and is intended to facilitate an adaptive approach to watershed management as well as to provide a strategy for SWWT to further develop implementation.

Since the development of the Menomonee WRP, watershed management has consistently followed this structure implicitly or explicitly. For example, the first Menomonee Watershed Based Permit focused on facilitating group projects, educational efforts, and collaboration, as well as on using a desktop analysis to better target areas within the MS4 system with high potential for discharging human bacteria to area rivers. The second Menomonee Watershed Based permit requires having more robust bacteria source reduction plan, and more aggressive implementation of illicit discharge programs and fixing problems that have been identified to reduce pollutant loads into each MS4 drainage system(s). The new bacteria TMDL could be added to the desktop analysis to further help MS4s to prioritize this work going forward. New science and policy tools can also help us to better plan and check our actions relating to improving water quality.

The "Plan, Do, Check, Act" framework will be continued in this Plan as a mechanism for adapting previous projects and strategies to better achieve watershed restoration goals in the Menomonee River Watershed over the next ten years and beyond.

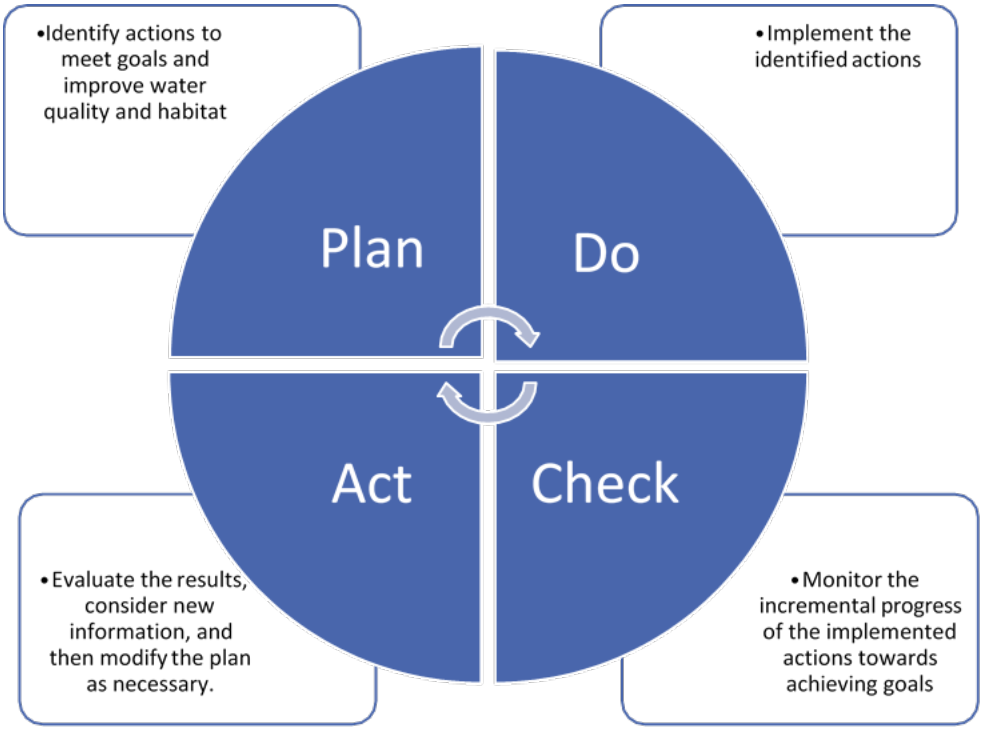


FIGURE 17. IMPLEMENTATION FRAMEWORK FOR THE PLAN

Actual implementation of suggested projects in the Plan will be based on several factors, including available funding, commitment of key participants, and organizational capacity. The adaptive management theory used in the development of this plan and its implementation framework is specifically designed to allow for changes and additions that may occur in the watershed over time. In order to strategically adapt and evaluate the success of the Plan, strong reporting, communication, and feedback systems are required and will be incorporated into each project.

MEASURABLE MILESTONES

In order to truly create an adaptive and comprehensive watershed restoration plan, data on practices implemented needs to be collected. For the Menomonee River Watershed Updated Implementation Plan, the effort will be led by SWWT through the creation of a system for annually compiling, analyzing and disseminating information on the watershed through an annual meeting. Metrics and information from this system will regularly be incorporated back into the Plan. In addition to the aforementioned metrics, a general timeline (Table 11) and several key milestones will be used by SWWT as indicators of the Plan's implementation progress.

TABLE 11. GENERAL TIMELINE FOR THE PLAN

Task	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Update the Implementation Plan priority projects based on activity in the watershed and SWWT's Annual Meeting with key stakeholders. Identify TMDL sub-basin where projects are underway and complete.		X		X		X		X		
Conduct project planning, site surveys, project design and budget development by TMDL sub-basin		X	X	X	X	X	X	X	X	X
Prioritize and incorporate the recommendations of The Plan into existing programs, activities and budgets.	X	X	X	X	X	X	X	X	X	X
Implement and construct projects; track projects by TMDL sub-basin in the watershed.	X	X	X	X	X	X	X	X	X	X
Re-evaluate plan schedule for projects and practices due to lack of progress/limited funding.			X				X			
Monitor, report and evaluate success by TMDL sub-basin	X	X	X	X	X	X	X	X	X	X

SWWT will take the lead in collecting, summarizing and distributing data and efforts in the watershed through an annual meeting. Information will be collected with a uniform, fillable template that contains metrics from pre-existing reports in addition to new, useful tracking information so as to limit additional work for stakeholders. Data collected will be used to update the watershed restoration plans. In addition, the annual meeting will provide stakeholders the opportunity to provide feedback and report on successes from the prior year, and formally request the help of SWWT in the upcoming year to overcome any barriers to successful watershed restoration. The completion of plans prioritized in the Plan will serve as milestones for implementation.

SUPPORTING PLANS

Many of the plans and supporting studies that form the basis for this Plan are still in-process, with many schedules, implementation timelines, and funding needs to be determined in 2020 and thereafter. Table 12 lists these plans and studies, along with their associated time frames. As these are completed and made available, specific goals, recommendations, milestones, and costs from the underlying plans will be added to this Plan matrix and updated regularly (at least annually). As shown in the table, of the plans that have already established implementation deadlines, all will be completed by 2050, or within 3-4 iterations of the Plan. This is consistent with the requirement that implementation schedules be reasonably expeditious. The Plan will serve as a consolidated and comprehensive source of information gathering and sharing to facilitate true watershed-based planning that addresses the nine key elements, especially those regarding implementation schedules, measurable milestones, and criteria for success.

TABLE 12. SUPPORTING PLANS.

Plan/Study	Organization (s)	ETA/ Effective Date	Timespan	Notes	Practices	Costs
MN Watershed Based Stormwater Permit/Individual MS4 Permits	WDNR, MS4s, Counties	2020	20+ years	Permits renew every 5 years	TBD	TBD
MN Watershed Restoration Plans & Implementation Plans	SWWT, NGOs, Stakeholders	2010	2010-2020	These plans superseded by the present Plan	N/A	N/A
Chloride Impact Study	SEWRPC	2021	2021 - ?	Will recommend "state of the art" best practices and policy changes	Chloride reduction practices; wet deicing practices; product alts.	TBD
2020 Facilities Plan (FP)	MMSD	2010	2010-2020	2050 FP will supersede	Grey and green infr. improve-ments	N/A
2050 Facilities Plan	MMSD	2020	2020-2050	In development.	Grey and green infr. improve-ments	TBD
MMSD GI Plan	MMSD	2013	2013-2035	Includes region wide goals and watershed goals	Rain gardens, porous pavement, bioswales, cisterns, soil amdts.	$410 M
Green Infrastructure Identification and Prioritization in the Menomonee River Watershed	MMSD, CH2M, SWWT,	2015	2015-2025	Provides designs, pollution reduction, and cost estimate for 2 projects each for 10 MN MS4s and 4 projects for MKE County	Bioswales, filtration, porous pavement, rain gardens, etc.	Approx. $80M

Plan/Study	Organization (s)	ETA/ Effective Date	Timespan	Notes	Practices	Costs
SEWRPC RWQMPU	SEWRPC	2007/2013	- 2020+	Companion to 2020 FP	N/A	N/A
MRB TMDL	MMSD/ WDNR	July 2018	-2050+	Imp. Strategy will confirm practices and pollutant reductions per TMDL sub-basin	N/A	N/A
Bacteria Working Group Report	SWWT	03/2018	N/A	Baseline info report	IDDE, testing, sewer repair	N/A
Stream Habitat Conditions and Biological Assessment of the Kinnickinnic and Menomonee River Watersheds: 2000-2009	SEWRPC	2010	N/A	Baseline Info report	Dam removal, culvert retrofits, fish passage, etc.	N/A

The following items will be tracked on an annual basis and will be organized by TDML sub-basin:

- Metrics for Water Quality, Flood Management and Quantity, Habitat, and Recreational Use goals identified in the Plan;
- Staff hours and resource and/or funding levels that were needed to implement projects identified in the Plan;
- Land use changes or weather events that may impact plan implementation;
- Participation by other groups, organizations and citizens to implement the Plan;
- Status of other programs that reduce pollutant loadings i.e., Adaptive Management, Water Quality Trading, etc.;
- Successes and lessons learned in the prior year;
- Barriers to watershed restoration; and
- Additional data as needed.

Through this reporting process, implementation will stay true to the adaptive nature of a comprehensive watershed restoration plan. If the below indicators are not met by year five (5) of implementation, key stakeholders led by SWWT, will initiate a new cycle of the implementation framework: “Plan, Do, Check, Act”.

- At least 20% of planned projects have been implemented.
- At least 20% of the watershed goals have been met for water quality, flood management, habitat, policy and recreation.
- At least 20% of required financial resources are available for practice implementation

LEADERSHIP STRUCTURE

Extensive collaboration exists in the Menomonee River Watershed and includes the following lead organizations. With the extensive network already in place, implementation of The Plan will continue to function through these lead organizations.

TABLE 13. LEAD ORGANIZATIONS FOR THE MENOMONEE RIVER UPDATED IMPLEMENTATION PLAN.

Organization	Leadership Roles
Southeastern Wisconsin Watersheds Trust, Inc. (SWWT)	-Develop and House Updated Implementation Plan -Host Annual Meeting -Secure Funding for Watershed Work -Support Key Initiative Coordinators -Policy Committee -Science Committee
Milwaukee Riverkeeper	-Project Implementation -Annual River Clean Ups -Citizen Water Quality Monitoring -Milwaukee Urban Water Trail/Public Access -Citizen Participation/Involvement -Education and Outreach Efforts -Water Policy
Clean Wisconsin	-Municipal Stormwater Ordinance Audits -Green Infrastructure Planning and Implementation -Water Policy
Milwaukee Metropolitan Sewerage District (MMSD)	-Funding -Menomonee River Watershed Green Infrastructure -Flood Management Projects -Green Infrastructure Plan -2020/2050 Facilities Planning Program -Project Implementation -Water Quality Monitoring
Southeastern Wisconsin Regional Planning Commission (SEWRPC)	-Watershed Modeling and TMDL Development
Municipalities and Menomonee River Watershed-Based Stormwater Group Permittees, Counties	-Project Implementation -Project Tracking -Monitoring/IDDE -TMDL compliance -Education and Outreach Efforts -Public Involvement Activities

Organization	Leadership Roles
WI Department of Natural Resources (WDNR)	-TMDL Implementation -MS4 and other Permitting -Water Monitoring -Education and Outreach -Policy
Menomonee Valley Partners	-Project Implementation -Business Improvement District Support -Stormwater Management -Public Access -Education and Outreach
Harbor District Initiative	-Develop and Implement Water and Land Use Plan for the Harbor Estuary -Project Implementation -Public Access to Estuary Rivers/Harbor -Education and Outreach
Community and Neighborhood Organizations (Garden Clubs, Men's Clubs, Women's Clubs, Rotary, Scouts, Churches, etc.)	-Project Implementation -Fundraising -Business Support -Community Support Activities -River Clean-Ups/Access Projects -Education and Outreach -Public Involvement

Another recommended task for all of these lead organizations is to review all maps included in the Plan. This review should be conducted in order to identify:

- The source organization for each map;
- Any outdated or inaccurate information included in the maps that needs to be replaced; and
- If there is a need for completely revised maps.

Southeastern Wisconsin Watersheds Trust, Inc.

SWWT is the lead organization on the Menomonee River Watershed Updated Implementation Plan. SWWT was formed in 2008 as a collaborative organization intended to, in part, implement the recommendations made in the WRP and RWQMP for in the Greater Milwaukee Watersheds. The organization operates with a Board of Directors, Executive Director, staff and several partnering non-profits and consultants that form the Key Initiative Coordinators. Additionally, SWWT collaborates with regional policy makers and scientists through its Policy and Science Committees, with participation open to the public.

1. Key Initiative Coordinators

   Key Initiative Coordinators (KICs) exist for all of the Greater Milwaukee Watersheds: The Milwaukee, Menomonee, and Kinnickinnic Rivers, the Milwaukee Harbor Estuary, and one for Emerging Issues identified by the Board. The KIC for the Menomonee River Watershed is local non-profit Milwaukee Riverkeeper. The KICs operate in three main categories: advancing policy, implementing projects, and education and outreach. The purpose of the KICs is to advise SWWT's Executive Director, Board of Directors, other KICs, and its Science and Policy Committees on important issues pertaining to SWWT's work in the Greater Milwaukee Watersheds. Each Coordinator is primarily responsible for managing and reporting on the work relating to their Key Initiative. The KICs meet approximately two times a month.

2. Science Advisory Committee

   The Science Advisory Committee is a group of regional professionals that volunteer their expertise for a membership period of at least two years to advance SWWT's work. The purpose of the committee is to advise SWWT's executive director, its Policy Advisory Committee and its Key Initiative Coordinators on important science and technical issues pertaining to SWWT's activities, watershed restoration goals, and other endeavors. This committee meets approximately four to six times a year.

3. Policy Advisory Committee

   The Policy Advisory Committee is a group of regional professionals that volunteer their expertise for a membership period of at least two years to advance SWWT's work. The purpose of the Policy Advisory Committee is to advise SWWT's executive director, its Science Advisory Committee and its Key Initiative Coordinators, on important policy issues pertaining to SWWT's activities, watershed restoration goals, and other endeavors. This committee meets approximately four to six times a year.

FUNDING SOURCES

One major pool of funding that is accessible with a US-EPA approved nine key element watershed plan is Section 319 funding outlined in the Clean Water Act. In addition, there has been a notable shift in funding opportunities in Wisconsin towards watersheds plans that are approved nine key element plans, most notably the funding available through the Great Lakes Restoration Initiative, which prior to 2016 did not require an approved watershed plan. Other examples of traditionally 319 funded projects include targeted runoff management (TRM) grants, and other Wisconsin Department of Natural Resources administered grants for lake planning, river planning, and urban stormwater projects. Table 14 provides a list of several of these programs. Section 319 funding cannot be used for practices that directly implement MS4 permits. Practices that support, but do not directly implement activities required by the permit, and practices that go above and beyond permit requirements may be eligible for 319 funding. Examples of such practices include GI, where not required as a condition of the permit.

In addition to Section 319 funding, extensive funding sources were compiled for the Menomonee WRP and are available for use in The Plan (WRP Chapter 8.3 and Appendix 8A of Planning Report 50). Other funders include the Joyce Foundation, the Fund for Lake Michigan, Wisconsin Coastal Management Program, and MMSD, who have all previously funded efforts in the Menomonee River Watershed. MMSD plans to invest 410 million dollars into the Menomonee River Watershed for GI alone (MMSD 2013). For development of riverside trails and walkways, Department of Transpiration Transportation Infrastructure Finance and Innovation Act (TIFIA) funding may be available. Projects using these funds have been developed with the co-benefits of improved transportation, recreation, and environmental quality. Signage that explains the benefits of implemented water quality projects can be especially effective along trails and at other public access points. Funding for signage can play an important role in the Plan's ongoing education and outreach.

TABLE 14. EXISTING GRANT OPPORTUNITIES.

Notice of Discharge Grant Program
Lake Protection and Management Grant Program
River Protection Grant Program
Urban Nonpoint Source & Storm Water Management Grant Program
DATCP Soil Water Resource Management Grant Program
Wisconsin Coastal Management Program
Great Lakes Restoration Initiative
NRCS financial assistance grants and programs
EPA nonpoint source related funds
Water Quality Trading
Adaptive Management
Trails and Walkways
EPA Urban Stormwater Runoff

COST ESTIMATES AND ANNUAL FUNDING NEEDS FROM GREEN INFRASTRUCTURE PLANS

Several cost estimates for green infrastructure practices have been estimated for the Menomonee River Watershed. Below is a summary of the costs associated with MMSD's Regional Green Infrastructure Plan, and the City of Milwaukee's Green Infrastructure Plan. These cost estimates will help determine funding needs for implementation of the Menomonee River Watershed Updated Implementation Plan.

The MMSD Regional Green Infrastructure Plan of 2013 estimates that an investment of $410 million for capital costs through 2035 is required in the Menomonee River Watershed to meet its portion of the overall goal of the Regional GI Plan. The cost breakdown is roughly $154 million each for GI strategies to address runoff from buildings and streets, $80 million for parking lots, and $23 million for conversion of turf grass areas. Capital costs for porous pavement and bioretention/raingardens are $117-122 million each, and green roofs account for an additional $112 million. Planting stormwater trees would cost an estimated $28 million, with an additional $30 million spread among soil amendments, rain barrels, native landscaping, and cisterns. Through 2025, which covers much of the time period of the present plan, approximately half of these capital funds would be expended, with the remaining 50% of expenditures occurring 2026-2035.

Capital costs are broken out for each GI strategy (but not individually by watershed), including both stand-alone and incremental costs, where the latter represent the cost differences of incorporating GI strategies over conventional rebuilding methods that do not contain GI features. For example, porous pavement and green roofs cost more than conventional paving and roofing, and these costs represent the incremental costs of GI. Cost estimates here are not true life cycle costs, in that they do not incorporate potential cost savings from GI strategies, such as lower building heating and cooling costs after green roof installation.

Incremental capital costs of full implementation amount to $1.3 billion, compared to $2.15 billion stand-alone costs. Annual operation and maintenance costs are estimated to be $10.4 million. The $410 million incremental cost of GI strategies in the Menomonee River Watershed amounts to 32% of the total GI capital cost for the region. (p. 62-65).

Potential Funding Sources for GI Strategies (MMSD 2013, p. 79):

- Property tax assessments (though these may be subject to state-imposed caps);
- Municipal stormwater utility fees;
- A regional or watershed-permit-based stormwater/green infrastructure utility;
- Smart growth and smart community grants for pilot projects;
- State and private grants for pilot projects;
- State revolving loan funding;
- Cost-sharing models that leverage local funding to obtain regional funding;
- Private funding of green infrastructure following energy service company (ESCO) models;
- Incentives for private property implementation that may be phased out over time; and
- Issuing bonds to fund sub-basin scale demonstration projects or to establish local funds for a revolving fund program.

To put MMSD's GI Plan in perspective, the 2015 City of Milwaukee Green Infrastructure Baseline Inventory provides capital cost estimates for various types of GI from a range of sources to meet MMSD capture goals. Annual capital funding required to meet the City of Milwaukee's 173-million-gallon goal (based on the city's percentage of MMSD's service area), assuming incremental progress from 2015-2035, would be $62 million. To reach the 380-million-gallon goal (based on city's share of impervious surfaces in MMSD Service Area) would require an investment of approximately $130 million annually. The portion of funding needed to meet goals in the Menomonee River Watershed would vary similarly based on percentage of the City of Milwaukee in that watershed, or percentage of impervious surfaces. Regardless, to achieve the desired goal for GI would be extremely expensive, requiring significant and exponential progress toward implementing GI, as well as significant political commitment and major investment in capital construction.

COST ESTIMATES FOR AGRICULTURAL BMPS

See Appendix M for cost estimates for agricultural BMPs needed in the upstream portion of the Menomonee River Watershed (TMDL Reaches MN 1 and MN 9; 040400030401 and 040400030402 HUC 12s).

MONITORING

Water Quality monitoring is an essential component of this plan. Results from monitoring data in the Menomonee River Watershed will create the necessary database for ultimately delisting impaired waterways and for meeting and maintaining their natural community classifications, two goals of The Plan.

WATER QUALITY-CURRENT MONITORING:

Several agencies having existing water quality monitoring programs in place in the Menomonee River Watershed (Table 15). These agencies will therefore serve as the main sources of monitoring periodically during the plan's ten year schedule. Monitoring stations may be expanded and improved to reflect TMDL implementation priorities/requirements and also Wisconsin's Consolidated Assessment and Listing. Methodology (WisCALM) standards. Current monitoring sites in the Menomonee River Watershed are shown in Figure 18.

TABLE 15. CURRENT MONITORING ENTITIES WITHIN THE MENOMONEE RIVER WATERSHED.

Local Non-Profit	
Milwaukee Riverkeeper	
Quasi-Government	
SEWRPC	MMSD
State	
WDNR	UWM-SFS
Federal	
US Fish and Wildlife	USGS
US EPA	NOAA
County	
Ozaukee County	

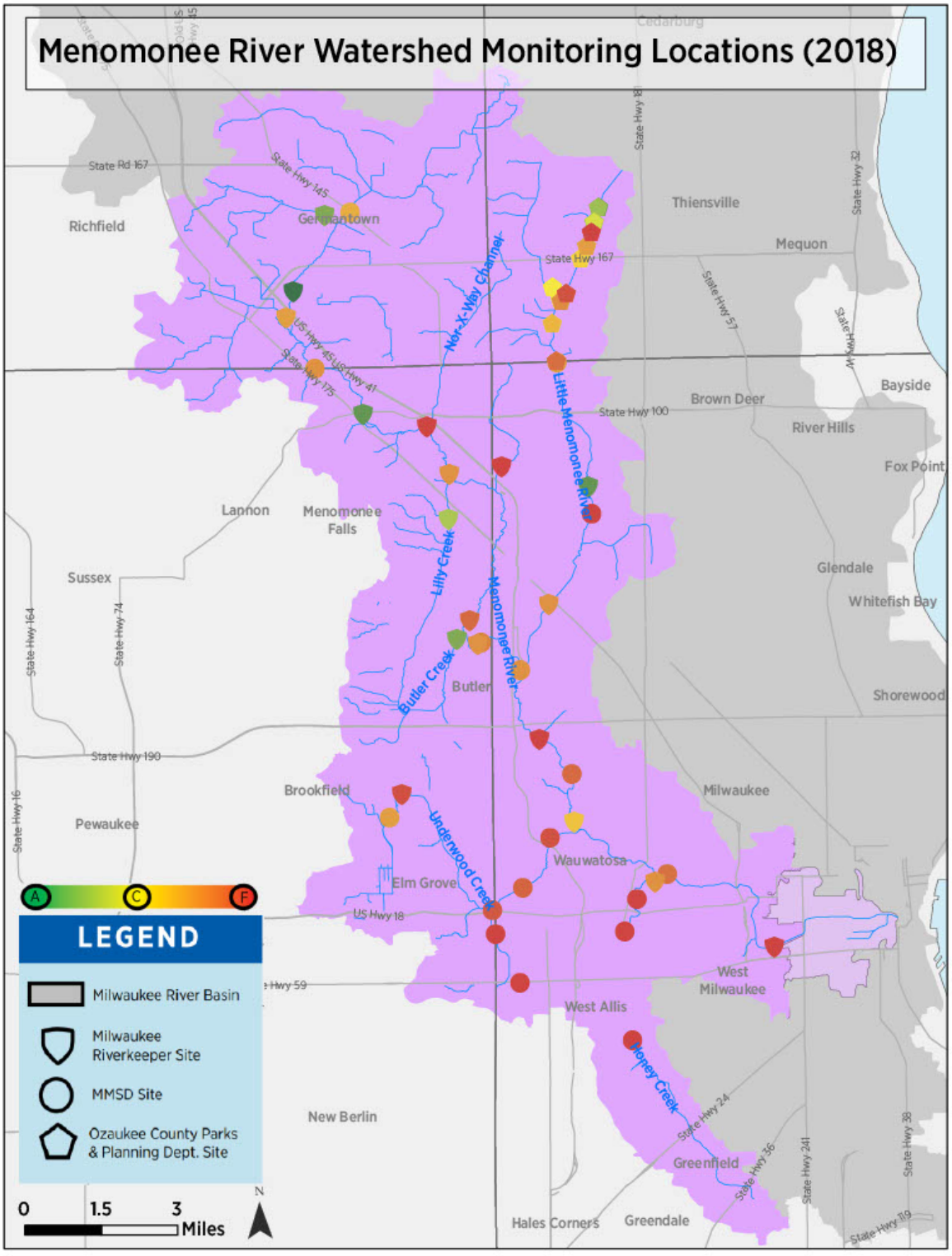


FIGURE 18. WATER QUALITY MONITORING STATIONS BY ENTITY

(SYMBOLS SHOW ENTITY, AND COLORS SHOW WATER QUALITY GRADE BY SITE – AS OF 2020).

SOURCE: MILWAUKEE RIVERKEEPER

Parameters currently being monitored monthly from May-October in the Menomonee River Watershed by Milwaukee Riverkeeper include:

- Total Phosphorus
- Turbidity
- Dissolved Oxygen
- pH
- Conductivity
- Chloride (when triggered by high conductivity levels)
- Temperature (hourly for select sites and monthly for others)
- Bacteria (at select sites)
- Flow (at select sites, and considering USGS locations)
- Macroinvertebrates and freshwater mussels (seasonally)

Water Quality-Updated Implementation Plan Monitoring

For the purposes of The Plan, Wisconsin DNR approved protocols and methodology will be followed and, to the maximum extent possible, current monitoring efforts will be updated to these standards. The 2020 Wisconsin Consolidated Assessment and Listing Methodology (WisCALM) for Clean Water Act Section 305(b), 314, and 303(d), and Integrated Reporting were used to establish the sampling criteria. Sample methodology for monitoring Total Phosphorus, Total Suspended Solids, and Fecal Coliform is shown in Appendix H.

As seen in Figure 18, a majority of the watershed has and will continue to be monitored annually or every two years to evaluate pollutant concentrations/levels over the next ten years. However, this plan recommends each TMDL sub-basin includes a monitoring site upstream of the confluence with the next sub-basin to determine if water quality standards are being met or not met in each sub-basin over time – particularly after adoption of multiple pollution reduction projects/practices. The Plan will rely on prior and expert monitoring agencies in the determination of any other monitoring locations. Also, monitoring may not be completed within TMDL sub-basins that make little or no progress towards meeting this plan's implementation milestones. Decisions to reduce or stop monitoring will be completed in consultation with watershed partners, including DNR.

Information and Education

Significant sharing of information and education already occurs in the Menomonee River Watershed and the Milwaukee River Basin through agencies like SWWT, Milwaukee Riverkeeper, WDNR, MMSD, other NGOs, and the Menomonee municipalities and counties. The Plan will leverage these established communication channels over the next ten years as well as create two new outlets to overcome identified barriers of communication. The following efforts will target five key audiences: Municipal, Residential/Homeowners, Private Businesses, Voters, and Implementation Partners.

CURRENT COMMUNICATION CHANNELS IN THE MENOMONEE RIVER WATERSHED:

1. Respect Our Waters Campaign: *Residential/Homeowners/Voters*
   Respect Our Waters (ROW) is an information and education campaign to raise awareness about the problem of stormwater runoff and encourage residents to help prevent it through behavioral changes. ROW's goal is to educate homeowners and residents on the many small steps they can take to keep our waterways clear of pollutants. The campaign is a collaboration between SWWT and the Root-Pike Watershed Initiative Network. ROW regularly hosts booths at community events throughout Southeastern Wisconsin and includes television and mobile advertisements that run in summer months where water use increases. Results from the most recent ROW survey in 2016 are found in Appendix I.

2. SWWT Annual Clean Rivers, Clean Lake Conference: *Implementation Partners, Municipalities*
   Every spring, SWWT hosts its annual Clean Rivers, Clean Lake Conference. The conference is an opportunity for water professionals, government representatives, nonprofit organizations, and private businesses to learn about improving the health of our watersheds through policy innovation, technical expertise and engineering, watershed restoration planning and practices, and collaboration and stakeholder involvement. It is an all-day event that includes presentations, workshops, exhibits, and an awards presentation for SWWT Mini-Grant recipients.

3. SWWT Mini-Grant Program: *Implementation Partners*
   SWWT's Mini-Grant Program distributes grants every year of $1,000 - $5,000 each to established non-profit organizations, community, and civic groups for projects or activities that advance the objectives of SWWT. Funding is available for eligible projects located in the Menomonee, Kinnickinnic, Milwaukee, Root, and Oak Creek Watersheds. The aim of the Water Quality Mini-Grant Program is to support local, grassroots efforts that employ green infrastructure practices and other water quality-related activities that will improve water quality, enhance conservation, restore habitat, or educate people about these issues.

4. Milwaukee Riverkeeper Report Card: *Implementation Partners, Residential/Homeowners, the Public*
   Each year, Milwaukee Riverkeeper compiles a report card for the watersheds in the Milwaukee River Basin, including the Menomonee. The report card assigns a letter grade to each water quality monitoring site and watershed based on an analysis by Milwaukee Riverkeeper of its own monitoring data, as well as WDNR, MMSD, and Ozaukee County monitoring data. The report is distributed to Riverkeeper's members and partners, government agencies, and watershed stakeholders to help inform the public on the water quality conditions in the watershed. The Report Card also highlights ongoing restoration and monitoring efforts that aren't included in the water quality grades, and that can help provide a bigger picture in evaluating the effectiveness of management practices,

restoration projects, and policy efforts over time. Historic report cards can be found here: https://www.milwaukeeriverkeeper.org/category/report-cards/

5. Green Infrastructure Roundtables: *Municipalities, Implementation Partners*
   Over the course of 2016, SWWT in conjunction with Clean Wisconsin hosted a series of meetings with local green infrastructure stakeholders to address the current barriers to green infrastructure in the Greater Milwaukee area. The series of gatherings was intended to create a set of prioritized strategies and collaborative steps to effectively promote and implement green infrastructure in the region. Goals of the roundtable included: identifying areas where more support is needed and brainstorming a range of options to overcome social, financial, and political barriers. SWWT and Clean Wisconsin have continued to host a series of green infrastructure workshops for the general public, NGOs, and municipalities from 2018-2020.

Planned Communication Channels in the Menomonee River Watershed

In addition to the aforementioned current communication channels, the following programs will be implemented as part of this Watershed Restoration Plan for the Menomonee River Watershed:

1. SWWT Annual Meeting: *Municipalities, Project Implementers*

   The Annual Meeting will provide the communication structure needed to make effective watershed restoration plan implementation a reality and achieve effective improvements. The Annual Meeting will serve as an official exchange of information in the watersheds by first requiring project implementers in the Menomonee River Watershed to submit metrics (described in Measurable Milestones). And second, by providing stakeholders in the watershed with the opportunity to provide feedback, lessons learned, and suggest priority projects, research or policy changes that would facilitate effective TMDL implementation.

   Information shared at the Annual Meeting will be compiled by SWWT to be shared with all stakeholders in the watershed. This process will inform project implementers on other efforts in the watershed that they may not otherwise know of, encourage collaboration, and over all, improve the effectiveness of watershed restoration in the Menomonee. Information will additionally be used to feedback into future adaptations of the Plan.

CONCLUSION

Successful and cost-effective watershed restoration requires comprehensive, thoughtful efforts by multiple agencies and organizations to advance water quality, flood and water quantity, habitat and fish passage, recreation, and policy improvements. The Plan for the Menomonee River Watershed outlines goals for each of these aspects of watershed restoration and then prioritizes projects that address numerous goals in order to best address the issues in the watershed. By identifying and evaluating past barriers to successful implementation of prior plans in the watershed, the Plan uses the adaptive process of "Plan, Do, Check, Act" presented in the Menomonee River Watershed Restoration Plan of 2010. The Plan layers the goals and priorities from prior plans, uses the 2018 Milwaukee River TMDL report and sub-basin reduction goals, upcoming plans (e.g., MMSD 2050), and establishes specific evaluation criteria to guide the next 10 years of project implementation in the Menomonee River Watershed and beyond.

By incorporating the US EPA's Nine Minimum Elements of a Watershed Plan, the Plan additionally ensures that areas within Menomonee watershed will be eligible for Section 319 and other federal grant funding such as Great Lakes Restoration Initiative funding, upon its approval by WNDR and US EPA.

The Menomonee River Watershed is at a critical juncture. Although significant headway has been made towards restoring the watershed in the past 10 years, several barriers have impeded making further progress. The Menomonee River Watershed Updated Implementation Plan addresses many of these barriers and will help guide the comprehensive restoration of the Menomonee River Watershed for the next 10 years.