THE MENOMONEE RIVER WATERSHED UPDATED IMPLEMENTATION PLAN

A COMPREHENSIVE WATERSHED RESTORATION PLAN

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TABLE OF CONTENTS

PART 1. BACKGROUND 5

INTRODUCTION 5
PLAN OBJECTIVES 7
HOW TO USE THIS PLAN 7
OVERVIEW OF THE WATERSHED 9
PREVIOUS AND ONGOING PLANNING EFFORTS IN THE WATERSHED 13
PLAN CONSOLIDATION 15
WHERE IS THE WATERSHED TODAY? 15
OVERVIEW OF NINE KEY ELEMENTS 19

PART 2. WATER RESTORATION GOALS 21

WATER QUALITY IN THE MENOMONEE RIVER WATERSHED 21
Current Conditions and Critical Source Areas 21
Water Quality Goals and Metrics 38
FLOODING AND WATER QUANTITY CONTROL 53
Current Conditions 53
Flooding and Water Quantity Control Goals and Metrics 54
AQUATIC AND TERRESTRIAL HABITAT 55
Current Conditions 55
Aquatic and Terrestrial Habitat Goals and Metrics 62
POLICY IMPLICATIONS 62
Policy Goals and Metrics 65
RECREATION AND PUBLIC ACCESS 66
Current Conditions 66
Recreation and Public Access Goals and Metrics 67

PART 3. IMPLEMENTATION AND EVALUATION 68

UPDATED IMPLEMENTATION PLAN FRAMEWORK 94
MEASURABLE MILESTONES 95
LEADERSHIP STRUCTURE 99
FUNDING SOURCES 102
MONITORING 104
Water Quality-Current Monitoring: 104
Water Quality-Updated Implementation Plan Monitoring 106
INFORMATION AND EDUCATION 106
Current Communication Channels in the Menomonee River Watershed: 107
Planned Communication Channels in the Menomonee River Watershed 108
CONCLUSION 109

APPENDICES 110

APPENDIX A. FULL LIST OF PLANS AND REFERENCE DOCUMENTS IN MENOMONEE RIVER UPDATED IMPLEMENTATION PLAN 111
APPENDIX B. REACH DEFINITIONS CROSS REFERENCE MATRIX 112
APPENDIX C. GREEN INFRASTRUCTURE PRIORITY HOTSPOT ANALYSIS – SWWT 2013 114

APPENDIX D. GREEN INFRASTRUCTURE IDENTIFICATION AND PRIORITIZATION IN THE MENOMONEE RIVER WATERSHED 119
APPENDIX E. INTERFLUVE MENOMONEE AND KINNICKINNIC RIVERS FINAL CONCEPT DESIGN REPORT 229
APPENDIX F. MENOMONEE RIVER MUNICIPAL GROUP STORMWATER PERMIT 2020 254
APPENDIX G. MUNICIPAL SEPARATE STORM SEWER SYSTEM MAPS 297
APPENDIX H. MONITORING METHODOLOGY 317
APPENDIX I. SWWT RESPECT OUR WATERS (ROW) HOUSEHOLD SURVEY, PUBLIC POLICY FORUM 2011; UNIVERSITY OF WISCONSIN WHITEWATER'S FISCAL AND ECONOMIC RESEARCH CENTER 2016-17 323
APPENDIX J. MICROBIAL COMMUNITY ASSESSMENT FOR THE MILWAUKEE RIVER BASIN 2017, DR. RYAN MILLER, UNIVERSITY OF WISCONSIN-MILWAUKEE SCHOOL OF FRESHWATER SCIENCES 355
APPENDIX K. WDNR AGRICULTURAL CONVERSION ESTIMATE FOR THE MENOMONEE RIVER WATERSHED 360
APPENDIX L. WNDR SNAPPLUS AGRICULTURAL ANALYSIS FOR REMAINING AGRICULTURAL LAND IN THE MENOMONEE RIVER WATERSHED 364
APPENDIX M. COST ANALYSIS FOR AGRICULTURAL BMP INSTALLATION 374
Menomonee River HUC 12 – 040400030401 (TMDL MN 1) cost analysis 374
Menomonee River HUC 12 – 040400030402 (TMDL MN 9) cost analysis 374

TABLES

TABLE 1. THE MENOMONEE RIVER AND MAIN TRIBUTARIES. 11
TABLE 2. CIVIL DIVISIONS IN THE MENOMONEE RIVER WATERSHED. 11
TABLE 3. STORMWATER OUTFALLS TESTED FROM 2008-2016. 26
TABLE 4. WATER QUALITY IMPAIRMENT TERMS AND DEFINITIONS. 33
TABLE 5. IMPAIRED WATERWAYS IN THE MENOMONEE RIVER WATERSHED. 35
TABLE 6. SUMMARY OF TMDL ALLOCATIONS FOR TOTAL SUSPENDED SOLIDS AND TOTAL PHOSPHORUS BY REACH IN THE MENOMONEE WATERSHED. 44
TABLE 7. MONTHLY TMDL FECAL COLIFORM WASTELOAD ALLOCATION BY MUNICIPALITY. 46
TABLE 8. REQUIRED PERCENT REDUCTION OF AGRICULTURAL AND NON-PERMITTED URBAN TP AND TSS BY REACH. 48
TABLE 9. AGRICULTURAL PRACTICE MILESTONES FOR THE MENOMONEE WATERSHED 52
TABLE 10. PRIORITY PROJECTS. 69
TABLE 11. GENERAL TIMELINE FOR THE PLAN 96
TABLE 12. SUPPORTING PLANS. 97
TABLE 13. LEAD ORGANIZATIONS FOR THE MENOMONEE RIVER UPDATED IMPLEMENTATION PLAN. 99
TABLE 14. EXISTING GRANT OPPORTUNITIES. 102
TABLE 15. CURRENT MONITORING ENTITIES WITHIN THE MENOMONEE RIVER WATERSHED. 104

FIGURES

FIGURE 1. COMPONENTS OF SUCCESSFUL WATERSHED RESTORATION 6
FIGURE 2. MILWAUKEE RIVER BASIN AND SUBBASINS 9
FIGURE 3. MENOMONEE WATERSHED MAJOR SUB-BASINS AND HUC 12 WATERSHED BOUNDARIES 10
FIGURE 4. MENOMONEE RIVER MUNICIPALITIES AND MENOMONEE RIVER WATERSHED MS4 PERMIT 17
FIGURE 5. GREEN INFRASTRUCTURE HOTSPOTS IN THE MENOMONEE RIVER WATERSHED WITH COMMERCIAL AND INDUSTRIAL LAND USES. 22
FIGURE 6. AVERAGE TOTAL PHOSPHORUS FOR MONITORING SITES FROM 2016-2019 USING MILWAUKEE RIVERKEEPER, MMSD, AND WDNR DATA. 24
FIGURE 7. ACTUAL VS. MODELED BACTERIA DATA FOR FECAL COLIFORM IN THE UPPER AND LOWER MENOMONEE RIVER. 26
FIGURE 8. HUMAN BACTEROIDES LEVELS FROM STORMWATER OUTFALLS SAMPLED 2008-2016. 27
FIGURE 9. COMMUNITY MICROBIAL ASSESSMENT SITES IN THE MENOMONEE RIVER FOR 2017 MILWAUKEE BASIN STUDY. 29
FIGURE 10. COUNT OF ACUTE EXCEEDANCES OF CHLORIDE WATER QUALITY STANDARDS FOR WISCONSIN FROM 2002-2019. 32
FIGURE 11. MAP OF MENOMONEE IMPAIRED WATERS PER 2018 303D LIST. 34
FIGURE 12. MUNICIPALITIES WITHIN THE MENOMONEE RVER WATERSHED AND TMDL REACHES. 39
FIGURE 13. REMAINING AGRICULTURAL AREAS WITHIN TMDL REACHES MN1 AND MN9 ESTIMATED FOR CONVERSION TO URBAN LAND USE WITHIN TEN YEARS. 50
FIGURE 14. EVAAL RESULTS FOR MENOMONEE WATERSHED AGRICULTURAL LANDS - TMDL REACHES MN1 AND MN9. 51
FIGURE 15. STREAM CHANNEL AND BIOLOGICAL QUALITY CONDITIONS WITHIN THE MENOMONEE RIVER WATERSHED: 2000-2009. 60
FIGURE 16. RIPARIAN CONDITIONS AND GROUNDWATER RECHARGE POTENTIAL WITHIN THE MENOMONEE RIVER WATERSHED: 2000-2009. 61
FIGURE 17. IMPLEMENTATION FRAMEWORK FOR THE PLAN 95
FIGURE 18. WATER QUALITY MONITORING STATIONS BY ENTITY 105

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.

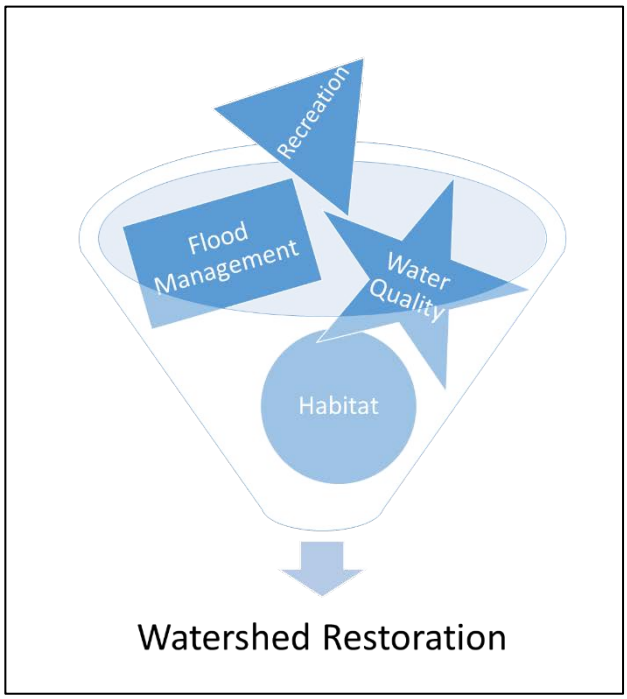


FIGURE 1. COMPONENTS OF SUCCESSFUL WATERSHED RESTORATION

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

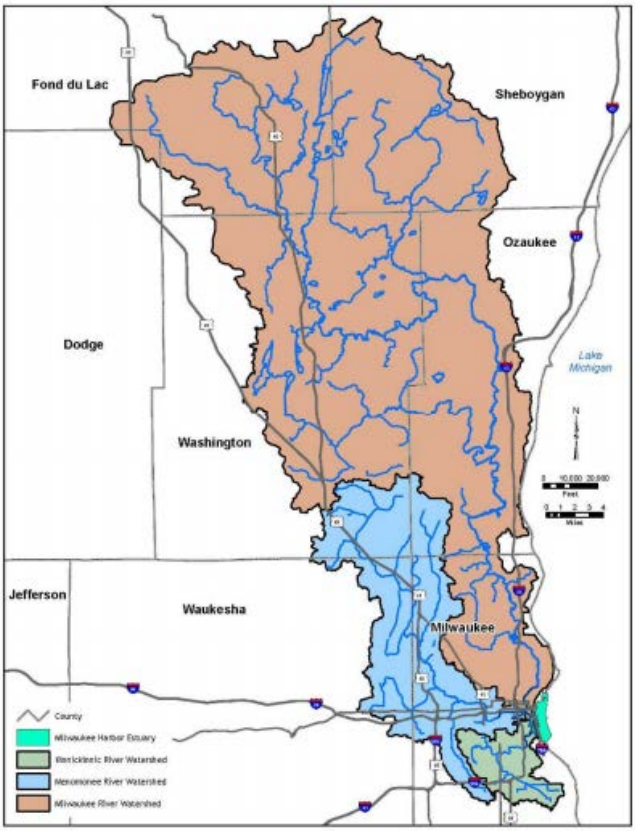


FIGURE 2. MILWAUKEE RIVER BASIN AND SUBBASINS

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.

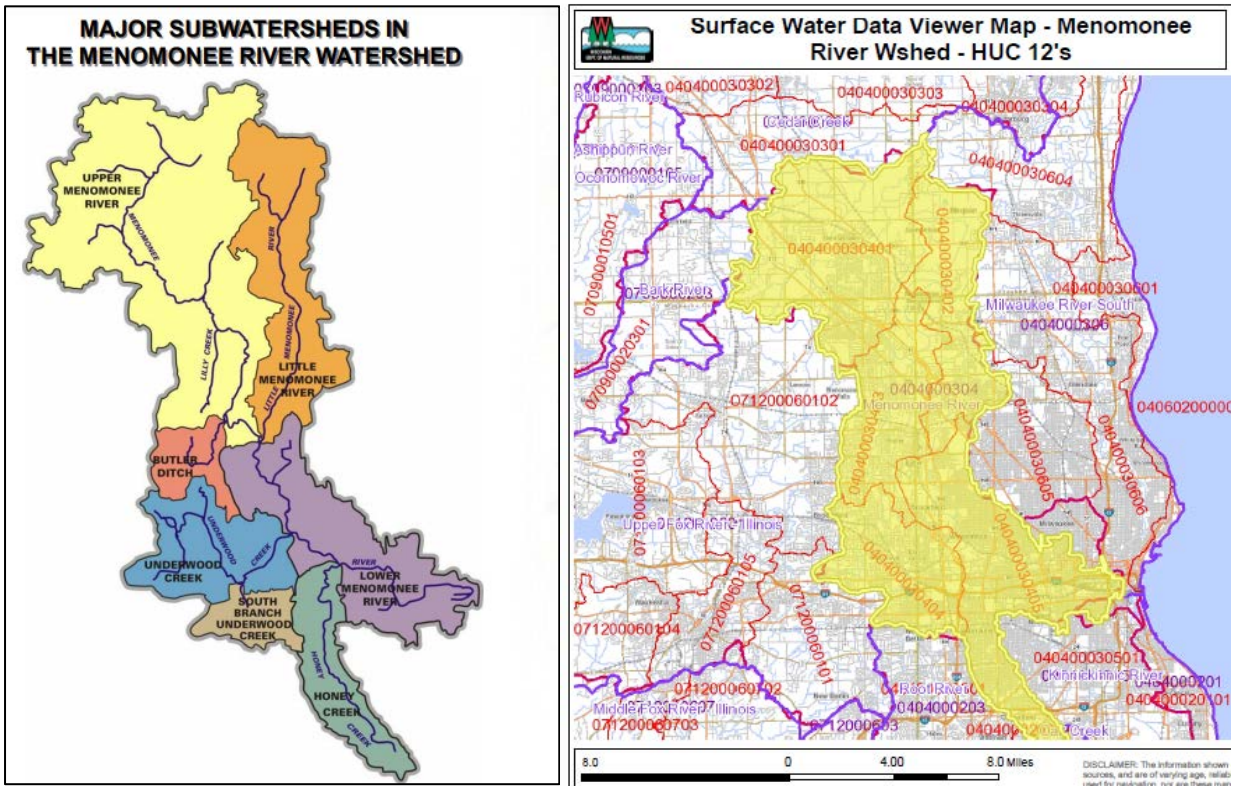


FIGURE 3. MENOMONEE WATERSHED MAJOR SUB-BASINS AND HUC 12 WATERSHED BOUNDARIES

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?

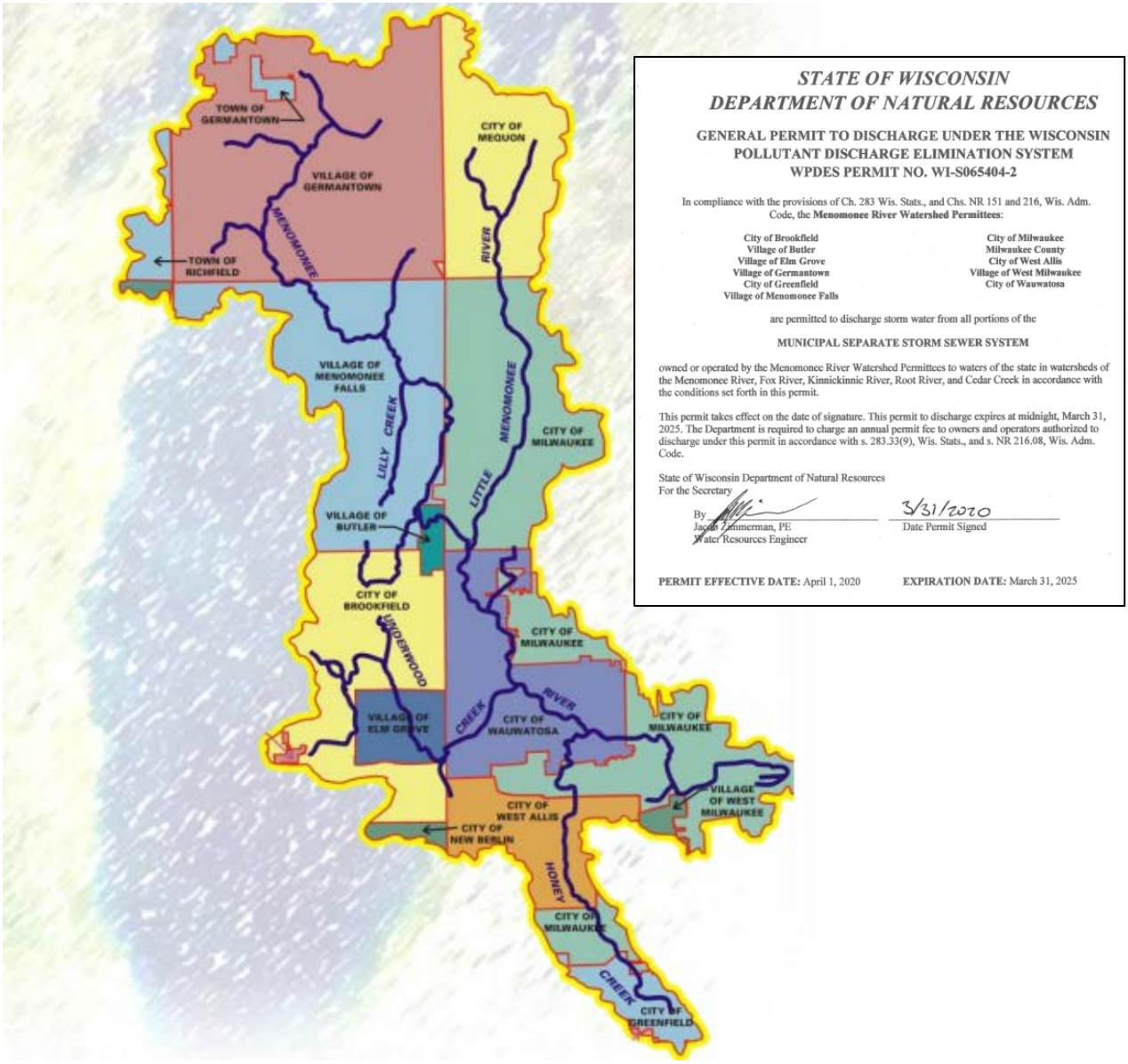
Since the creation of the Watershed Restoration Plan for the Menomonee River Watershed in 2010, several of the priority restoration actions have been completed and additional restoration goals identified. Despite these successes, the watershed is not yet meeting the goals and timelines set in the Watershed 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	City of Milwaukee
Village of Butler	Milwaukee County
Village of Elm Grove	City of West Allis
Village of Germantown	Village of West Milwaukee
City of Greenfield	City of Wauwatosa
Village of Menomonee Falls	

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 _____ 3/31/2020
Jacob Zimmerman, PE — Date Permit Signed
Water Resources Engineer

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

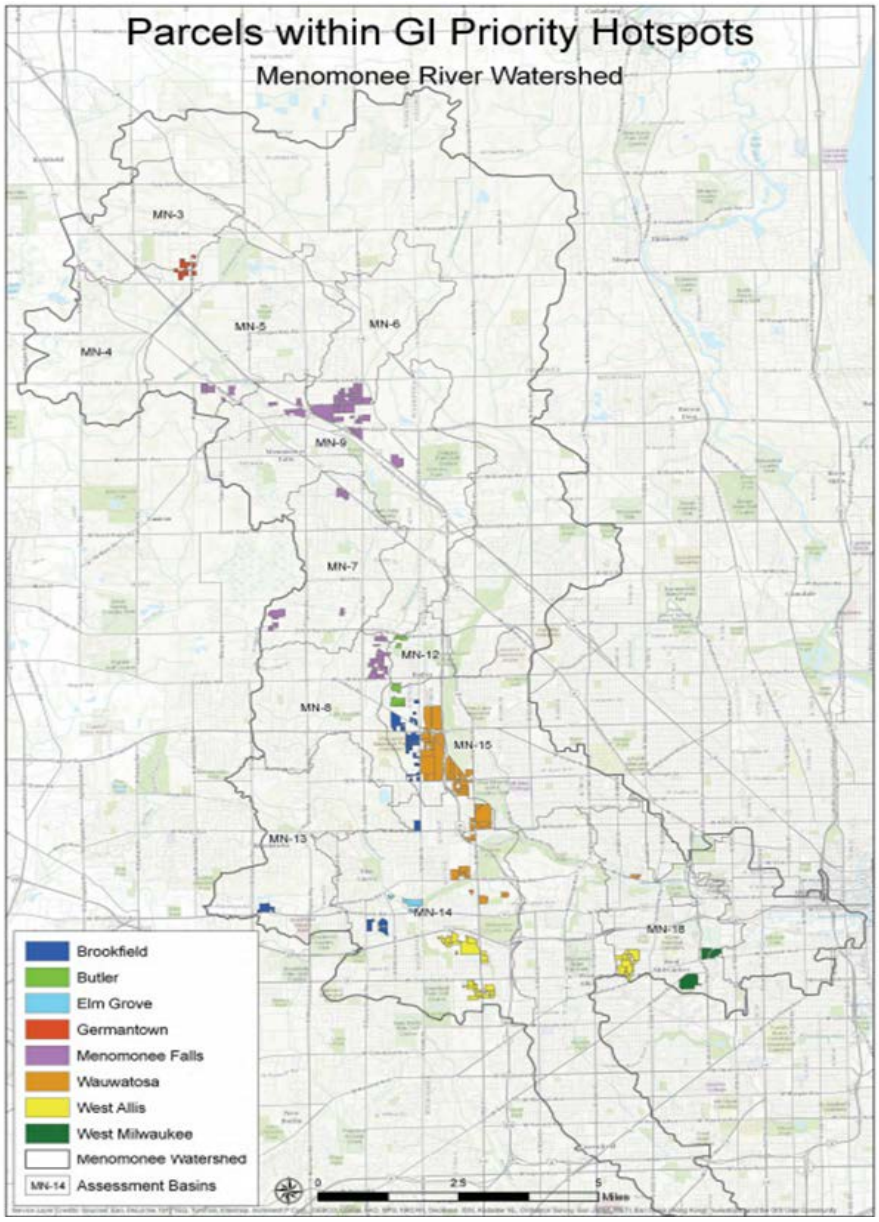


FIGURE 5. GREEN INFRASTRUCTURE HOTSPOTS IN THE MENOMONEE RIVER WATERSHED WITH COMMERCIAL AND INDUSTRIAL LAND USES.

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.

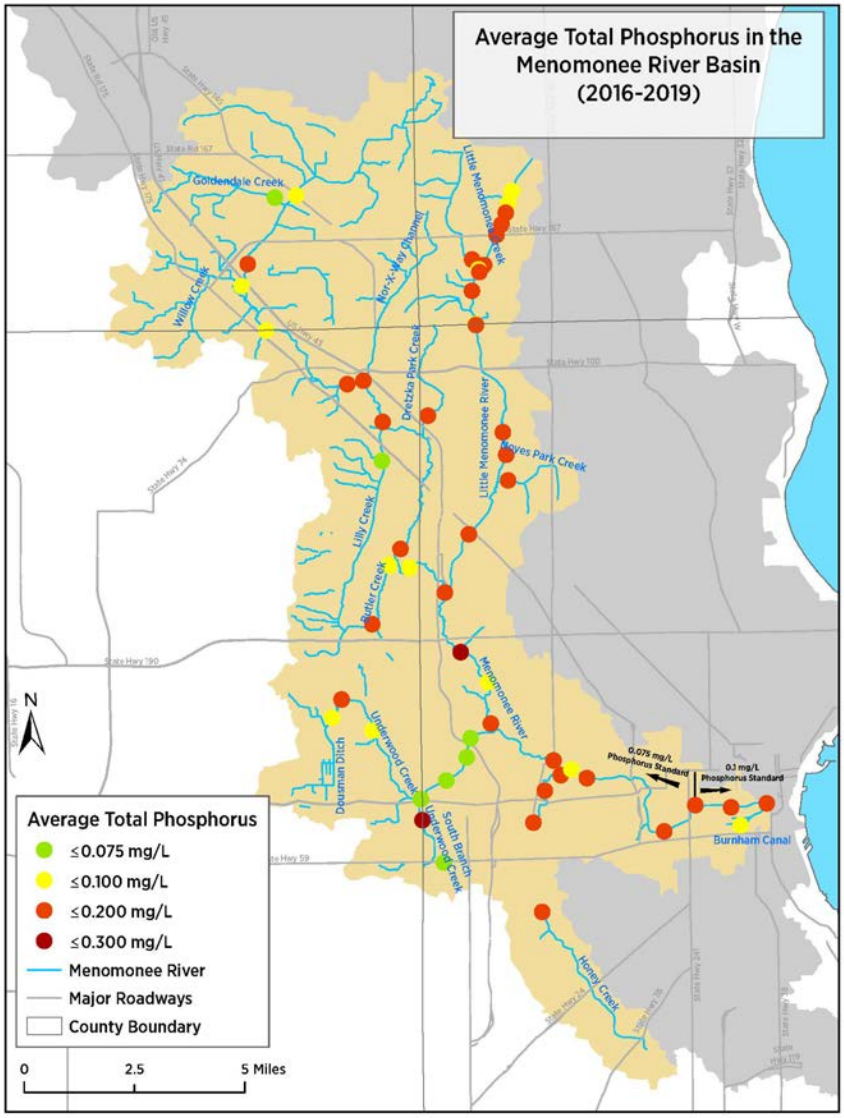


FIGURE 6. AVERAGE TOTAL PHOSPHORUS FOR MONITORING SITES FROM 2016-2019 USING MILWAUKEE RIVERKEEPER, MMSD, AND WDNR DATA.

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.

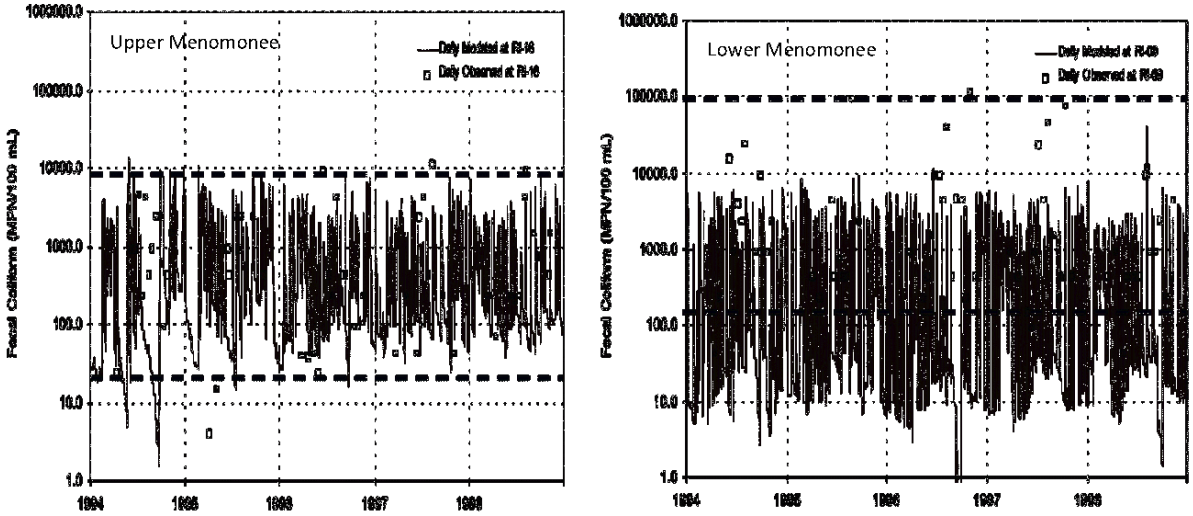


FIGURE 7. ACTUAL VS. MODELED BACTERIA DATA FOR FECAL COLIFORM IN THE UPPER AND LOWER MENOMONEE RIVER.

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.

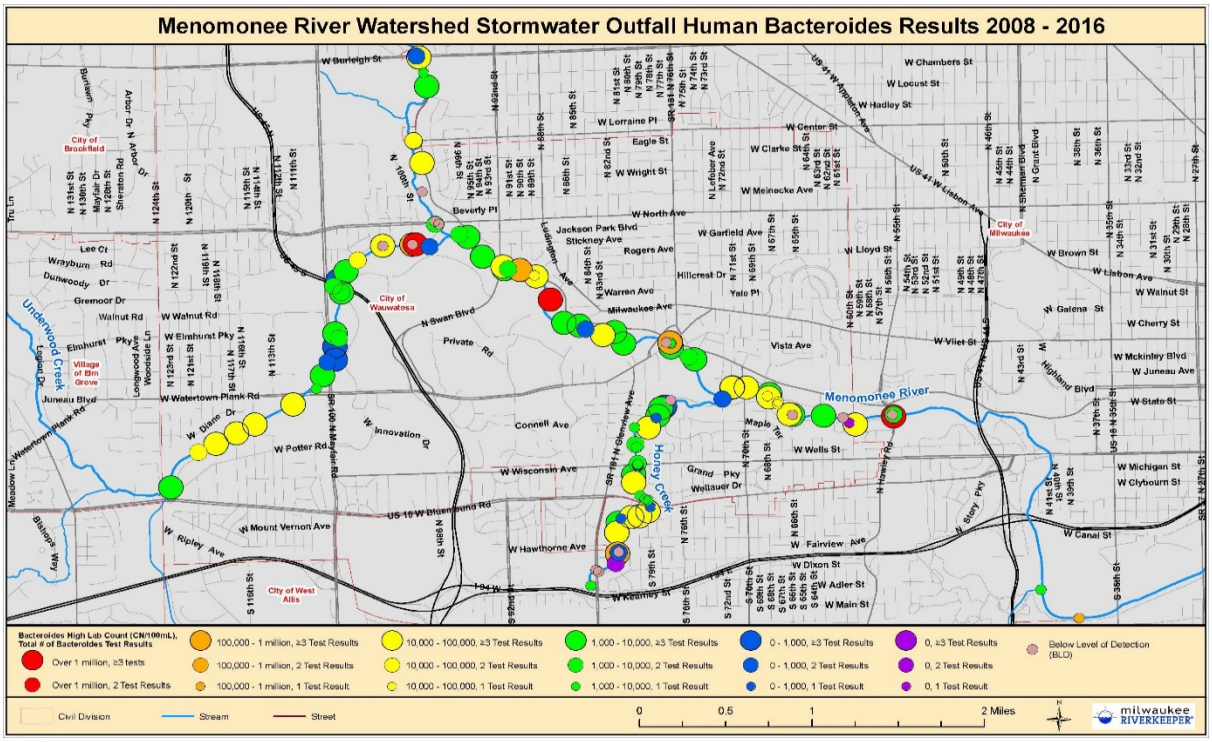


FIGURE 8. HUMAN BACTEROIDES LEVELS FROM STORMWATER OUTFALLS SAMPLED 2008-2016.

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.

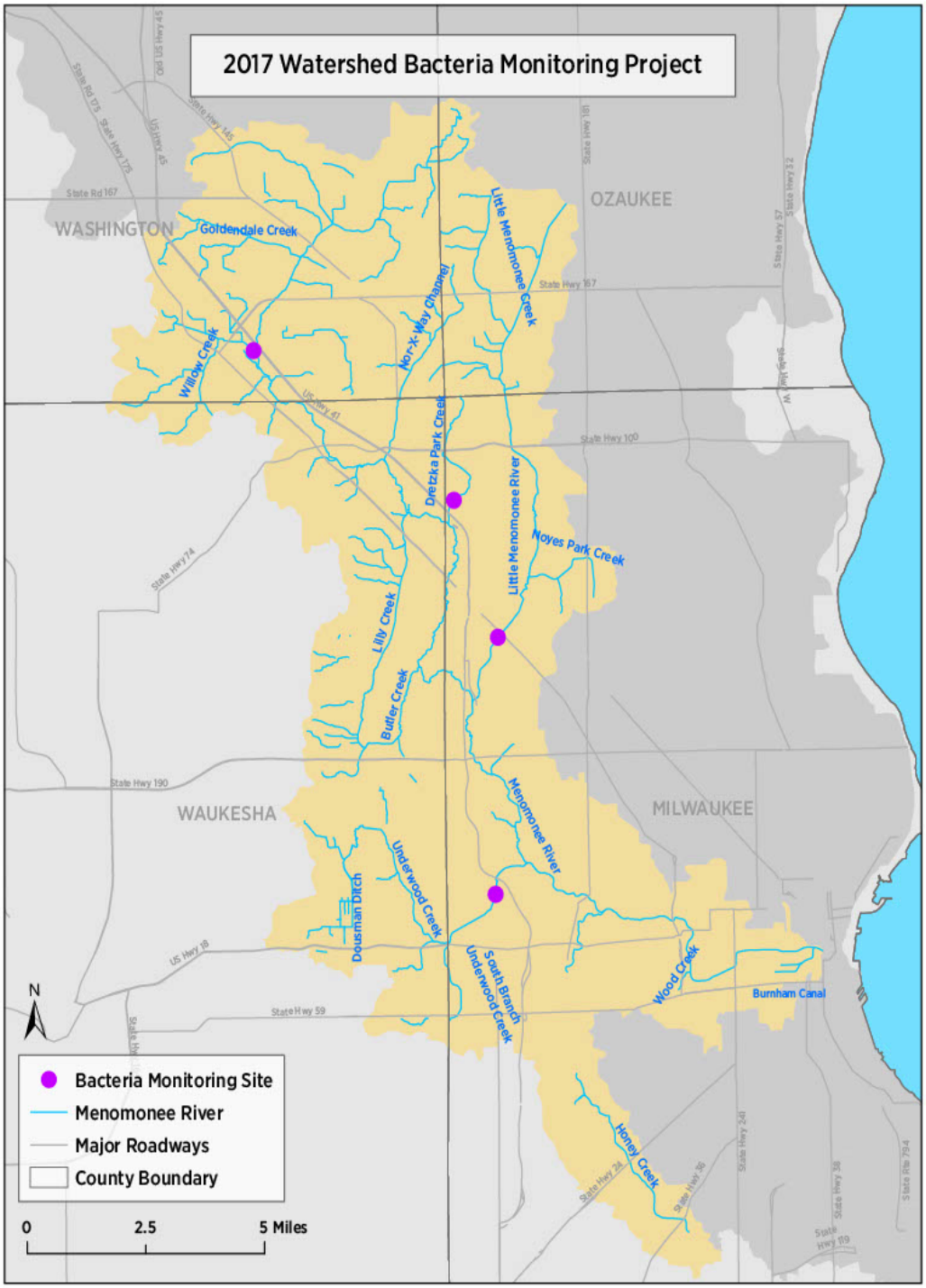


FIGURE 9. COMMUNITY MICROBIAL ASSESSMENT SITES IN THE MENOMONEE RIVER FOR 2017 MILWAUKEE BASIN STUDY.

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

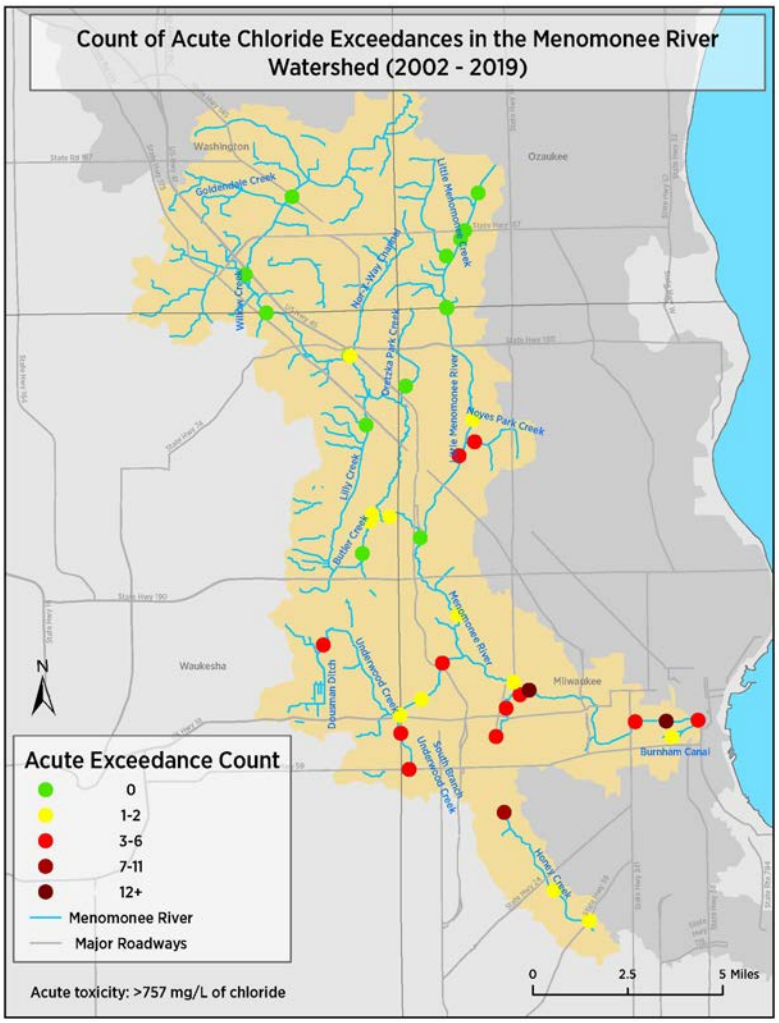


FIGURE 10. COUNT OF ACUTE EXCEEDANCES OF CHLORIDE WATER QUALITY STANDARDS FOR WISCONSIN FROM 2002-2019.

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.

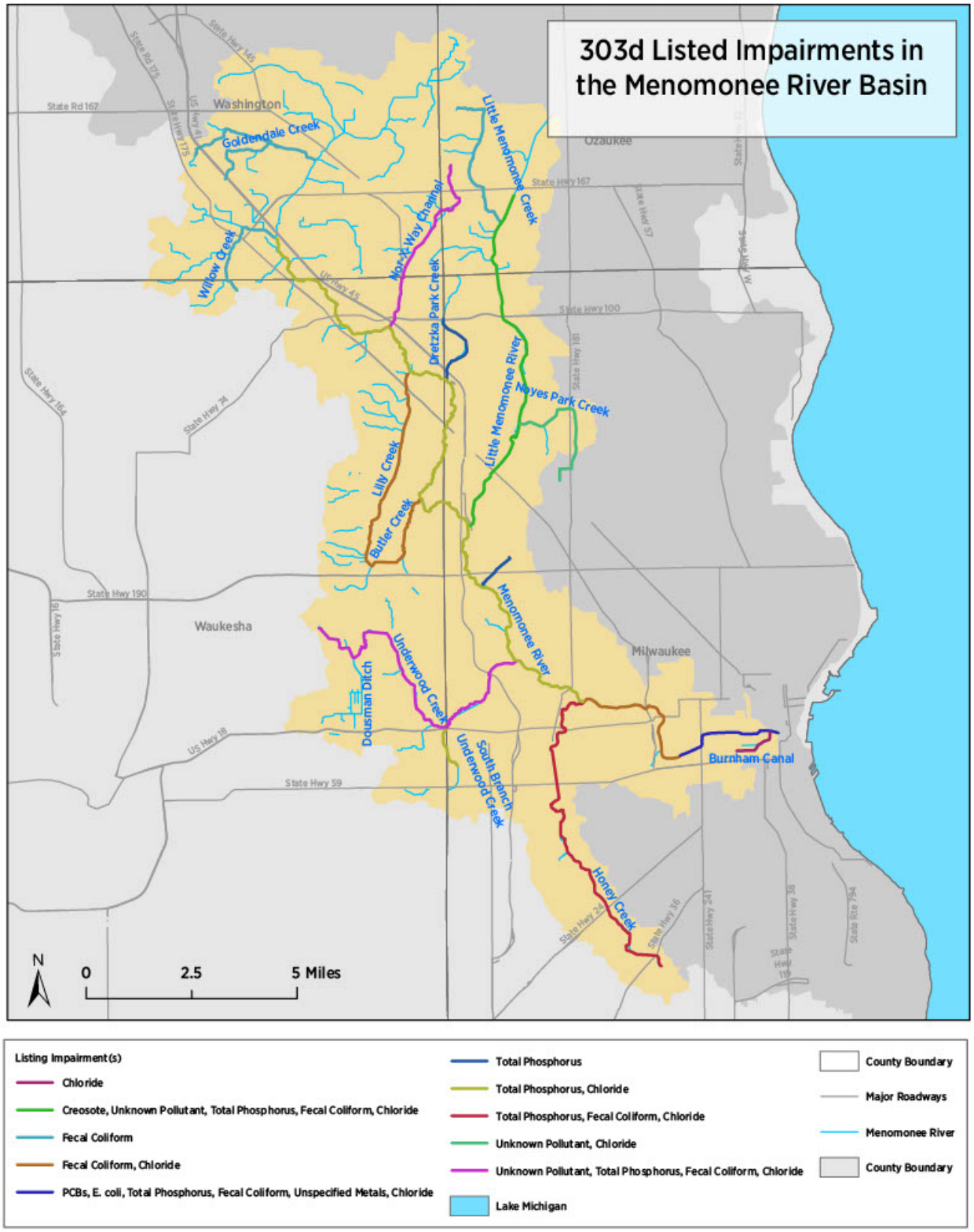


FIGURE 11. MAP OF MENOMONEE IMPAIRED WATERS PER 2018 303D LIST.

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

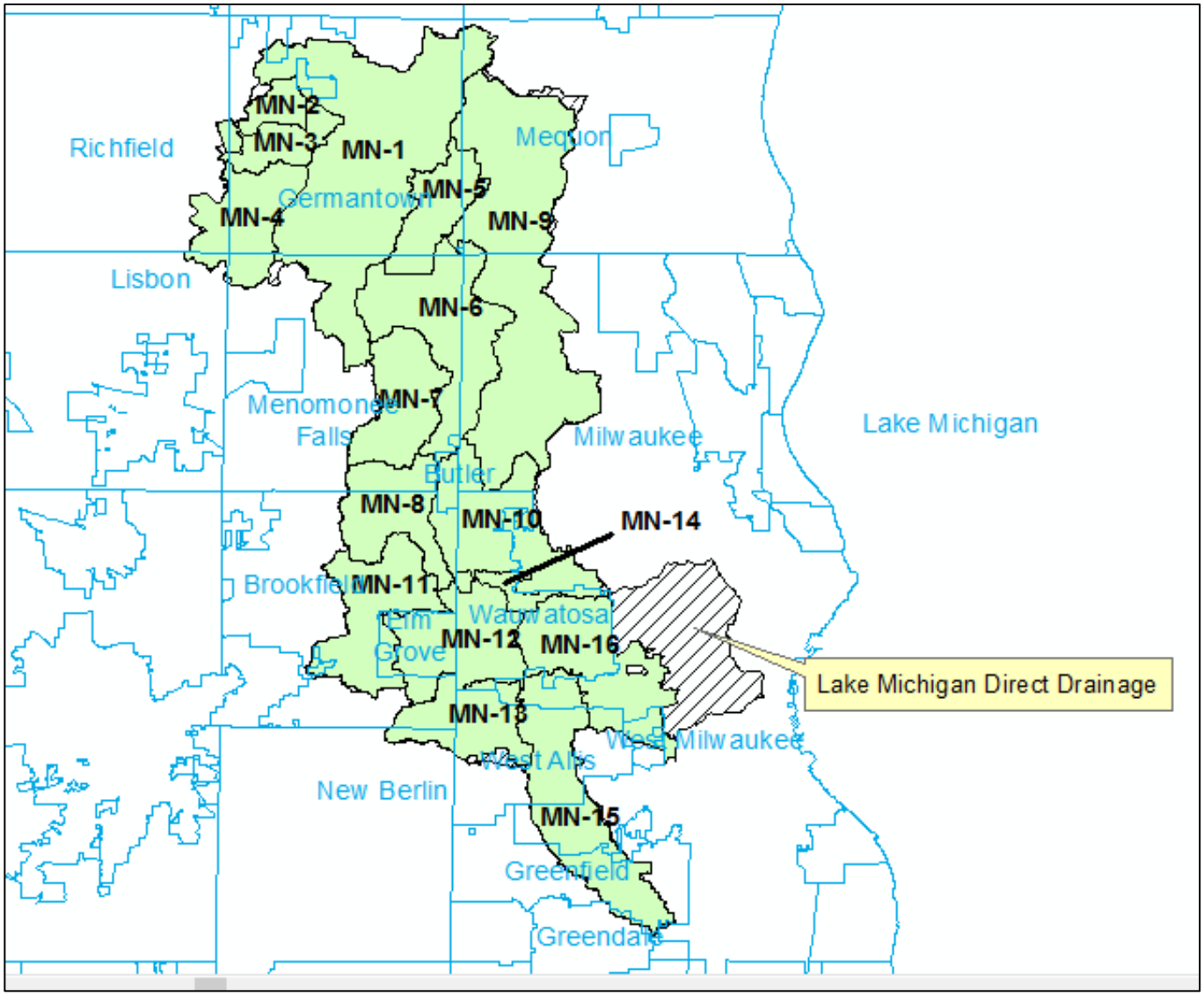


FIGURE 12. MUNICIPALITIES WITHIN THE MENOMONEE RVER WATERSHED AND TMDL REACHES.

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.

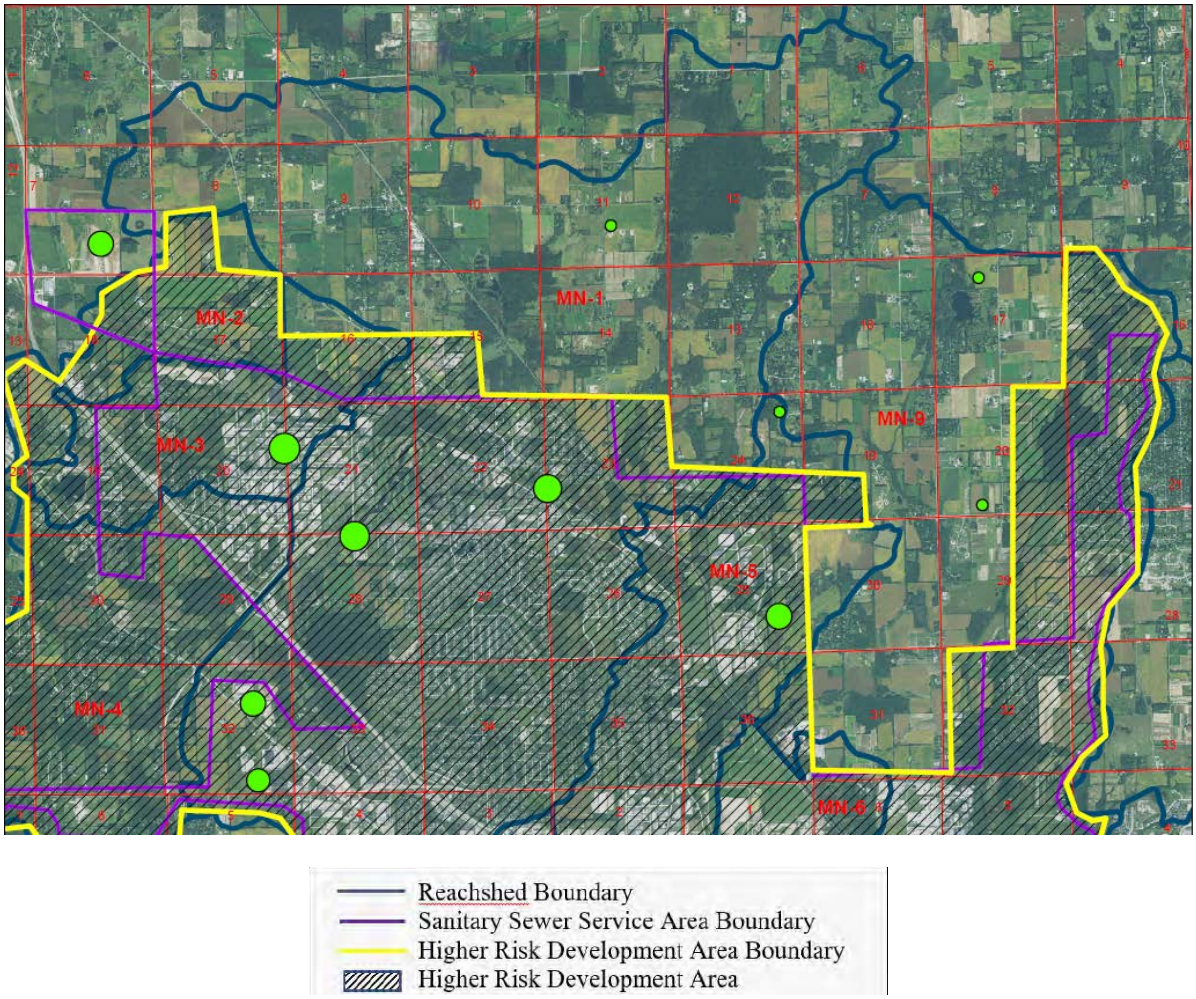


FIGURE 13. REMAINING AGRICULTURAL AREAS WITHIN TMDL REACHES MN1 AND MN9 ESTIMATED FOR CONVERSION TO URBAN LAND USE WITHIN TEN YEARS.

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.

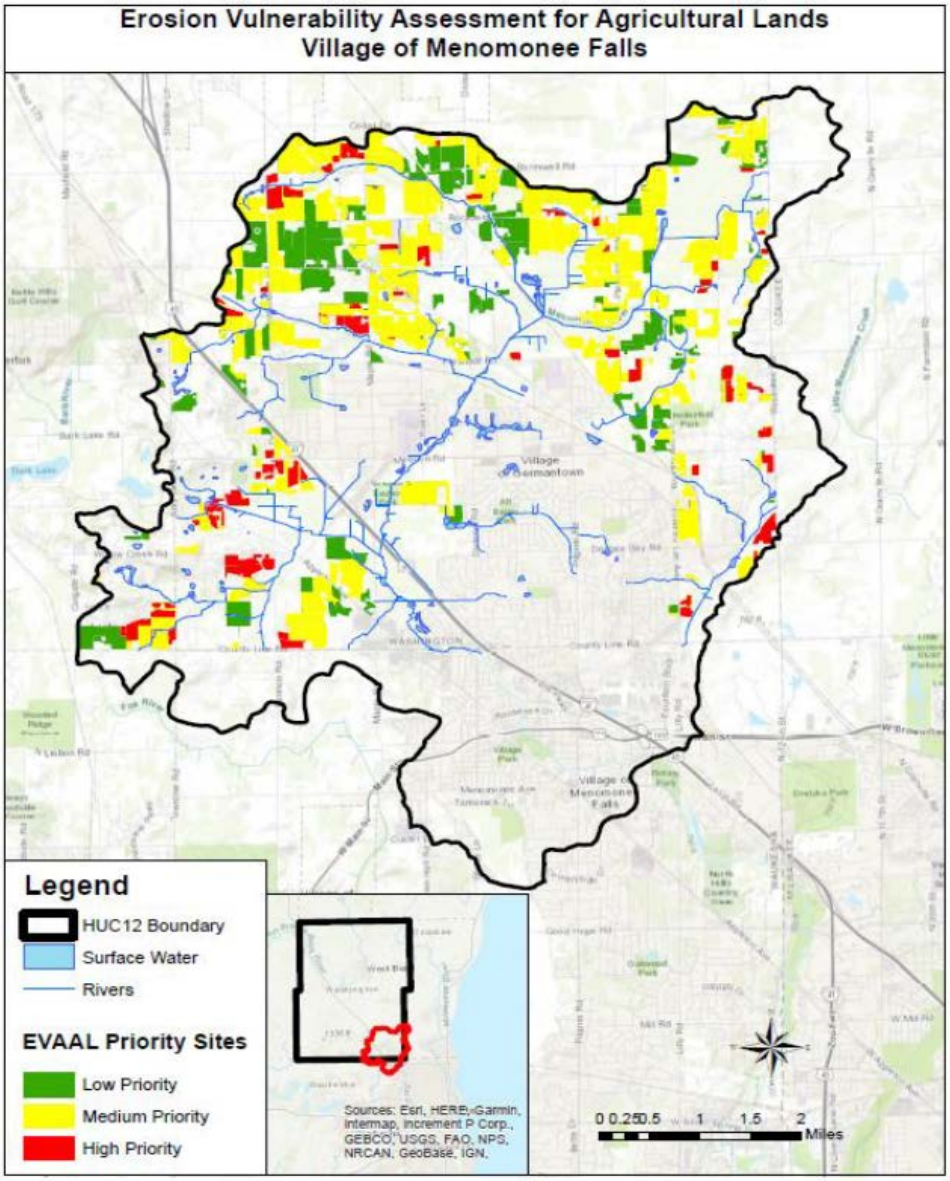


FIGURE 14. EVAAL RESULTS FOR MENOMONEE WATERSHED AGRICULTURAL LANDS - TMDL REACHES MN1 AND MN9.

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.

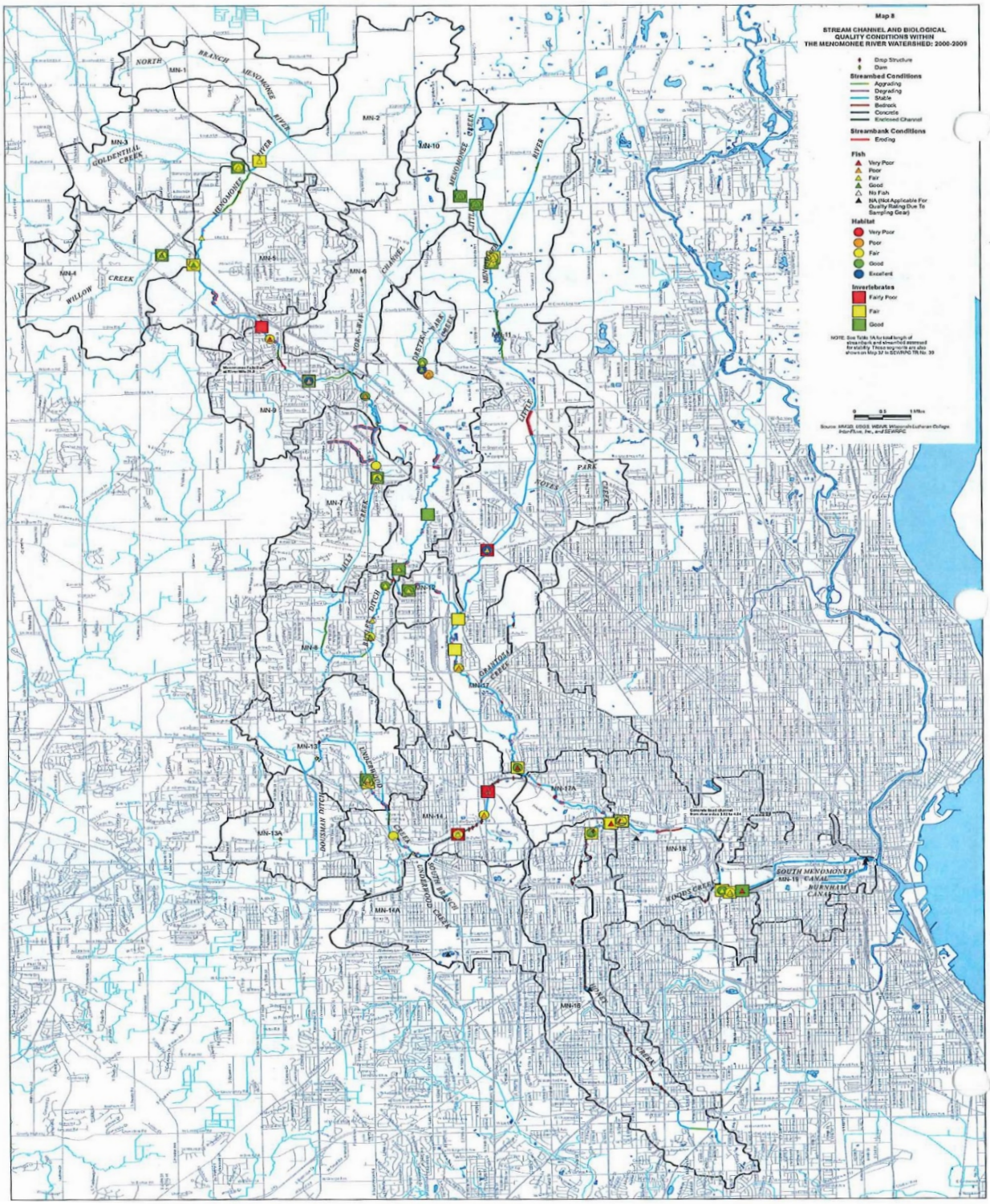


FIGURE 15. STREAM CHANNEL AND BIOLOGICAL QUALITY CONDITIONS WITHIN THE MENOMONEE RIVER WATERSHED: 2000-2009.

Source: SEWRPC, 2010

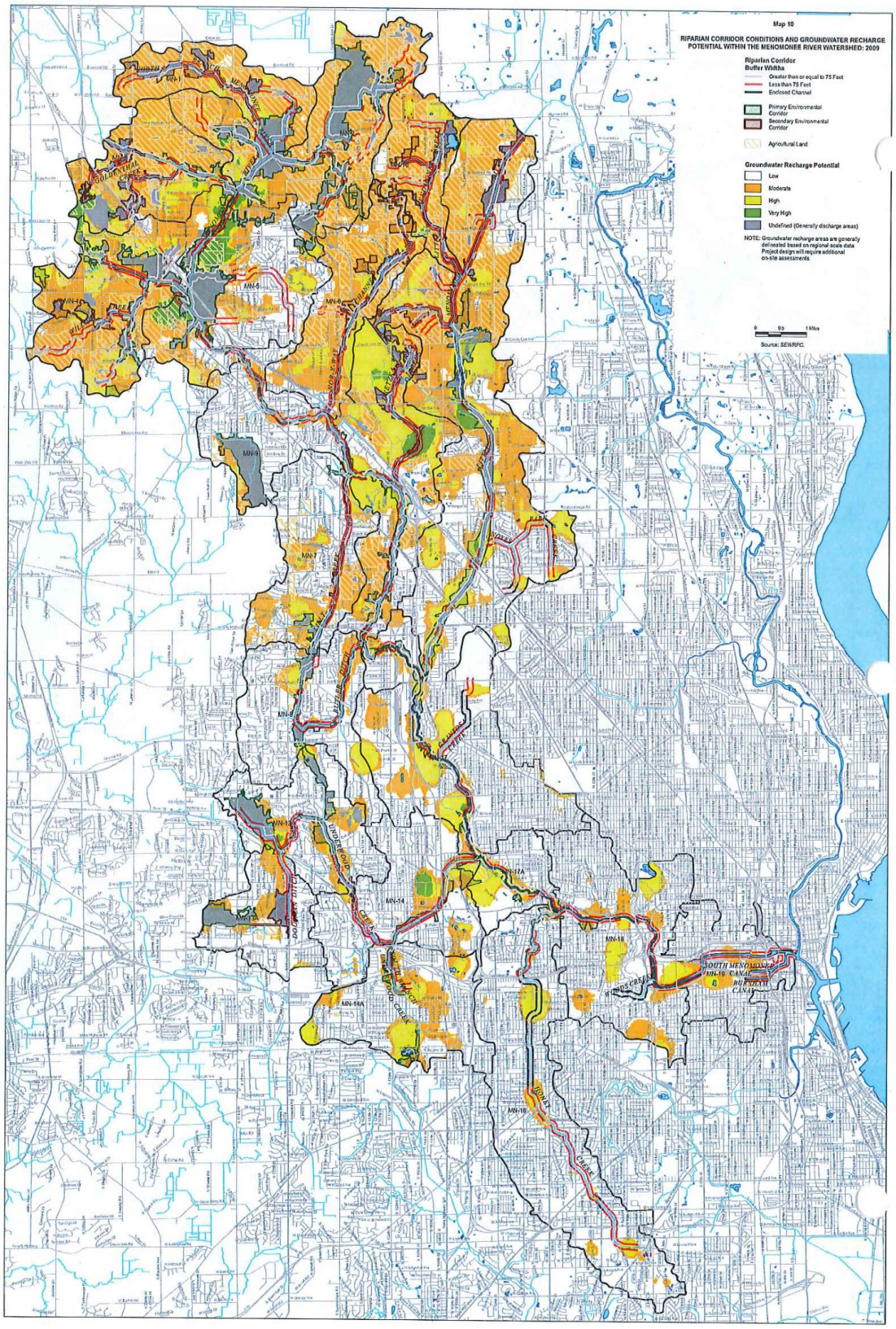


FIGURE 16. RIPARIAN CONDITIONS AND GROUNDWATER RECHARGE POTENTIAL WITHIN THE MENOMONEE RIVER WATERSHED: 2000-2009.

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.

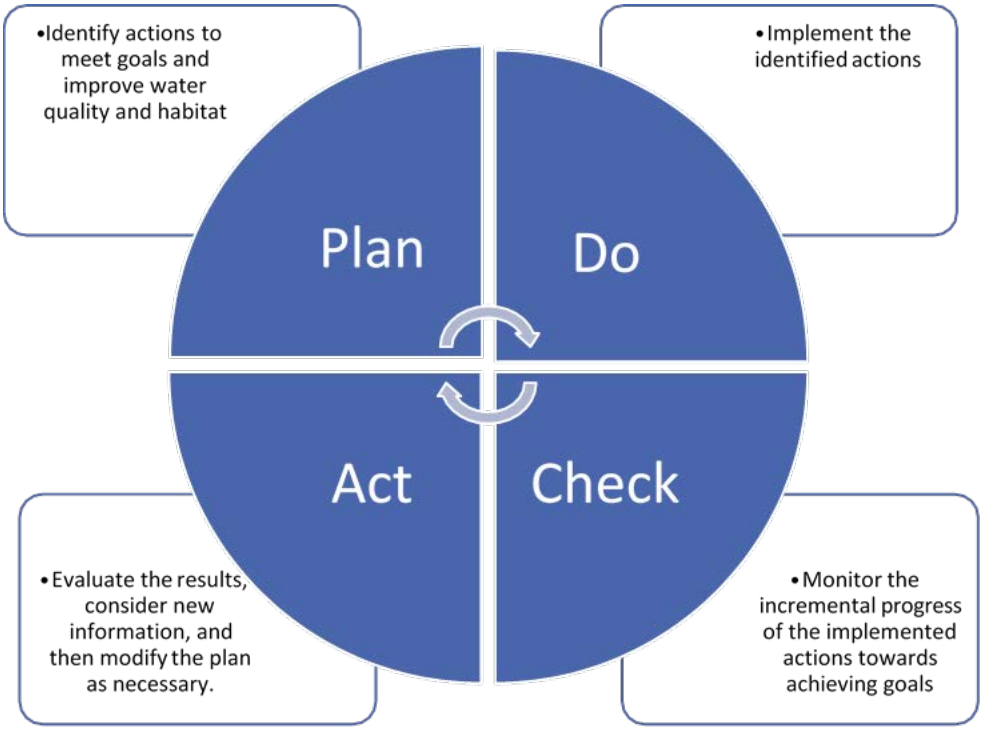


FIGURE 17. IMPLEMENTATION FRAMEWORK FOR THE PLAN

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	

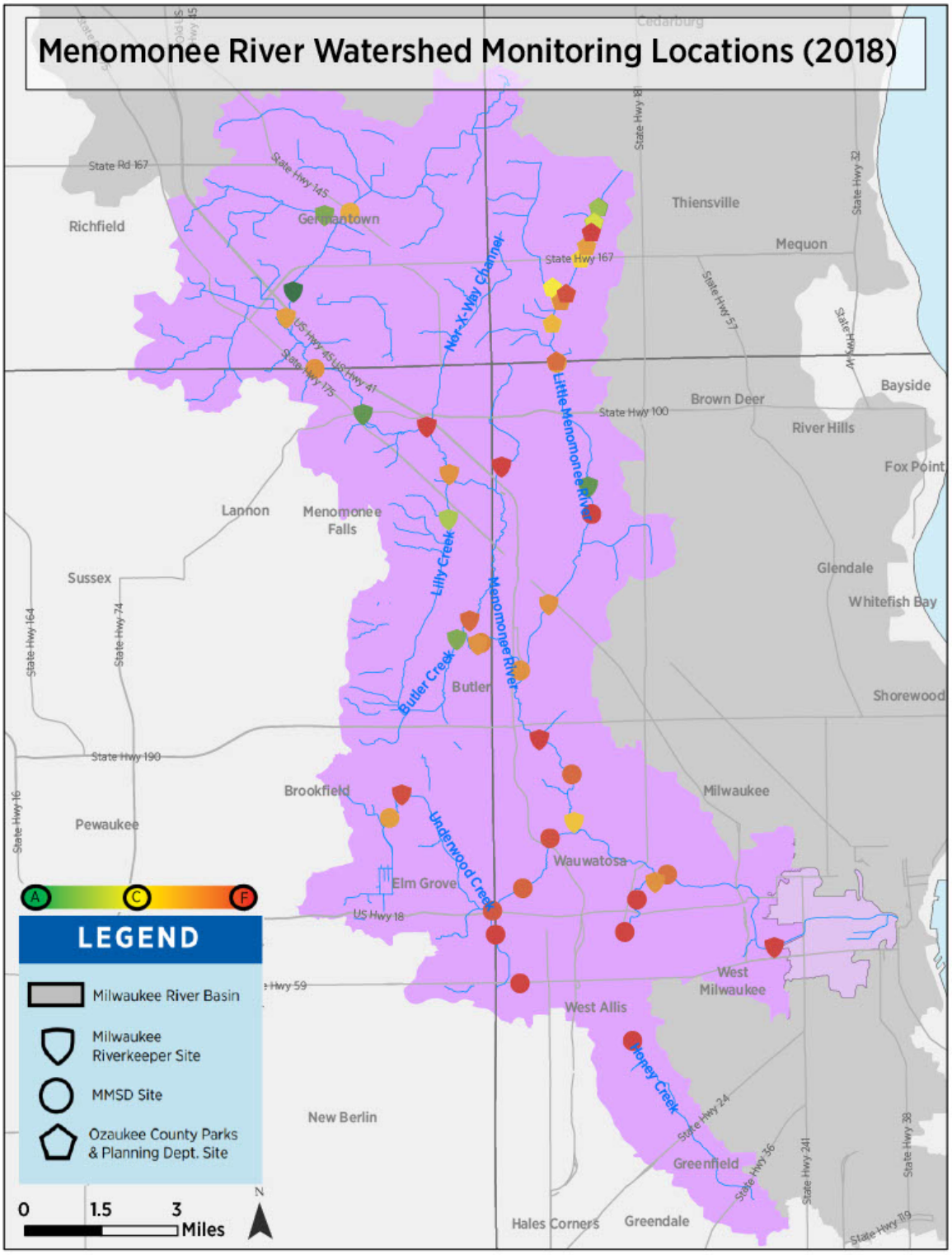


FIGURE 18. WATER QUALITY MONITORING STATIONS BY ENTITY

(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.

APPENDICES

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APPENDIX A. FULL LIST OF PLANS AND REFERENCE DOCUMENTS IN MENOMONEE RIVER UPDATED IMPLEMENTATION PLAN

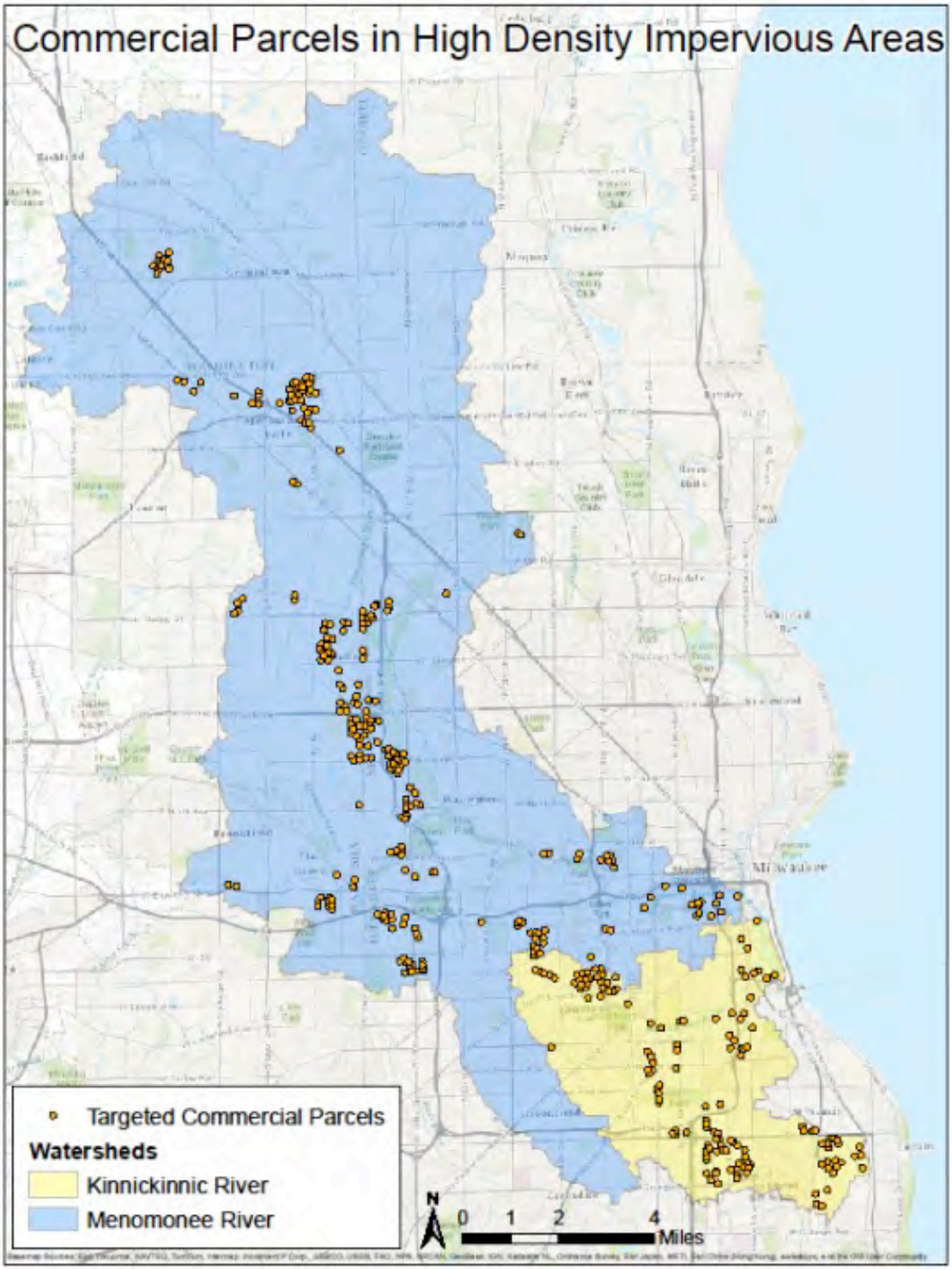
1. Milwaukee River TMDL, 2016, CDM Smith/MMSD. (Approved by EPA 2018)
2. Planning Report 39,Water Quality Conditions and Sources of Pollution in the Greater Milwaukee Watersheds, part 1 and part 2, 2007a, SEWRPC.
3. Planning Report 51, Regional Water Quality Management Plan Update, (part 1, part 2, part 3), 2007b and 2013, SEWRPC.
4. Menomonee Watershed Restoration Plan, (Part 1) (Part 2) (Part 3) (Part 4), 2010, MMSD
5. Menomonee Implementation Plan, 2010, Southeastern Wisconsin Watershed Trust Inc. Menomonee Watershed Action Team
6. Milwaukee River Basin Report Cards 2013-2018, Milwaukee Riverkeeper
7. Stream Habitat Conditions and Biological Assessment of the Menomonee and Kinnickinnic River Watersheds, 2009, SEWRPC
8. MMSD Regional GI Plan, 2013, MMSD
9. ReFresh Sustainability Plan, 2013, City of Milwaukee
10. Green Infrastructure Baseline Inventory, 2015, City of Milwaukee
11. Green Infrastructure Plan, 2019, City of Milwaukee
12. Odefey, et al., 2012. Banking on Green: A Look at How Green Infrastructure Can Save Municipalities Money and Provide Economic Benefits Community-wide
13. What is Green Infrastructure, https://www.epa.gov/green-infrastructure/what-green-infrastructure, US EPA
14. Wisconsin Consolidation Assessment and Listing Methodology (WISCALM) for CWA Section 303(d) and 305(b) Integrated Reporting, 2018 and 2020 (DRAFT), WDNR.
15. Menomonee River Fish Passage Survey Report and Attachments, 2012, Milwaukee Riverkeeper.
16. Menomonee River Concrete Removal, MMSD
17. Underwood Creek Flood Management and Habitat Restoration, MMSD.
18. County Grounds Flood Management, MMSD.
19. Western Milwaukee Flood Management, MMSD.
20. Menomonee River Watershed Water Quality Management Plan Update, 2010, WDNR.
21. The State of the Milwaukee River Basin, WT704-2001, 2001, WDNR.
22. Waters in Watershed MI03-Menomonee River, Surface Water Viewer, Accessed 2020, WDNR.

APPENDIX B. REACH DEFINITIONS CROSS REFERENCE MATRIX

TMDL Subbasin/ Reachshed/MN Watershed Permit	Menomonee Watershed Implementation Plan (SWWT)	Menomonee Watershed Restoration Plan	SWWT Green Infrastructure Hot Spot Analysis of Commercial and Industrial Property	SEWRPC Habitat Condition and Biological Assessment of Kinnickinnic and Menomonee River Watersheds
MN1 Menomonee River (from Nor-X-Way to headwaters)	MN1	MN1		MN1 North Branch Menomonee River
MN2 Goldendale Creek	MN2	MN2		MN2 Menomonee River Upper a
MN3 West Branch Menomonee River	MN3	MN3	MN3 Germantown	MN3 West Branch Menomonee River
MN4 Willow Creek	MN4	MN4	MN4 Germantown	MN4 Willow Creek
MN1 Menomonee River (from Nor-X-Way to headwaters)	MN5	MN5	MN5 Germantown MN5 Menomonee Falls	MN5 Menomonee River Upper b
MN5 Nor-X-Way Channel	MN6	MN6	MN6 Menomonee Falls	MN6 Nor-X-Way Channel
MN7 Lilly Creek	MN7	MN7	MN7 Menomonee Falls	MN7 Lilly Creek
MN8 Butler Ditch	MN8	MN8	MN8 Menomonee Falls	MN8 Butler Ditch
MN6 Menomonee River (from Little Menomonee River to Nor-X-Way) and Dretzka Creek	MN9	MN9	MN9 Menomonee Falls	MN9 Menomonee River Upper c
MN9 Little Menomonee River	MN10	MN10		MN10 Little Menomonee Creek
MN9 Little Menomonee River	MN11	MN11	SLAMM Shed 2090 Milwaukee	MN11 Little Menomonee River
MN6 Menomonee River (from Little Menomonee to Nor-X-Way)	MN12	MN12	SLAMM Shed 2132 Milwaukee SLAMM Shed 2131 Milwaukee SLAMM Shed	MN12 Menomonee River Upper d

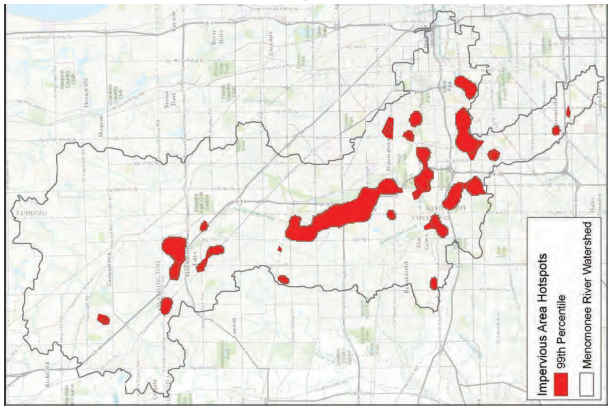
			2130 Milwaukee MN12 Butler MN12 Milwaukee (Non-SLAMM Area)	
MN11 Underwood Creek and Dousman Ditch (from South Branch to headwaters)	MN13	MN13	MN13 Brookfield	MN13A Dousman Ditch MN13 Underwood Creek-Upper
MN12 Underwood Creek (from Menomonee to South Branch) MN13 South Branch Underwood Creek	MN14	MN14	MN14 Wauwatosa MN14 West Allis MN14 Elm Grove MN14 Brookfield	MN14A South Branch Underwood Creek MN14 Underwood Creek-Lower
MN10 Menomonee River (from Underwood to the Little Menomonee)	MN15	MN15	MN15 Wauwatosa MN15 Butler MN15 Brookfield	MN17 Menomonee River Lower b
MN15 Honey Creek	MN16	MN16		MN16 Honey Creek
MN14 Menomonee River (from Honey Creek to Underwood Creek)	MN17	MN17		MN17A Menomonee River Lower a
MN16 Menomonee River (from Estuary to Honey Creek)	MN18	MN18	MN18 Wauwatosa MN18 West Allis MN18 West Milwaukee	MN18 Menomonee River Lower c
MN16 Menomonee River from Estuary to Honey Creek	*NA	*NA	SLAMM Shed 2335 SLAMM Shed 2578	MN19 Menomonee River Lower d

APPENDIX C. GREEN INFRASTRUCTURE PRIORITY HOTSPOT ANALYSIS – SWWT 2013

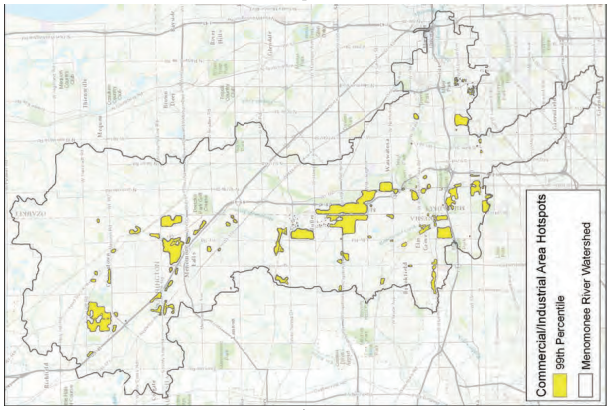


Impervious Hotspot Assessment
Menomonee River Watershed

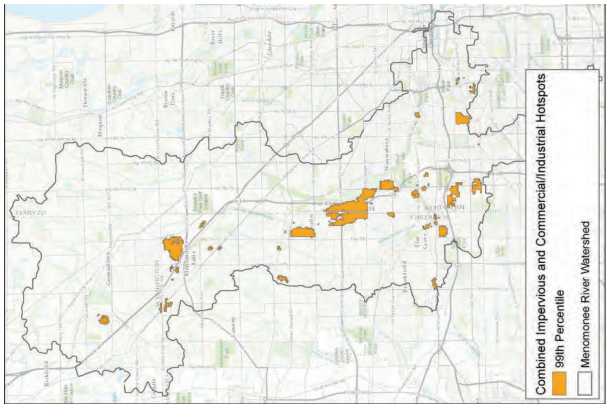
Hotspot Analysis used for Parcel Selection



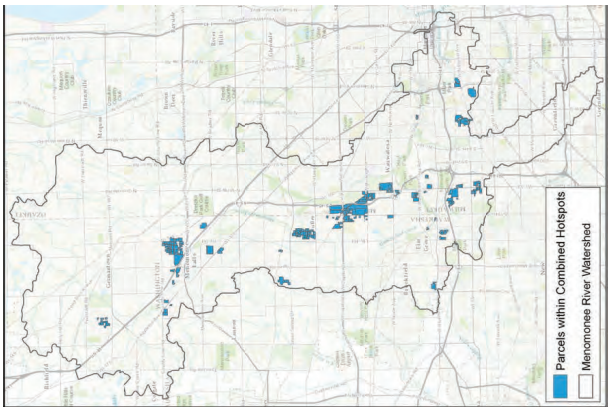
High Density of Impervious Surfaces



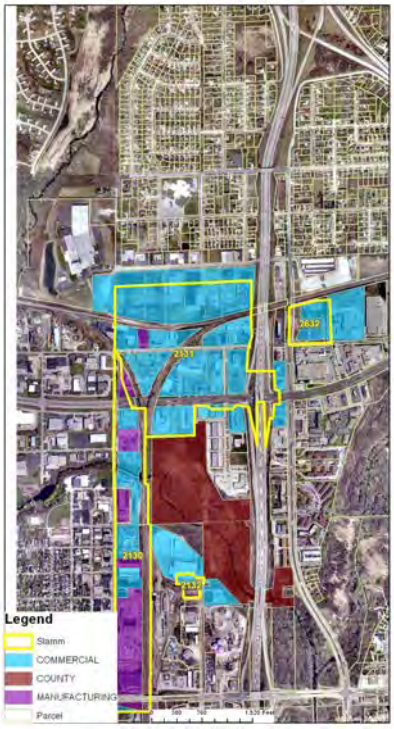
High Density of Commercial/Industrial Parcels



High Density of Both Impervious and Commercial/ Industrial Areas



Parcels located in Combined Hotspots



SLAMM Shed 2131 Factsheet

Watershed: Menomonee River
Assessment Basin: MN-12
Assessment TSS Rank: 2
Acres: 97.94 Acres (GIS): 98.50
TSS Load No Control (LBS/Year): 56,842.28
TSS Load Control (LBS/Year): 49,751.6
Reduction: 7,090.68
Percent Reduction: 12.47%
TSS Load Control Intensity (LBS/Acre per Year): 507.98

Tax Key		Owner Name	Mailing Address	Owner City	Parcel Address	Description	ERU
1820341000	Milwaukee	STORAGE MASTER LLC	2601 S MOORLAND RD	NEW BERLIN WI	12000 W SILVER SPRING DR	COMMERCIAL	57
1820342000	Milwaukee	MEGAL DEVELOPMENT CORP	POB 18661	MILWAUKEE WI	11912 W SILVER SPRING DR	COMMERCIAL	57
1819950210	Milwaukee	MILBROOK DEVELOPMENT CO	1945 FAIRHAVEN BL	ELM GROVE WI	12210 W SILVER SPRING RD	COMMERCIAL	66
1820311000	Milwaukee	M & J'S NO 1 LLC, HICKORY	PO BOX 4057	WATERLOO IA	11927 W SILVER SPRING DR	COMMERCIAL	42
1820291000	Milwaukee	MANCHESTER INN	5429 NORTH 118 CT	MILWAUKEE WI	11777 W SILVER SPRING DR	COMMERCIAL	46
1829997110	Milwaukee	CTA INVESTMENTS LLC	W136N4901 CAMPBELL DR	MENOMONEE FALLS WI	11715 W SILVER SPRING RD	COMMERCIAL	110
1820282000	Milwaukee	QUEENIE LLC	12125 W SILVER SPRING RD	MILWAUKEE WI	12125 W SILVER SPRING RD	COMMERCIAL	13
1819949110	Milwaukee	CHARLES E DICKENSON JR	12120 W SILVER SPRING RD	MILWAUKEE WI	12120 W SILVER SPRING RD	MANUFACTURING	23
1820281000	Milwaukee	TRACK, TRUCK & EQUIPMENT	12101 W SILVER SPRING RD	MILWAUKEE WI	12101 W SILVER SPRING RD	COMMERCIAL	49
1829973110	Milwaukee	FRANTZ COMPANY, INC.	PO BOX 344	BUTLER WI	5500 N 124TH ST	MANUFACTURING	44
1820294110	Milwaukee	RUDITYS VENTURE LLC	11801 W SILVER SPRING #200	MILWAUKEE WI	5445 N 118TH CT	COMMERCIAL	38
1820312000	Milwaukee	CTA INVESTMENTS, LLC	12011 W SILVER SPRING DR	MILWAUKEE WI	12011 W SILVER SPRING DR	COMMERCIAL	17
1820261000	Milwaukee	BROOKS INC	1900 WEST MAIN STREET	SUN PRAIRIE WI	12101 W SILVER SPRING DR	COMMERCIAL	72
1810581000	Milwaukee	SOUTH CENTRAL INDUSTRIAL	PO BOX 7008	WACO TX	11811 W CARMEN AVE	COMMERCIAL	65
1829998110	Milwaukee	HWY 45 LLC	5169 N 37TH ST	MILWAUKEE WI	5501 N LOVERS LANE RD	COMMERCIAL	20
1810413000	Milwaukee	ELEVEN EIGHT HUNDRED LLC	13600 W SUN VALLEY DR	NEW BERLIN WI	11800 W SILVER SPRING RD	COMMERCIAL	39
1829973120	Milwaukee	MILWAUKEE PROPERTIES LIMITED	P O BOX 1229	CAMP HILL PA	5444 N 124TH ST	COMMERCIAL	54
1810582000	Milwaukee	JAMES F & MERCEDES C HEYRMAN	11721 W CARMEN AVE	MILWAUKEE WI	11721 W CARMEN AVE	COMMERCIAL	63
1820241000	Milwaukee	DDMDN LAND LLC	5547 N LOVERS LANE RD	MILWAUKEE WI	5547 N LOVERS LANE RD	COMMERCIAL	24
1820283110	Milwaukee	MARAL PROPERTY LLC	4561 HIGHWAY Y	SAUKVILLE WI	12305 W SILVER SPRING RD	COMMERCIAL	74
1810411000	Milwaukee	THE FIRE PLACE, LTD	11700 W SILVER SPRING	MILWAUKEE WI	11700 W SILVER SPRING RD	COMMERCIAL	1
1820231100	Milwaukee	KBT BIRCHWOOD SILVER SPRING	11911 W SILVER SPRING DR	MILWAUKEE WI	11911 W SILVER SPRING RD	COMMERCIAL	83
1829999212	Milwaukee	BECKER PROPERTIES INC	11715 W SILVER SPRING RD	MILWAUKEE WI	11801 W SILVER SPRING RD	COMMERCIAL	0
1829978113	Milwaukee	MILWAUKEE COUNTY	901 N 9TH ST	MILWAUKEE WI	12000 W VILLARD AVE	COUNTY	0
1819953113	Milwaukee	CENTERPOINT PROPERTIES	1808 SWIFT DR	OAK BROOK IL	11925 W CARMEN AVE	COMMERCIAL	0
1819953115	Milwaukee	METRO TRUCKING	12001 W CARMEN AVE	MILWAUKEE WI	12001 W CARMEN AVE	COMMERCIAL	0
1810412100	Milwaukee	RC YARD LLC	545 W33449 HENGEN DR	DOUSMAN WI	11750 W SILVER SPRING RD	COMMERCIAL	0
1829992113	Milwaukee	CAI LONG HUANG	4005 S AVON DR	NEW BERLIN WI	5413 N LOVERS LANE RD	COMMERCIAL	0
1829993112	Milwaukee	KENSINGTON MGMT INC	7915 KENSINGTON CT	BRIGHTON MI	5441 N LOVERS LANE RD	COMMERCIAL	0
1810642000	Milwaukee	ARCHER DANIEL MIDLAND CO	12500 W CARMEN AV	MILWAUKEE WI	12111 W CARMEN AVE	COMMERCIAL	0
1810641000	Milwaukee	ARCHER DANIEL MIDLAND CO	12500 W CARMEN AV	MILWAUKEE WI	12255 W CARMEN AVE	COMMERCIAL	0
1819949121	Milwaukee	TRI-S CORPORATION	PO BOX 250937	MILWAUKEE WI	12100 W SILVER SPRING RD	COMMERCIAL	0
1819953121	Milwaukee	ROLLINS LEASING CORP	P O BOX 563	READING PA	11701 W CARMEN AVE	COMMERCIAL	0
1810561000	Milwaukee	ARCHER-DANIELS-MIDLAND CO	12500 W CARMEN AV	MILWAUKEE WI	5701 N 124TH ST	COMMERCIAL	0
1829996112	Milwaukee	BECKER PROPERTIES INC	11715 W SILVER SPRING RD	MILWAUKEE WI	11811 W SILVER SPRING RD	COMMERCIAL	0
1829999111	Milwaukee	BAWA LAND LLC	N61 W15526 EDGEMONT DR	MENOMONEE FALLS WI	11900 W SILVER SPRING DR	COMMERCIAL	0

SLAMM Shed 2090 Factsheet

Watershed: Menomonee River
Assessment Basin: MN-11
Assessment TSS Rank: 7
Acres: 79.62 Acres (GIS): 9.35
TSS Load No Control (LBS/Year): 46,242.4
TSS Load Control (LBS/Year): 40,425.04
Reduction: 5,817.36
Percent Reduction: 12.58%
TSS Load Control Intensity (LBS/Acre Per Year): 507.72

Tax Key		Owner Name	Mailing Address	Owner City	Parcel Address	Description	ERU
1190032000	Milwaukee	EMMA M ERDMANN	6930 N 76TH ST	MILWAUKEE WI	6930 N 76TH	COMMERCIAL	20
1190031000	Milwaukee	DANIEL J & BARBARA A RIVA	S75W35621 WILTON RD	EAGLE WI	6920 N 76TH	COMMERCIAL	20
1190021000	Milwaukee	GEORGE SALVAT	PO BOX 170227	MILWAUKEE WI	6902 N 76TH	COMMERCIAL	15
1199990120	Milwaukee	RONALD I PACHEFSKY LIVING	9287 N WAVERLY DR	MILWAUKEE WI	7016 N 76TH	COMMERCIAL	26
1199988100	Milwaukee	MARK S HALBMAN	W180 N7686 TOWN HALL RD	MENOMONEE FALLS WI	6940 N 76TH	COMMERCIAL	16
1190042000	Milwaukee	TRIANGLE PARK LLC	39 S LA SALLE ST, STE 1010	CHICAGO IL	7000 R N 76TH	COMMERCIAL	0
1190041000	Milwaukee	MARK HALBMAN	W180 N7686 TOWN HALL RD	MENOMONEE FALLS WI	7000 N 76TH	COMMERCIAL	0

SLAMM Shed 2335 Factsheet

Watershed: Menomonee River
Assessment Basin: MN-
Assessment TSS Rank:
Acres: 17.5 Acres (GIS): 22.27
TSS Load No Control (LBS/Year): 10,230.032
TSS Load Control (LBS/Year): 8,818.372
Reduction: 1,411.66
Percent Reduction: 13.79%
TSS Load Control Intensity (LBS/Acre Per Year): 503.906

Tax Key		Owner Name	Mailing Address	Owner City	Parcel Address	Description	ERU
4260033120	Milwaukee	EMMPACK FOODS INC	PO BOX 5626	MINNEAPOLIS MN	219 S EMMBER	MANUFACTURING	358
4260132000	Milwaukee	ZIEGLER BENCE PARTNERS 5 LLC	10700 W RESEARCH DR, STE 1	MILWAUKEE WI	1207 W CANAL	COMMERCIAL	189
4260133000	Milwaukee	EMMPACK FOODS INC	PO BOX 5626	WAYZATA MN	320 S EMMBER	MANUFACTURING	177
4260022100	Milwaukee	ALDRICH CHEMICAL CO INC	6000 N TEUTONIA AV	MILWAUKEE WI	210 S EMMBER	MANUFACTURING	61

SLAMM Shed 2578 Factsheet

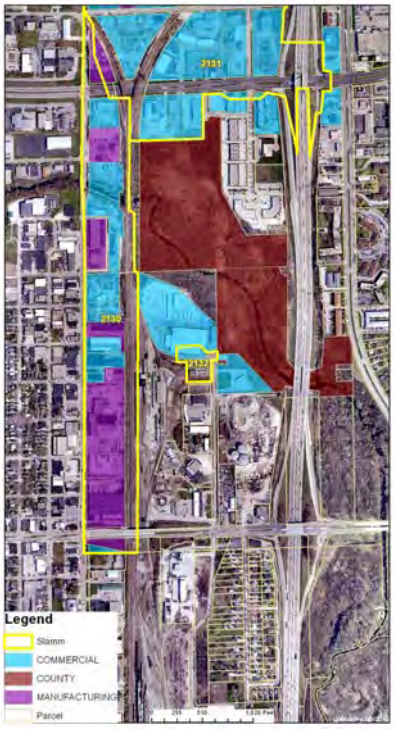
Watershed: Menomonee River
Assessment Basin: MN-
Assessment TSS Rank:
Acres: 5.74 Acres (GIS): 6.14
TSS Load No Control (LBS/Year): 3,355.42
TSS Load Control (LBS/Year): 2,892..39
Reduction: 463.03
Percent Reduction: 13.79%
TSS Load Control Intensity (LBS/Year Per Acre): 503.9

Tax Key		Owner Name	Mailing Address	Owner City	Parcel Address	Description	ERU
4019999110	Milwaukee	THIELE TANNING CO	123 N 27TH ST	MILWAUKEE WI	123 N 27TH	MANUFACTURING	62

SLAMM Shed 2130 Factsheet

Watershed: Menomonee River
Assessment Basin: MN-12
Assessment TSS Rank: 2
Acres: 26.7 Acres (GIS): 56.816
TSS Load No Control (LBS/year): 15,607.902
TSS Load Control (LBS/year): 13,643.502
Reduction: 1,964.4
Percent Reduction: 12.58%
TSS Load Control Intensity (LBS/Acre Per year): 510.992

Tax Key		Owners Name	Mailing Address	Owners City	Parcel Address	Description	ERU
2189993000	Milwaukee	CMC AMERICAN LLC	205 NORTH ST	MARATHON WI	5000 N 124TH ST	MANUFACTURING	150
2189983100	Milwaukee	GREG F GENSCH	5140 N 124 ST	MILWAUKEE WI	5140 N 124TH ST	COMMERCIAL	20
1829973110	Milwaukee	FRANTZ COMPANY, INC.	PO BOX 344	BUTLER WI	5500 N 124TH ST	MANUFACTURING	44
1820271000	Milwaukee	SRM MILWAUKEE, LLC	PO BOX 250847	MILWAUKEE WI	5400 N 124TH ST	MANUFACTURING	64
2189983200	Milwaukee	GREG F GENSCH	5140 N 124 ST	MILWAUKEE WI	5126 N 124TH ST	COMMERCIAL	6
2189990120	Milwaukee	CMC AMERICAN, LLC	205 NORTH STREET	MARATHON WI	4900 N 124TH ST	MANUFACTURING	58
1820351100	Milwaukee	ALANS AUTO SALES OF BROWN	5300 N 124TH ST	MILWAUKEE WI	5300 N 124TH ST	COMMERCIAL	1
2189988320	Milwaukee	VERO METAL LLC	5050 N 124TH ST	MILWAUKEE WI	5050 N 124TH ST	MANUFACTURING	19
1829973120	Milwaukee	MILWAUKEE PROPERTIES LIMITED	P O BOX 1229	CAMP HILL PA	5444 N 124TH ST	COMMERCIAL	54
1829977420	Milwaukee	ALANS AUTO SALES OF BROWN	13043 W LANCASTER	BUTLER WI	12300 W VILLARD AVE	COMMERCIAL	24
2189988310	Milwaukee	WASCO PARTNERS,	5070 N 124TH ST	MILWAUKEE WI	5070 N 124TH ST	COMMERCIAL	36
2189990110	Milwaukee	HAMPTON 4800 LLC	3885 N BROOKFIELD RD #200	BROOKFIELD WI	4810 N 124TH ST	MANUFACTURING	99
2199997110	Milwaukee	MARSHALL PEEBLES	15680 LAURA LN	BROOKFIELD WI	4770 N 124TH ST	COMMERCIAL	2
2189982000	Milwaukee	GREG F GENSCH	5140 N 124TH ST	MILWAUKEE WI	5164 N 124TH ST	COMMERCIAL	38
1820371000	Milwaukee	TYLER CO INC	5344 N 124TH ST	MILWAUKEE WI	5344 N 124TH ST	COMMERCIAL	54
2189985110	Milwaukee	ACE IRON & STEEL CORP	5118 N 124TH ST	MILWAUKEE WI	5118 N 124TH ST	MANUFACTURING	41
2189985210	Milwaukee	WASCO PARTNERS,	5070 N 124TH ST	MILWAUKEE WI	5110 N 124TH ST	COMMERCIAL	29
1820352100	Milwaukee	ALANS AUTO SALES OF BROWN	5290 N 124TH ST	MILWAUKEE WI	12300 W ROHR AVE	COMMERCIAL	26
1829977213	Milwaukee	RUDOLPH DREXLER	17855 ST JAMES RD	BROOKFIELD WI	5214 N 124TH ST	MANUFACTURING	0
2189988113	Milwaukee	RICHARD A BAUMGARTNER	5040 N 124TH ST	MILWAUKEE WI	5040 N 124TH ST	COMMERCIAL	0
2199995000	Wauwatosa	OLD MILWAUKEE MATERIALS LLC	7601 79TH ST	BRIDGEVIEW, IL	12005 W HAMPTON AVE	MANUFACTURING	0
2189986000	Milwaukee	CHURCH METAL SPINNING	P O BOX 10	BUTLER WI	5050 N 124TH ST	MANUFACTURING	0
2189988114	Milwaukee	RICHARD A BAUMGARTNER	5030 N 124TH ST	MILWAUKEE WI	5030 N 124TH ST	COMMERCIAL	0
1829977112	Milwaukee	RUDOLPH DREXLER	17855 ST JAMES RD	BROOKFIELD WI	5200 N 124TH ST	MANUFACTURING	0
1829977311	Milwaukee	JOHN E YARMARK	12435 PARADISE DR	WEST BEND WI	5252 N 124TH ST	MANUFACTURING	0



SLAMM Shed 2132 Factsheet

Watershed: Menomonee River
Assessment Basin: MN-12
Assessment TSS Rank: 2
Acres: 2.39 Acres (GIS): 2.39
TSS Load No Control (LBS/Year): 1,402.82
TSS Load Control (LBS/Year): 1,226.24
Reduction: 176.57
Percent Reduction: 12.58%
TSS Load Control Intensity (LBS/Acre Per Year): 510.93

Tax Key		Owner Name	Mailing Address	Owner City	Parcel Address	Description	ERU
2180031100	Milwaukee	JACOBUS ENERGY INC	P O BOX 13009	MILWAUKEE WI	5008 N 119TH ST	COMMERCIAL	22
2189992111	Milwaukee	LEMASTER INVESTMENTS LLC	5059 N 119TH ST	MILWAUKEE WI	5059 N 119TH ST	COMMERCIAL	0
2189997112	Milwaukee	MILWAUKEE COUNTY	9480 WATERTOWN PLANK RD	WAUWATOSA WI	5063 N LOVERS LANE RD	COUNTY	0

Report

Green Infrastructure Identification and Prioritization in the Menomonee River Watershed

MMSD Contract No. M03064P08

Wisconsin Coastal Management Program Grant Agreement No. AD149883-015.06

Prepared for:

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

WISCONSIN COASTAL MANAGEMENT PROGRAM

sweet water
SOUTHEASTERN WISCONSIN WATERSHEDS TRUST, INC.

August 2015

Prepared by:

ch2m

Executive Summary

Residential setting bioretention with curb bump outs.

This project has been a collaboration on green infrastructure (GI) planning around street and parking lot capital improvement projects among the Milwaukee Metropolitan Sewerage District (MMSD), the Southeastern Wisconsin Watersheds Trust, Inc. (Sweet Water), Sweet Water's partners (Clean Wisconsin, American Rivers, and Milwaukee Riverkeeper), the 11 Menomonee River Watershed Permit municipalities, the Southeastern Wisconsin Regional Planning Commission (SEWRPC), and the Wisconsin Department of Natural Resources (WDNR).

The project builds upon the City of Milwaukee Green Streets Plan (CH2M HILL 2013a) and the MMSD Regional GI Plan (CH2M HILL 2013b) to work with local municipalities within the Menomonee River Watershed using available street reconstruction capital improvement plans (CIP) to identify near-term GI opportunities. This evaluation identified the top two GI opportunities within each municipality (Table ES-1), enabling the municipalities to plan for GI implementation and to have the project information needed for funding applications from a wide range of potential funding partners. The table is color coded by municipality.

The project vision focused upon raising GI opportunity awareness with road and parking lot reconstruction projects. Through feedback from one-on-one meetings and results from the project survey, 8 out of 11 respondents indicated the project raised GI opportunity awareness.

The project goals included:

1. Develop a list of municipal staff-endorsed projects.
2. Prepare planning-level budgets and benefits to support funding requests.
3. At the end of the project, have support to expand the process to other municipalities in the MMSD service area.

Table ES-1 includes the list of recommended GI projects, including planning-level budgets for preparing budget requests that realized project goals 1 and 2. Feedback through the project survey indicated that 9 out of 11 survey respondents believed the project should be expanded to more municipalities. Based upon the project feedback, MMSD has included a draft budget request to expand the evaluation to the remaining 18 municipalities in the MMSD service area.

Other survey results (see Appendix B) indicated all respondents thought that Sweet Water provided a valuable service to the municipalities by envisioning this project. The survey also provided significant insight into barriers to widespread GI implementation, including the importance of funding as well as understanding maintenance cost impacts to municipal budgets and available training/equipment.

In their responses to the survey, municipalities emphasized the importance of operation and maintenance costs to inform GI implementation decisions. Including operation and maintenance costs in addition to capital costs in future analyses will allow municipalities to consider the overall life-cycle costs of GI projects.

The project identified improvements for the GI prioritization process used in this project that could be implemented in the future. For example, the information available for calculating scores for depth to

groundwater and depth to bedrock was limited and could be improved upon. Developing more depth categories (i.e. 4, 5, 6, 7, 8, etc.) would expand the scoring values available and provide more differentiation in the numerical scoring results as to what projects would have more constraints to implementation.

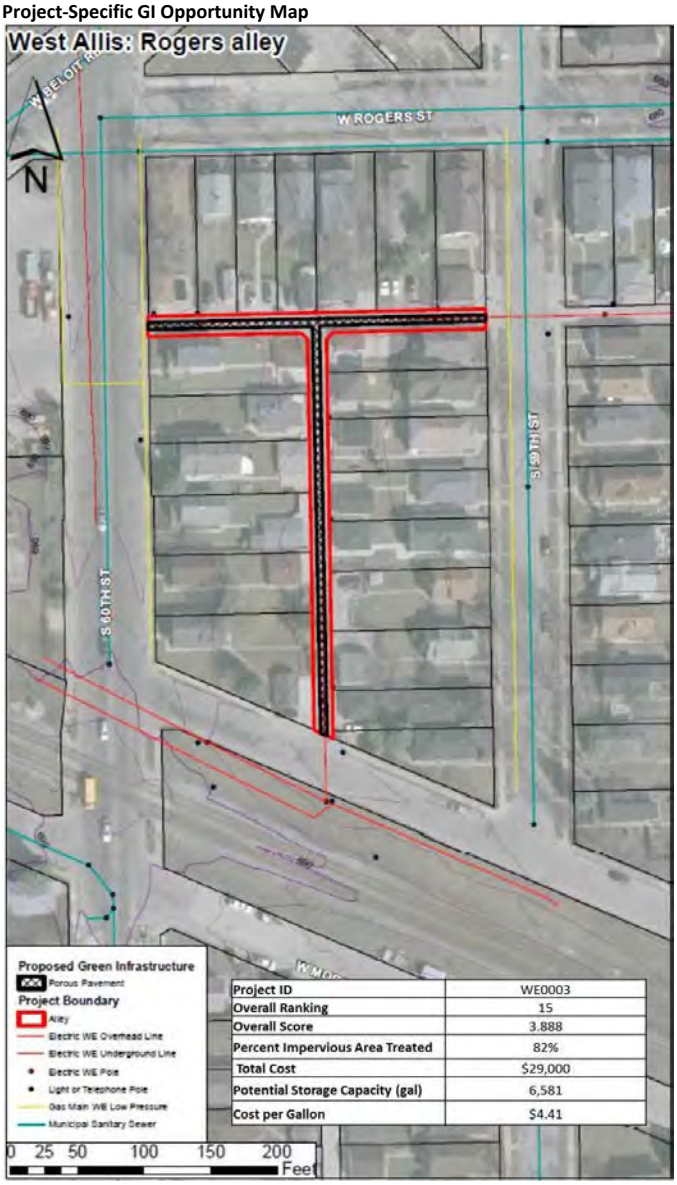
The project created a map for each GI opportunity that passed an initial screening analysis to understand site-specific GI implementation constraints, including: topography, utility conflicts, median and/or terrace widths, tree conflicts, and other features. An example map created for each project is included in Figure ES-1.

As a result of this project, the 11 municipalities have two or more GI opportunities they can implement with cost estimates and maps to support funding requests.

TABLE ES-1
GI Project Recommendations

Project ID	Project Name	Municipality	Total Cost
BR0001	North Ave East	Brookfield	$ 1,972,000
BR0002	North Ave West	Brookfield	$ 783,000
BU0004	Frontier Park (south lot)	Butler	$ 12,000
BU0003	N 127th St	Butler	$ 27,000
EG0001	Village Hall	Elm Grove	$ 105,000
EG0002	North Ave East	Elm Grove	$ 1,972,000
GE0001	River Crest Drive	Germantown	$ 41,000
GE0002	Concord Rd	Germantown	$ 333,000
GF0004	35th Frontage Rd	Greenfield	$ 59,000
GF0002	60th St	Greenfield	$ 87,000
MF0005	St. Francis Drive	Menomonee Falls	$ 36,000
MF0003	Cheyenne Drive	Menomonee Falls	$ 63,000
MI0002	W Lisbon Ave	Milwaukee	$ 590,000
MI0001	N 91st St	Milwaukee	$ 367,000
MC0004C	BHD Parking Lot North	Milwaukee County	$ 38,000
MC0001	West Oklahoma	Milwaukee County	$ 111,000
MC0004A	BHD Parking Lot South	Milwaukee County	$ 48,000
MC0004B	BHD Parking Lot Central	Milwaukee County	$ 181,000
WA0005	Gridley Alley	Wauwatosa	$ 22,000
WA0008	State Street	Wauwatosa	$ 206,000
WE0005	89th Street	West Allis	$ 37,000
WE0003	Rogers Alley	West Allis	$ 29,000
WM0001	Greenfield Ave	West Milwaukee	$ 91,000
WM0002	Miller Park Way	West Milwaukee	$ 515,000

FIGURE ES-1
Project-Specific GI Opportunity Map



Project ID	WE0003
Overall Ranking	15
Overall Score	3.888
Percent Impervious Area Treated	82%
Total Cost	$29,000
Potential Storage Capacity (gal)	6,581
Cost per Gallon	$4.41

Contents

Executive Summary ..... **iii**

1 Introduction **1**
1.1 Project Vision 1
1.2 Project Goals 1

2 Workshops **3**

3 Data Gathering **3**
3.1 Types of Data 4
3.2 Focus on Reconstruction Projects 5

4 Project Scoring **7**
4.1 Initial Scoring 7
4.2 Criteria-Specific Scoring Results 9
4.3 Cost Score 17
4.4 Efficiency Score 19
4.5 Final Score 21

5 Technical Considerations **23**

6 One-on-One Meetings **28**

7 Water Quality Benefits through Source Loading and Management Model Analysis **31**

8 Project Survey **32**

9 Improvements for Future Analysis **33**

10 Available Funding **34**

11 Conclusions **34**

12 References **35**

Appendixes

A Maps
B Survey Questions and Responses
C GI Criteria Analysis Table

Tables

ES-1 GI Project Recommendations iv
1 Projects Evaluated by Municipality 5
2 Scoring Criteria 7
3 Assumed Values 18
4 Project Scoring and Cost Results 24

Figures

ES-1 Project-Specific GI Opportunity Map v
1 Example CIP Formats 4
2 Ground Slope Score Histogram 9

3 Depth to Groundwater Score Distribution 10
4 Depth to Bedrock Score Distribution 11
5 Existing Tree Canopy Score Distribution 12
6 Opportunity Score Histogram 13
7 Benefit Score Histogram 13
8 Parking Lane Score Distribution 14
9 Project Impervious Area Score Relationship to Impervious Area 15
10 Best Professional Judgement Score 16
11 Initial Project Score Histogram 17
12 Potential Project GI Area by Municipality 18
13 Cost Score Distribution 19
14 Efficiency Score Distribution 20
15 Overall Score Histogram 21
16 Totals by Municipality 22
17 Project-Specific GI Opportunity Map 27
18 Example GI Strategy Flow Chart Decision Process from Milwaukee Green Streets Plan 29

1 Introduction

This report documents the collaboration on green infrastructure (GI) planning around street and parking lot capital improvement projects between the Milwaukee Metropolitan Sewerage District (MMSD), the Southeastern Wisconsin Watersheds Trust Inc., (Sweet Water), Sweet Water's partners (Clean Wisconsin, American Rivers, and Milwaukee Riverkeeper), and the 11 Menomonee River Watershed Permit municipalities. Besides the 11 municipalities, the Southeastern Wisconsin Regional Planning Commission (SEWRPC) and the Wisconsin Department of Natural Resources (WDNR) also actively participated.

The project builds from the City of Milwaukee Green Streets Plan (CH2M HILL 2013a) and the MMSD Regional GI Plan (CH2M HILL 2013b) to work with local municipalities within the Menomonee River Watershed using available street reconstruction capital improvement plans (CIP) to identify near-term GI opportunities. This evaluation identified the top two GI opportunities within each municipality, enabling the municipalities to plan for GI implementation and to have the project information needed for funding applications from a wide range of potential funding partners.

The Wisconsin Coastal Management Program Grant program provided funding for the project under Agreement No. AD149883-015.06.

1.1 Project Vision

The project team developed a project vision to guide the project. The project vision is: *Increase awareness of GI opportunities within municipal street reconstruction projects so municipalities can cost-effectively implement GI as part of their normal capital improvement plan (CIP) process.*

The project vision focused on communication with municipal stakeholders during workshops and with the project team. Feedback from municipal partners on raising awareness of GI projects was obtained through the project survey, which found 8 out of 11 respondents indicated the project raised awareness of GI opportunities. The survey and results are described in greater detail in the project survey section.

1.2 Project Goals

The project team identified three key goals to accomplish during the project. The three project goals are:

1. Develop a list of municipal-staff-endorsed projects.
2. Prepare planning-level budgets and benefits to support funding requests.
3. At the end of the project, have support to expand the process to the other municipalities in the MMSD service area.

As the project evaluation progressed, the project goals guided communications with the municipalities to ensure projects would be endorsed by staff. The project technical team developed the budget estimates for future budget requests. The report includes the information for the first two goals and the third goal is on track to be achieved based upon municipality recommendations and requested MMSD funding.

Bioretention garden.

Porous paver parking lane with bioretention garden.

Tree trenches in downtown setting.

During the project survey (described more below), 9 out of 11 survey respondents indicated the project should be expanded to the rest of the municipalities in the MMSD service area. Based upon the success of the project, MMSD has included a draft budget request to expand the evaluation to the remaining 18 municipalities in the MMSD service area. Final MMSD budgets are subject to MMSD Commission endorsement and approval.

Curb bump outs in residential neighborhood create bioretention garden.

2 Workshops

To communicate the project vision, goals, and roles for the municipal partners, the team held two project workshops. The workshops were held as part of regularly scheduled Menomonee Watershed Permit Group meetings in the City of Brookfield. All 11 municipalities (which includes Milwaukee County) participated in each workshop along with WDNR and SEWRPC representatives. Approximately 25 people participated in each workshop.

Workshop 1: Workshop 1 provided the municipal partners with an overview of the project, discussed roles and responsibilities, and requested information from the municipalities on street CIPs. Information on parking lot construction improvements was also requested and included in the analysis, especially when municipalities had limited street reconstruction plans and with Milwaukee County, which has many parking lots that are soon to be reconstructed.

Workshop 2: Workshop 2 previewed the project findings by communicating the analysis process, explaining the scoring criteria, and providing the basis for estimating project costs. The participants were informed of the remaining projects tasks including: upcoming one-on-one meetings to review individual municipality results, project survey, and report review. Municipalities were made aware of the opportunity to quantify the water quality benefits of the projects if they choose to conduct water quality modeling using Source Loading and Management Model (SLAMM) software.

Workshop Feedback: Feedback at both workshops from the municipalities stressed the importance of knowing GI operation and maintenance costs. Based upon this feedback, if this type of analysis is expanded to other municipalities, life cycle costs should be included in an analysis that combines one-time capital costs with annual operation and maintenance costs.

Workshop participants listen to GI funding opportunities available from MMSD.

Workshops provided opportunity for dialogue on GI questions.

3 Data Gathering

The project team requested road and parking lot CIP information for the next 5 years from each of the municipalities. Road and parking lot reconstruction projects were evaluated for GI implementation potential. The information provided varied in format and content depending upon the municipality. Some municipalities had limited information because the current CIP had limited funding, allowing only a few projects for the next several years.

The number of road or parking lot reconstruction projects planned varied according to the size of the municipalities, the age of the infrastructure, and their budgeting processes. Older municipalities tended to have a long list of projects because more roads and alleys had reached the end of their expected life and needed to be replaced.

The project team initially thought smaller municipalities might have a limited number of projects. However, not all small municipalities have limited street CIP plans. For example, Butler, one of the smaller municipalities, is developing a plan to have significant reconstruction on practically all of the roads in the municipality over the next 10 years. Such investments represent a once-in-a-lifetime opportunity to integrate GI into publicly-owned projects and would present a significant funding hurdle based upon current GI funding models, as described in the One-on-One Meetings Section, which rely heavily upon MMSD grants.

3.1 Types of Data

Data varied in form from geographic information system (GIS) shapefiles, maps, and also simple one-page village board funding resolutions (Figure 1). While CIP data was provided in differing formats, the information needed for the GI evaluation was readily available from each municipality by reviewing the CIP project description or through clarifying conversations with municipal staff.

The project team reviewed and screened the CIP list to select the projects for GI potential evaluation. The project team followed up with questions to public works staff to clarify the types of projects and which ones were most likely to occur within the next several years. Projects planned for 2015 were generally avoided to allow time for engineering design and opportunity to apply for grant funding. Exceptions were made where the municipality only had a few projects and good opportunities for GI existed in 2015 projects.

FIGURE 1
Example CIP Formats

3.2 Focus on Reconstruction Projects

The project team focused on road or parking lot reconstruction projects because reconstruction involves the most grading and earth moving, and therefore GI can typically be integrated more efficiently in road reconstruction projects than repaving projects. The Water Environment Federation (WEF) has documented the benefits of integrating GI into planned construction projects (WEF 2014) and the U.S. Environmental Protection Agency (USEPA) has recognized the cost savings available through integrating GI into municipal constructions projects (EPA 2015). Being able to mobilize construction equipment and labor coincident with other projects allows GI the opportunity to realize cost savings and economies of scale because the equipment and labor needed for GI is often already mobilized onsite for construction.

It is possible to cost-effectively implement GI with road resurfacing projects as well. However, there are implementation uncertainties with repaving projects without allowing for more investigation to check that road slopes will allow for runoff capture. Additional costs are likely compared to reconstruction projects.

Each project footprint was entered into GIS, once there was agreement on which projects to include in the evaluation. The project footprint enabled review of the amount of imperviousness, ground slope, depth to groundwater, depth to bedrock, and other GIS information that has been previously developed through the MMSD Regional GI Plan and subsequent efforts.

Of the 66 reconstruction projects initially received, the team narrowed down the number of projects with discussions with municipal representatives to 46 for evaluation. These projects were selected because they represented projects that are most likely to have GI opportunities readily available. More GI implementation opportunities exist, but these 46 projects provide sufficient opportunity to identify at least two GI implementation projects within each municipality. The list of projects by municipality is included in Table 1. The table is color coded by municipality.

TABLE 1
Projects Evaluated by Municipality

Project ID	Project Name	Municipality	Construction Year	Project Type
BR0001	North Ave East	Brookfield	2018	Road
BR0002	North Ave West	Brookfield	2019	Road
BU0001	Frontier Park	Butler	TBD	Parking
BU0002	Silver Spring	Butler	TBD	Road
BU0003	N 127th St	Butler	TBD	Road
BU0004	Frontier Park (south lot)	Butler	TBD	Parking
EG0001	Village Hall	Elm Grove	TBD	Parking
EG0002	North Ave East	Elm Grove	2018	Road
GE0001	River Crest Drive	Germantown	2015	Road
GE0002	Concord Rd	Germantown	2016	Road
GF0001	Crawford Ave	Greenfield	2019	Road
GF0002	60th St	Greenfield	2017	Road
GF0003	43rd St	Greenfield	2016	Road
GF0004	35th Frontage Rd	Greenfield	2017	Road
MC0001	West Oklahoma	Milwaukee County	2018	Road
MC0002	Currie Park Service Yard	Milwaukee County	2015	Parking

TABLE 1
Projects Evaluated by Municipality

Project ID	Project Name	Municipality	Construction Year	Project Type
MC0003	Currie Park Clubhouse	Milwaukee County	2015	Parking
MC0004A	BHD Parking Lot South	Milwaukee County	2016	Parking
MC0004B	BHD Parking Lot Central	Milwaukee County	2016	Parking
MC0004C	BHD Parking Lot North	Milwaukee County	2016	Parking
MC0005	Dretzka Chalet	Milwaukee County	2017	Parking
MC0006	Dretzka Golf Course	Milwaukee County	2018	Parking
MF0001	Arthur Ave	Menomonee Falls	2016	Road
MF0002	Cherokee Drive	Menomonee Falls	2017	Road
MF0003	Cheyenne Drive	Menomonee Falls	2018	Road
MF0004	May Ave	Menomonee Falls	2016	Road
MF0005	St. Francis Drive	Menomonee Falls	2018	Road
MI0001	N 91st St	Milwaukee	2018	Road
MI0002	W Lisbon Ave	Milwaukee	2019	Road
WA0001	N 113th Street	Wauwatosa	2016	Road
WA0002	Harding Blvd South	Wauwatosa	2016	Road
WA0003	Harding Blvd North	Wauwatosa	2016	Road
WA0004	WatertownPlk Alley	Wauwatosa	2017	Alley
WA0005	Gridley Alley	Wauwatosa	2016	Alley
WA0006	Center_74th to 75th Alley	Wauwatosa	2017	Alley
WA0007	Center_75th to 76th Alley	Wauwatosa	2017	Alley
WA0008	State Street	Wauwatosa	2016	Road
WA0009	N 92nd St	Wauwatosa	2018	Road
WE0001	Grant Alley	West Allis	2015	Alley
WE0002	Lapham Alley	West Allis	2015	Alley
WE0003	Rogers Alley	West Allis	2015	Alley
WE0004	85th Street	West Allis	2016	Road
WE0005	89th Street	West Allis	2016	Road
WE0006	124th Street	West Allis	2018	Road
WM0001	Greenfield Ave	West Milwaukee	2016	Road
WM0002	Miller Park Way	West Milwaukee	2016	Road

4 Project Scoring

Each of the 46 projects was reviewed and scored in two stages to generate three sub-scores: initial score, cost score, and efficiency score. The three sub-scores were averaged to calculate the overall score for potential GI implementation at a project site. The following subsections describe each of the sub-scores.

4.1 Initial Scoring

The 46 initial projects were first scored to understand site-specific constraints or benefits of GI implementation. The scoring considered the nine criteria listed in Table 2. The criteria were established based on the available GIS information in the region. Each criteria was scored 1 through 5, with the higher scores indicating a higher potential for GI implementation. Criteria-specific scores were averaged to generate the initial project-specific score. Each scoring criteria is described in more detail in the subsequent paragraphs and figures.

TABLE 2
Scoring Criteria

Criteria	Score Description
Ground Slope	Ground slope influences the potential for GI implementation. Mild slopes allow for easily capturing stormwater runoff allowing for GI implementation, while stormwater capture and storage on steep slopes becomes more difficult and costly. The team calculated the score by using the percent of the project area with mild, medium, and steep slopes multiplied by the scores listed below: 5: Mild Slope (less than 5 percent) 3: Medium Slope (5-10 percent) 1: Steep Slope (greater than 10 percent)
Depth to Groundwater	GI implementation generally requires separation between the groundwater and the GI strategy. A depth to groundwater of less than 6 feet may limit the type/depth of GI that can be employed. The team calculated the score by using the following approach: 5: groundwater depth greater than or equal to 6 feet throughout the entire project area 3: groundwater depth greater than or equal to 6 feet for a portion of the project area 1: groundwater depth less than 6 feet throughout the entire project area
Depth to Bedrock	GI implementation generally requires separation between bedrock and the GI strategy. A depth to bedrock of less than 6 feet makes GI implementation less likely to be practical. The team calculated the score by using the following approach: 5: depth to bedrock greater than or equal to 6 feet throughout the entire project area 3: depth to bedrock greater than or equal to 6 feet for a portion of the project area 1: depth to bedrock less than 6 feet throughout the entire project area
Existing Tree Canopy	Trees are part of the MMSD Regional GI Plan strategy. Where few trees exist, there is an opportunity to plant more and space available for bioretention or other GI strategies. Where many trees already exist, there are potential conflicts of needing to cut down or work around trees to install bioretention. Because the MMSD Regional GI Plan promotes trees for stormwater management, cutting down trees is avoided where possible. The team calculated the score by using the following approach: 5: less than 20 percent of project area 3: 20-40 percent of project area 1: greater than 40 percent project area

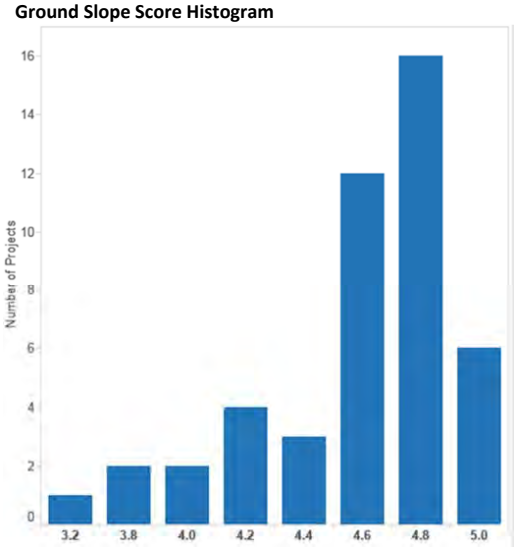
TABLE 2
Scoring Criteria

Criteria	Score Description
Opportunity	The MMSD Regional GI Plan developed watershed sub-basin-specific scores to describe GI implementation opportunities such as open space and other factors. The Plan developed a rank for each sub-basin. The percentile ranking of the opportunity score from the MMSD Regional GI Plan was divided into five categories and scores from 1 to 5.
Benefit	The MMSD Regional GI Plan developed watershed sub-basin-specific scores to describe GI implementation benefits such as water quality improvement and other factors. The Plan developed a rank for each sub-basin. The percentile ranking of the benefit score from the MMSD Regional GI Plan was divided into five categories and scores from 1 to 5.
Parking Lanes	The presence of parking lanes more easily enables implementation of the porous pavement GI strategy within the street right-of-way by using the parking lane. Parking lanes can also be conducive for bioretention in curb extensions. The team allocated scores as follows: 5: 2 or more parking lanes or a parking lot 3: 1 parking lane 1: 0 parking lanes
Project Impervious Area Size	A larger impervious area requires more GI to effectively treat the area, but also offers opportunity to achieve reduced costs through the economies of scale provided by larger projects. The team allocated scores by calculating the impervious area for each project and dividing them into 5 equal categories with scores of 1 to 5.
Best Professional Judgment	Some projects offered benefits that were not easily captured by the other scoring features. Benefits such as high visibility and interest expressed by the municipality were considered and a best professional judgment score was provided. The best professional judgment score considered if one of the other scoring factors may have unnecessarily provided a low score where field conditions have not been verified, such as low depth to groundwater or low depth to bedrock, and which would have taken the project out of consideration. Scores were assigned using values of 5, 3, or 1.

4.2 Criteria-Specific Scoring Results

Ground slope, depth to groundwater, depth to bedrock, and existing tree canopy are factors that influence the feasibility of GI and the ease of constructability at a project site. The slope of the ground constrains the area that can be constructed into GI. For example, project areas with steep slopes require additional excavation and additional expense or they might be unable to effectively capture the runoff if it flows too quickly. The greater Milwaukee area is generally flat with few hills, and parking lots are also mildly sloped if at all. Consequently, scores were generally high, reflecting few ground slope constraints. Figure 2 illustrates the ground slope score distribution.

FIGURE 2
Ground Slope Score Histogram



Figures 3 and 4 illustrate the percentage of projects based on their depth to groundwater and depth to bedrock scoring. For both criteria, a depth of 6 feet was used as the threshold due to the data readily available from the MMSD Regional GI Plan. While a review of the maps in the MMSD GI Plan indicates some areas of the region do have shallow constraint conditions, the vast majority of projects have a depth to groundwater and bedrock greater than or equal to 6 feet. As a result, the criteria did not provide significant differentiation in scoring among the projects. While the 6-foot delineation is beneficial for regional planning, a potential improvement for future analysis could provide more gradation in the depth to groundwater or depth to bedrock at project sites. Having information on the actual groundwater and bedrock depths (rather than just whether it is less than or greater than 6 feet) could provide refinement in the scoring approach and additional insight into the potential constraint.

FIGURE 3
Depth to Groundwater Score Distribution
Scores of 1 to 5 with 5 being the highest (best) score, see Table 2 for details

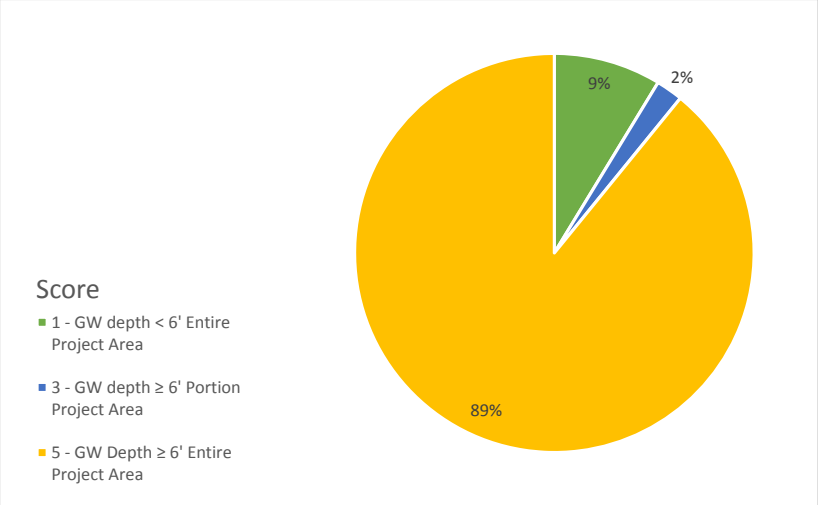


FIGURE 4
Depth to Bedrock Score Distribution
Scores of 1 to 5 with 5 being the highest (best) score, see Table 2 for details

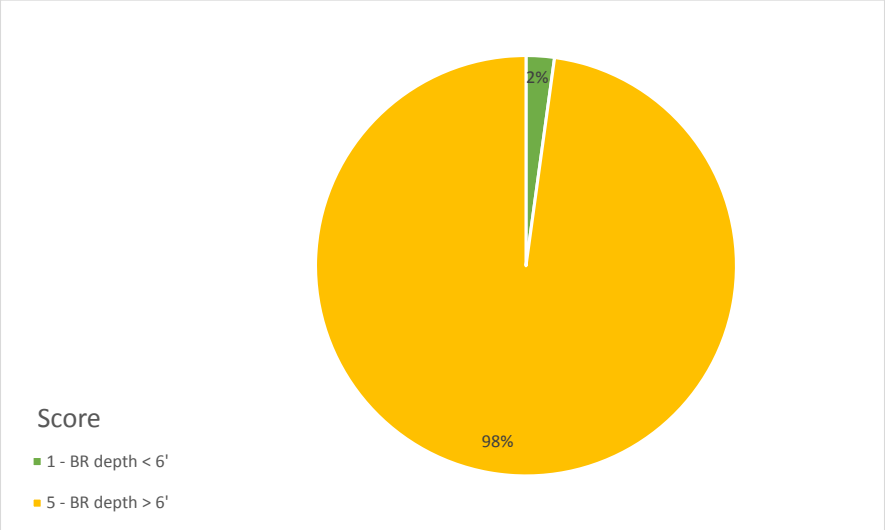
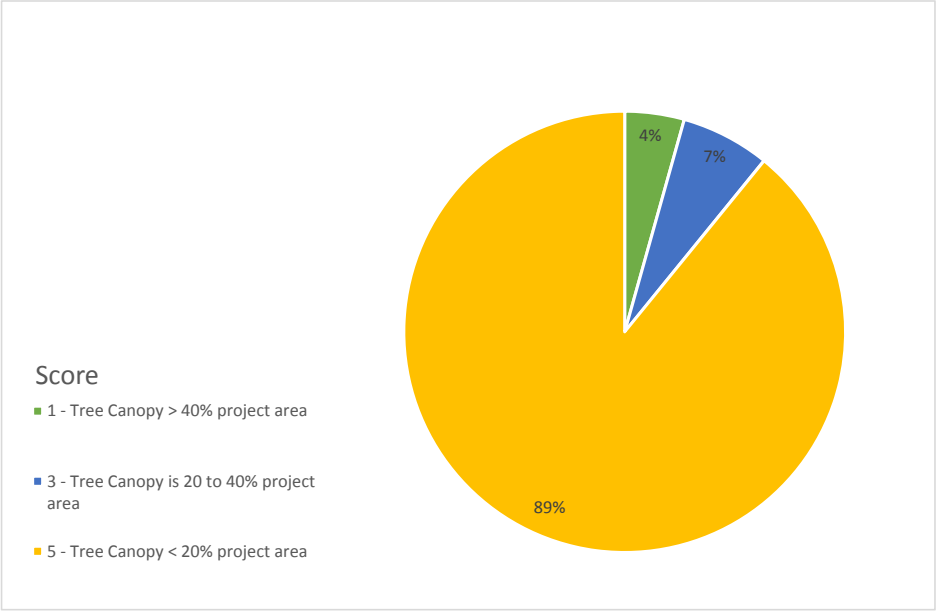


Figure 5 illustrates the project scoring distribution based on the existing tree canopy score. Projects with more trees were scored lower due to the desire to preserve existing trees within each municipality. Almost 90 percent of the projects have lower than 20 percent tree canopy and were thus scored a 5. Many of the CIP projects reviewed were alleys or two-lane streets, indicating that few streets have tree canopy that spans much of the impervious area. This indicates that many projects should have opportunities for bioretention installation and additional tree plantings. The stormwater and other benefits available from trees, as documented in the MMSD Regional GI Plan, and the low tree canopy percentage in the projects reviewed indicates there is a significant opportunity to increase tree canopy in the region.

FIGURE 5
Existing Tree Canopy Score Distribution
Scores of 1 to 5 with 5 being the highest (best) score, see Table 2 for details



The opportunity and benefit criteria capture the rankings calculated in the MMSD Regional GI Plan. The MMSD Regional GI Plan ranked 707 distinct sub-watershed areas based on their benefit and opportunity score. The scores factored in aspects such as: parks, redevelopment, existing neighborhood GI, vacant land, future watercourse projects, and other factors. Refer to the MMSD GI Plan for more information on how the scores were generated. Figures 6 and 7 display the score distribution for the project sites.

FIGURE 6
Opportunity Score Histogram

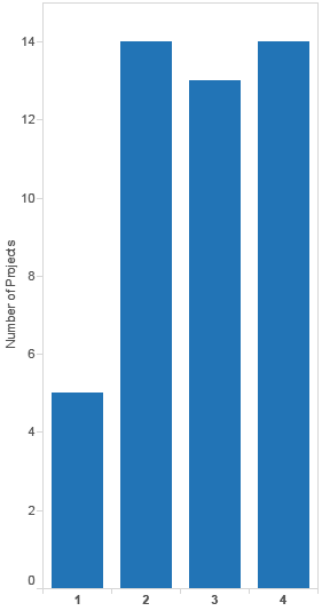
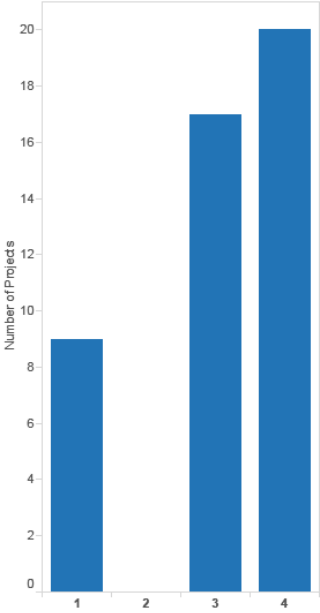
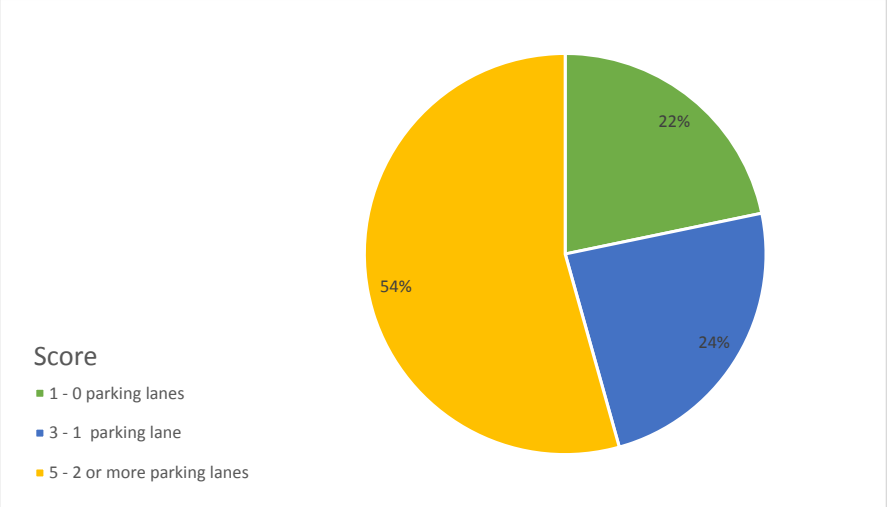


FIGURE 7
Benefit Score Histogram



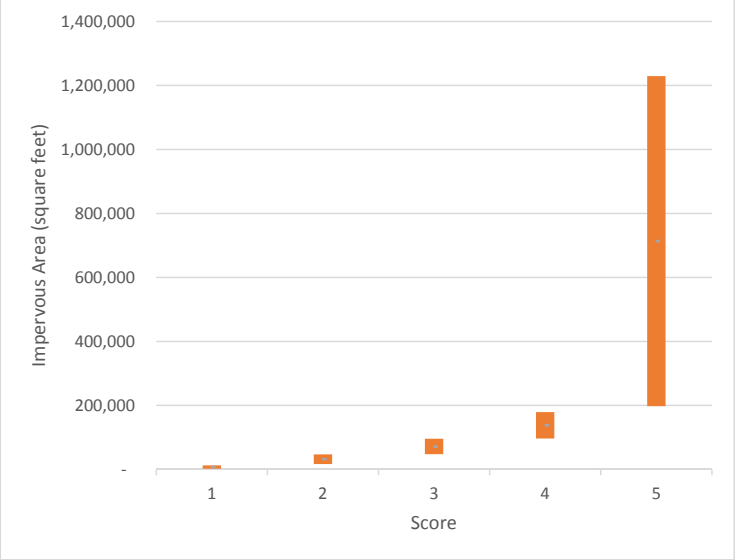
Projects with parking lanes nearby were scored higher due to the potential implementation of permeable pavement. Figure 8 illustrates the number of parking lanes for the projects. Parking lots were scored the same as roads, with two parking lanes representing a higher potential for permeable pavement.

FIGURE 8
Parking Lane Score Distribution
Scores of 1 to 5 with 5 being the highest (best) score, see Table 2 for details



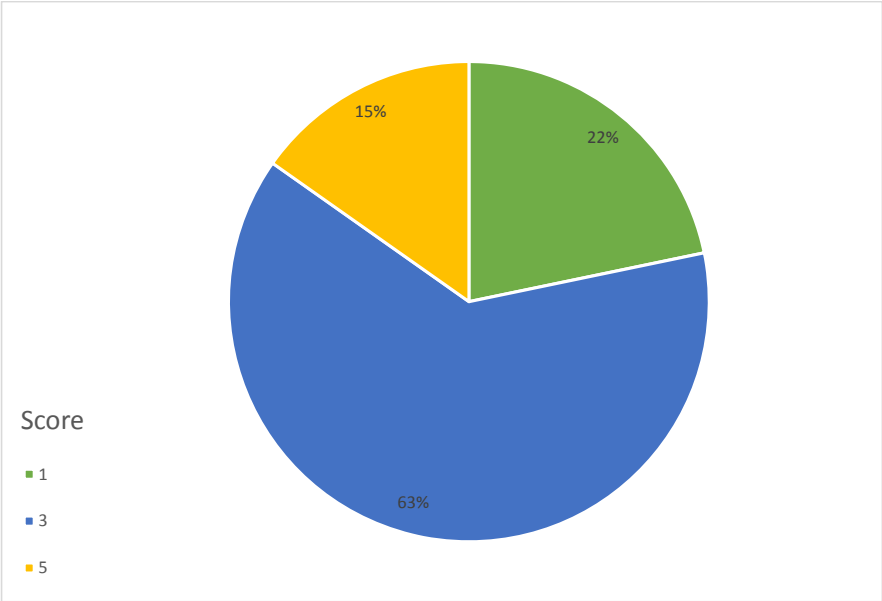
The project impervious area score is based on the total impervious area within the project right-of-way. Projects were divided into five equal categories, with projects scoring a 5 having the largest impervious area. Since impervious area is directly proportional to stormwater runoff, this criteria quantifies the need for stormwater best management practices (BMPs) and the potential for projects that could remove more pollutants with GI. Figure 9 shows the impervious area range for each scoring category. The range of impervious area increases with the score with two exceptionally large projects in the City of Brookfield. The Brookfield projects represent the largest impervious area and are several miles of road reconstruction and expansion.

FIGURE 9
Project Impervious Area Score Relationship to Impervious Area



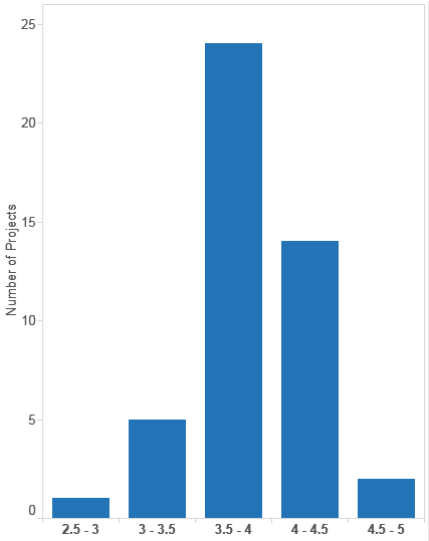
The best professional judgment score serves the purpose of any miscellaneous factors that need to be considered. The score was determined based on a detailed review of each project using a geographic information system (GIS). Projects were scored a 3 if there was no additional factor to consider for the project, while projects scored a 5 if there was a positive factor, such as wide terraces or open space, increasing the ease of GI constructability. Projects were scored as a 1 if there were negative factors, such as municipality GI strategy preferences or features not represented in other scores that could limit implementation. Figure 10 includes the best professional judgement scoring summary.

FIGURE 10
Best Professional Judgement Score
Scores of 1 to 5 with 5 being the highest (best) score, see Table 2 for details



Each criteria score was averaged to generate the initial score for each project. Figure 11 illustrates the initial score distribution. Twelve projects with lower initial scores within individual municipalities (scores varied from 3.4 to 4.2 depending upon the municipality) were eliminated from any further analysis. Some projects from some municipalities were eliminated were ranked higher than projects in other municipalities that were kept, this illustrates some municipalities have a lot of good projects and other municipalities have a limited number of projects. . An example of this is Milwaukee County which has many road and parking lot reconstruction projects slated for construction as illustrated in Table 4 at the end of this chapter.

FIGURE 11
Initial Project Score Histogram



Residential setting rain garden.

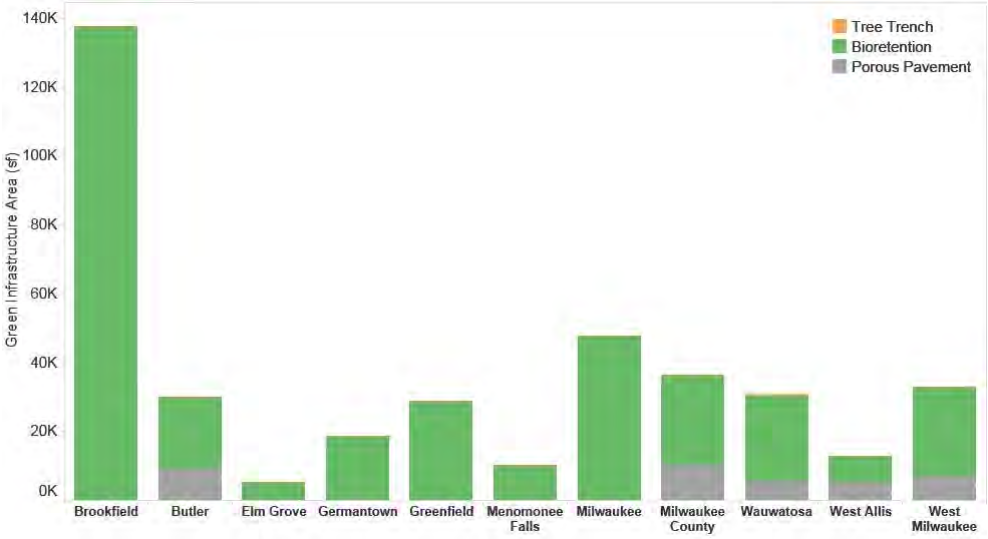
4.3 Cost Score

The initial score did not include any cost information. Municipalities expressed feedback during the one-on-one meetings that including an element of how cost-effective projects are would be helpful. Consequently, for the projects that were evaluated in detail after the initial screening, a cost score and efficiency score were added. For the cost score, the available area for bioretention or porous pavement was delineated based on site restrictions and potential utility conflicts (See Figure 12 for the total areas covered by the evaluated projects by municipality). Total cost was calculated using assumptions listed in Table 3. Cost information was obtained from the City of Milwaukee's recent projects (2014) and rounded up slightly to $20 per square foot to have a reasonably conservative funding request consistent with this high level GI screening. Tree trench costs were assumed the same as bioretention. Porous pavement costs considered a credit for pavement that would otherwise have to be installed. These costs are slightly higher than those assumed in the MMSD Regional GI Plan, however they are estimates based upon recent smaller projects. Additional efficiencies will likely result when broader GI installation occurs in the region.

TABLE 3
Assumed Values

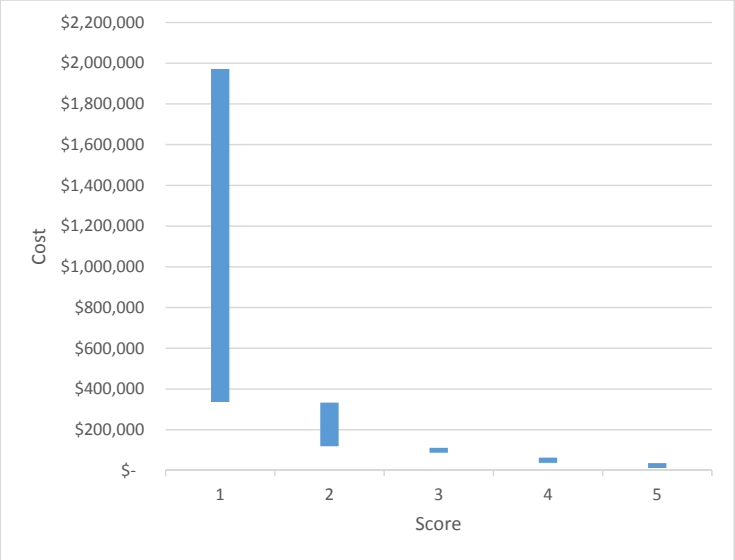
GI Type	Unit Cost ($/sf)	Loading Ratio (impervious area/GI area)	Potential Storage Capacity (gal/sf)
Bioretention/tree trenches	20	10	7.5
Porous Pavement	13	3 (roads/alleys); 5 (parking)	3

FIGURE 12
Potential Project GI Area by Municipality



For scoring, projects were divided into five equal categories based on their total cost, with projects with the highest cost given a score of 1 and projects with the lowest cost given a score of 5. Figure 13 illustrates the cost score distribution.

FIGURE 13
Cost Score Distribution



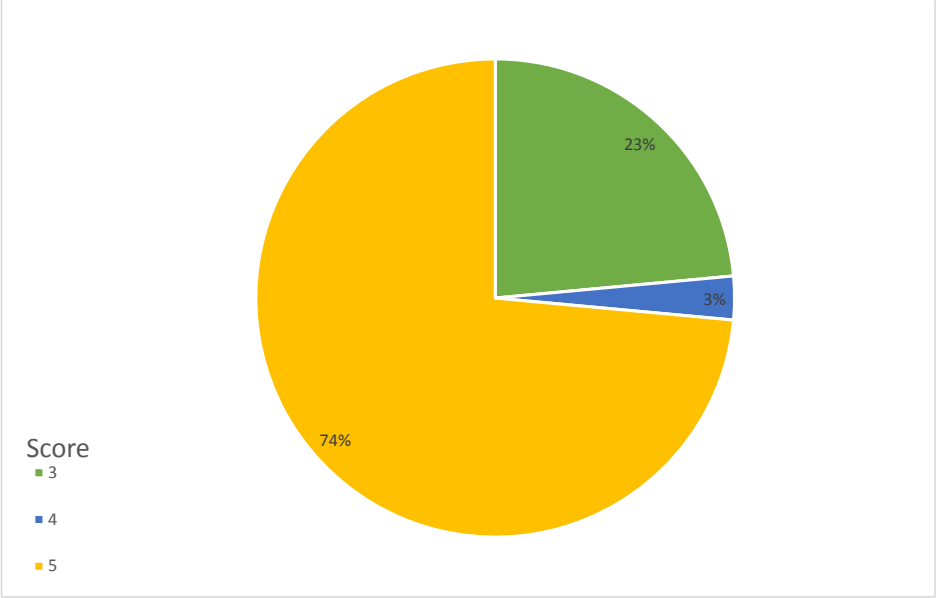
4.4 Efficiency Score

The efficiency score was used to prioritize GI projects that provided the most storage for the least cost. The efficiency score is based on the project's total cost per gallon of storage capacity. Projects were scored as follows:

- 3 when cost per gallon was greater than $4
- 4 when cost per gallon was between $3 and $4
- 5 when cost per gallon was less than $3

Figure 14 illustrates the number of projects for each score. Projects that implement bioretention have a higher score due to bioretention's ability to treat a larger impervious area per square foot of bioretention and potential storage capacity.

FIGURE 14
Efficiency Score Distribution
Scores of 1 to 5 with 5 being the highest (best) score, see Table 2 for details



4.5 Final Score

The initial feasibility score, cost score, and efficiency score was averaged to calculate the overall score. Figure 15 illustrates the overall score distribution. Projects that were eliminated after the initial scoring have the lowest scores in that municipality. Projects with scores less than 3 were not evaluated in detail.

FIGURE 15
Final Score Histogram

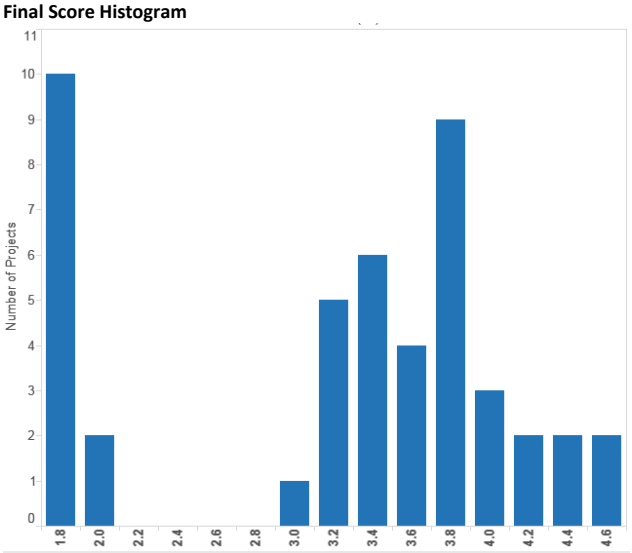


Figure 16 provides summary information by municipality. Brookfield had two very large state highway projects evaluated, which accounts for the highest cost associated with Brookfield and the largest impervious area. The project goal of evaluating two or more projects for each municipality was achieved, when accounting the second project in Elm Grove also included one of the large Brookfield projects.

FIGURE 16
Totals by Municipality

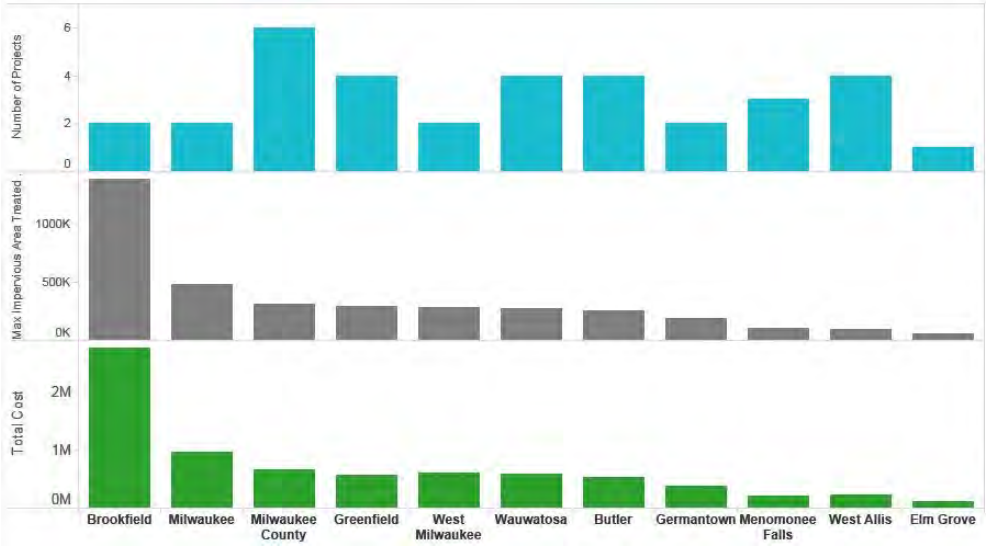


Table 4 has the final recommended projects in order of their overall score. Projects are color coded by municipality. An overall score for projects not at least within the top two projects by municipality is not provided.

Ready for implementation within the next several years, the analysis identified capital costs of over $7 million in potential GI projects that could provide nearly 3 million gallons of GI storage. Of potential interest to funders, the median project cost was just under $100,000. The median project cost was able to capture runoff from 75 percent of the impervious area within the road reconstruction project footprint, indicating runoff from all imperviousness cannot be readily captured without implementing additional technologies, such as porous pavement in conjunction with bioretention.

Additional analysis detail on all of the scoring categories for each project is included in Appendix C.

5 Technical Considerations

The initial prioritization considered 46 projects. The project team took the initial prioritization and selected the top two to four projects by municipality to do a further screening for GI potential. This team considered such elements as: topography, hydrologic soil group, the presence of utilities, GI siting, the space that is available for bioretention or porous pavement, the area that would be needed for GI to fully treat all of the imperviousness within the project footprint, and other factors. The process involved reviewing each project in GIS and “heads up” digitizing potential locations for GI. Preference was given to bioretention because it is the most cost-effective strategy evaluated for the project with the assumptions used.

In addition, several municipalities mentioned porous pavement maintenance as a concern due to the lack of equipment to maintain it, such as vacuum sweepers.

The GIS analysis of the projects resulted in draft GI recommendations for each project. This allowed the creation of project-specific maps with GI opportunity (see example in Figure 17). The maps were then reviewed with each municipality through one-on-one meetings.

TABLE 4
Project Scoring and Cost Results

Overall Rank	Project ID	Project Name	Municipality	CIP Year	Type	Overall Score	Total Cost	Potential Storage Capacity (gal)	Cost per Gallon
1	MF0005	St. Francis Drive	Menomonee Falls	2018	Road	4.65	$ 36,000	13,665	$ 2.63
2	BU0004	Frontier Park (south lot)	Butler	TBD	Parking	4.62	$ 12,000	4,522	$ 2.65
3	MC0004C	BHD Parking Lot North	Milwaukee County	2016	Parking	4.48	$ 38,000	14,202	$ 2.68
4	WE0005	89th Street	West Allis	2016	Road	4.45	$ 37,000	13,787	$ 2.68
5	MF0003	Cheyenne Drive	Menomonee Falls	2018	Road	4.31	$ 63,000	23,635	$ 2.67
6	GF0004	35th Frontage Rd	Greenfield	2017	Road	4.29	$ 59,000	22,076	$ 2.67
7	MC0001	West Oklahoma	Milwaukee County	2018	Road	4.16	$ 111,000	41,763	$ 2.66
8	GF0002	60th St	Greenfield	2017	Road	4.15	$ 87,000	32,727	$ 2.66
9	EG0001	Village Hall	Elm Grove	TBD	Parking	4.05	$ 105,000	39,318	$ 2.67
10	MF0002	Cherokee Drive	Menomonee Falls	2017	Road	3.99	$ 103,000	38,526	$ 2.67
11	WA0005	Gridley Alley	Wauwatosa	2016	Alley	3.98	$ 22,000	5,075	$ 4.34
12	MC0002	Currie Park Service Yard	Milwaukee County	2015	Parking	3.97	$ 94,000	35,098	$ 2.68
13	GE0001	River Crest Drive	Germantown	2015	Road	3.97	$ 41,000	15,545	$ 2.64
14	WA0006	Center_74th to 75th Alley	Wauwatosa	2017	Alley	3.96	$ 14,000	3,124	$ 4.48
15	WE0003	Rogers Alley	West Allis	2015	Alley	3.89	$ 29,000	6,581	$ 4.41
16	BU0003	N 127th St	Butler	TBD	Road	3.88	$ 27,000	6,118	$ 4.41
17	MC0004A	BHD Parking Lot South	Milwaukee County	2016	Parking	3.81	$ 48,000	11,129	$ 4.31
18	MC0003	Currie Park Clubhouse	Milwaukee County	2015	Parking	3.81	$ 183,000	68,643	$ 2.67
19	GF0001	Crawford Ave	Greenfield	2019	Road	3.67	$ 142,000	53,326	$ 2.66
20	WA0008	State Street	Wauwatosa	2016	Road	3.66	$ 206,000	72,127	$ 2.86
21	WE0001	Grant Alley	West Allis	2015	Alley	3.64	$ 38,000	8,796	$ 4.32
22	GF0003	43rd St	Greenfield	2016	Road	3.61	$ 288,000	108,046	$ 2.67

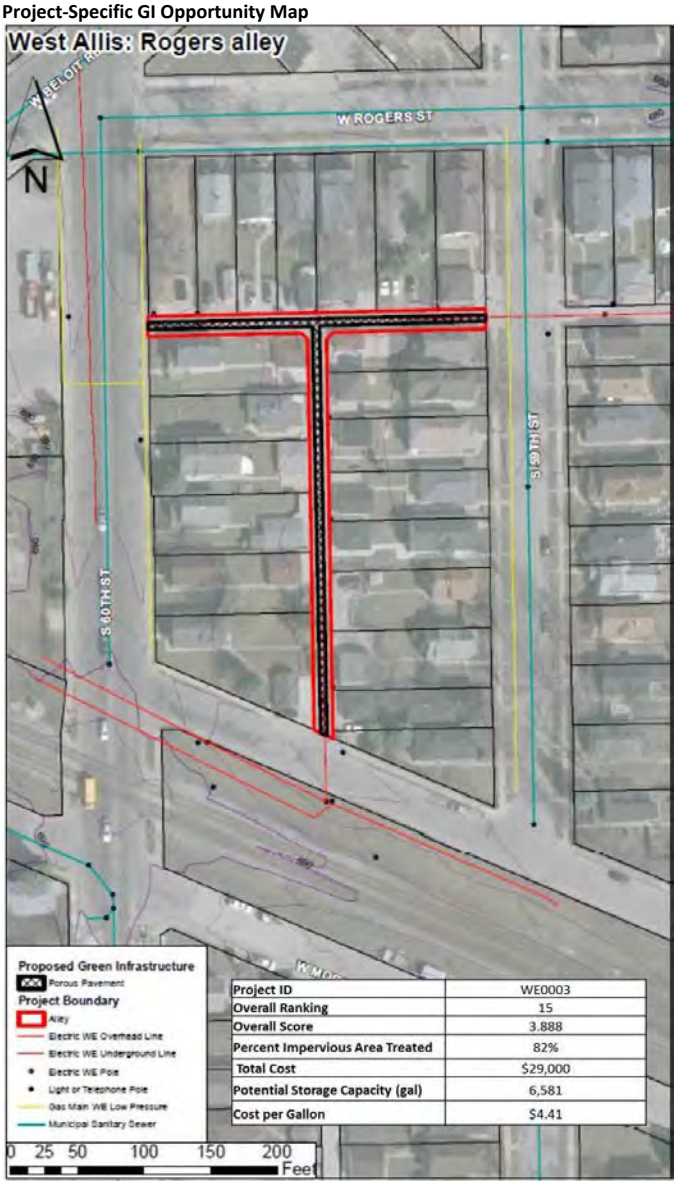
TABLE 4
Project Scoring and Cost Results

Overall Rank	Project ID	Project Name	Municipality	CIP Year	Type	Overall Score	Total Cost	Potential Storage Capacity (gal)	Cost per Gallon
23	WE0006	124th Street	West Allis	2018	Road	3.56	$ 119,000	44,730	$ 2.66
24	MC0004B	BHD Parking Lot Central	Milwaukee County	2016	Parking	3.55	$ 181,000	55,566	$ 3.26
25	MI0002	W Lisbon Ave	Milwaukee	2019	Road	3.52	$ 590,000	221,246	$ 2.67
26	GE0002	Concord Rd	Germantown	2016	Road	3.48	$ 333,000	125,031	$ 2.66
27	WA0009	N 92nd St	Wauwatosa	2018	Road	3.47	$ 336,000	125,941	$ 2.67
28	WM0001	Greenfield Ave	West Milwaukee	2016	Road	3.43	$ 91,000	21,080	$ 4.32
29	MI0001	N 91st St	Milwaukee	2018	Road	3.39	$ 367,000	137,541	$ 2.67
30	WM0002	Miller Park Way	West Milwaukee	2016	Road	3.37	$ 515,000	192,967	$ 2.67
31	BR0001	North Ave East	Brookfield	2018	Road	3.31	$ 1,972,000	739,521	$ 2.67
32	BR0002	North Ave West	Brookfield	2019	Road	3.28	$ 783,000	293,629	$ 2.67
33	BU0002	Silver Spring	Butler	TBD	Road	3.27	$ 402,000	150,700	$ 2.67
34	BU0001	Frontier Park	Butler	TBD	Parking	3.15	$ 95,000	22,008	$ 4.32
35	MC0005	Dretzka Chalet	Milwaukee County	2017	Parking	2.07	-	-	-
36	MC0006	Dretzka Golf Course	Milwaukee County	2018	Parking	2.03	-	-	-
37	EG0002	North Ave East	Elm Grove	2018	Road	1.97	-	-	-
38	WE0004	85th Street	West Allis	2016	Road	1.93	-	-	-
39	WA0003	Harding Blvd North	Wauwatosa	2016	Road	1.90	-	-	-
40	MF0004	May Ave	Menomonee Falls	2016	Road	1.90	-	-	-
41	WA0004	WatertownPlk Alley	Wauwatosa	2017	Alley	1.89	-	-	-
42	WA0007	Center_75th to 76th Alley	Wauwatosa	2017	Alley	1.88	-	-	-
43	WA0002	Harding Blvd South	Wauwatosa	2016	Road	1.85	-	-	-
44	WA0001	N 113th Street	Wauwatosa	2016	Road	1.82	-	-	-

TABLE 4
Project Scoring and Cost Results

Overall Rank	Project ID	Project Name	Municipality	CIP Year	Type	Overall Score	Total Cost	Potential Storage Capacity (gal)	Cost per Gallon
45	MF0001	Arthur Ave	Menomonee Falls	2016	Road	1.82	-	-	-
46	WE0002	Lapham Alley	West Allis	2015	Alley	1.81	-	-	-
					Total	-	$ 7,567,000	2,767,791	-
					Maximum	4.653	$ 1,972,000	739,520	$ 4.48
					Median	3.558	$ 99,000	36,812	$ 2.67
					Average	3.318	$ 222,558	81,405	$ 3.09
					Minimum	1.810	$ 12,000	3,124	$ 2.63

FIGURE 17
Project-Specific GI Opportunity Map



Project ID	WE0003
Overall Ranking	15
Overall Score	3.888
Percent Impervious Area Treated	82%
Total Cost	$29,000
Potential Storage Capacity (gal)	6,581
Cost per Gallon	$4.41

Disclaimer

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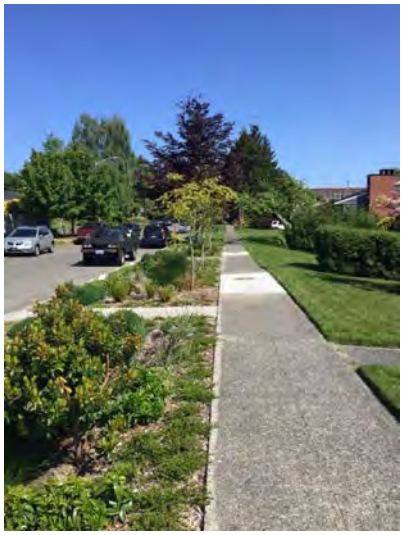
MMSD developed the map in Figure 17 as well as the other maps contained in Appendix A. The maps are intended to be a draft representation of GI locations that could be implemented once sufficient design is completed taking into account more detailed site-specific information. While care is taken in creating the maps, the disclaimer on this page accompanies Figure 17 and the maps in Appendix A.

The technical considerations for GI implementation followed much of the flow chart processes developed for the City of Milwaukee Green Streets Plan (CH2M HILL 2013a). An example of the evaluation process is shown in Figure 18. Key considerations include the amount of green space available in a street median or terrace area, the presence and width of street parking lanes, and other technical considerations, such as the depth of bedrock and depth to groundwater. These features drove the project evaluation.

GI strategies focused on bioretention and porous pavement. Other opportunities, such as tree trenches, could be applicable, especially in areas that have limited area for bioretention and would benefit from additional tree plantings.



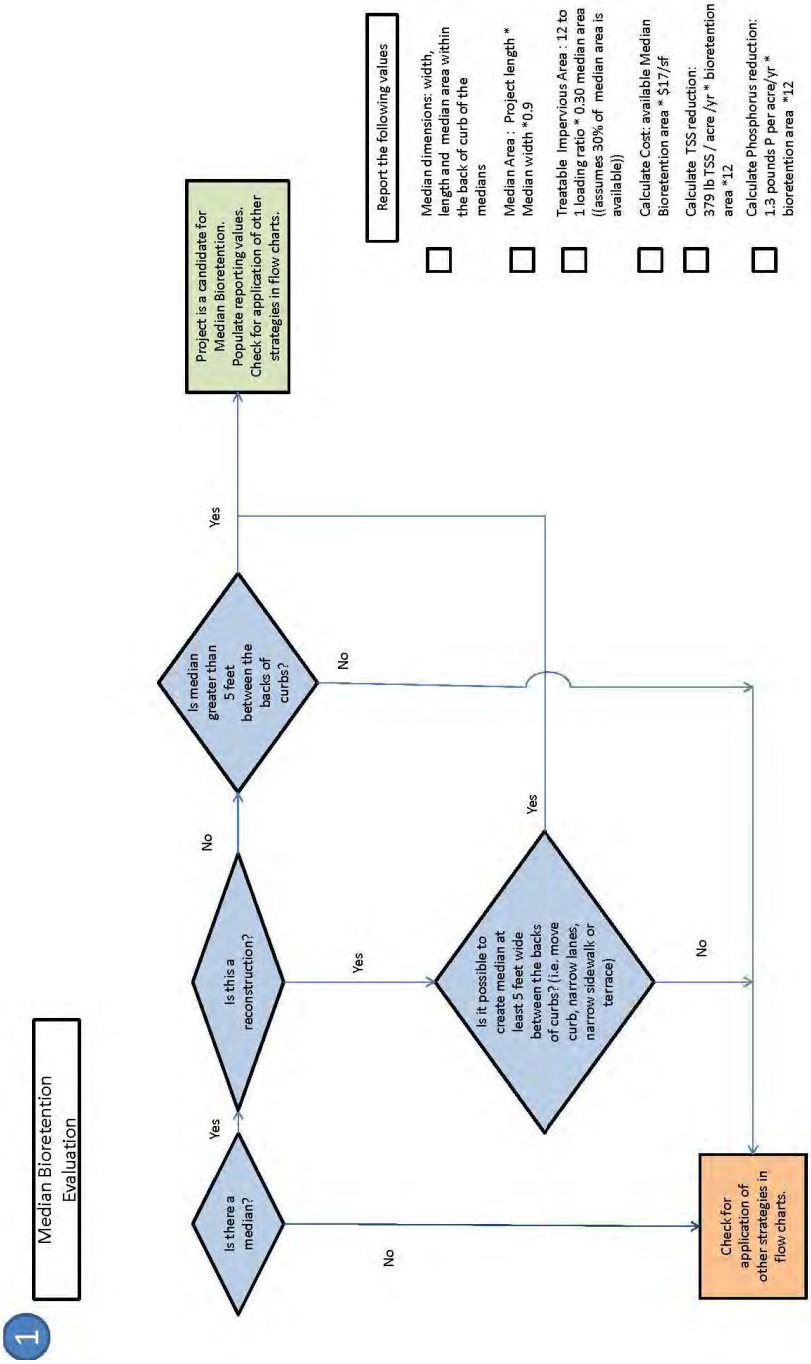
Residential rain gardens with porous sidewalk.

6 One-on-One Meetings

The one-on-one meetings provided valuable insight into municipal perspectives on GI implementation that could add value to similar analysis in the future. Meetings were scheduled with all 11 municipalities, with 9 out of the 11 meetings occurring at either the City of Wauwatosa or at MMSD headquarters over the course of one week. The meeting format included review of the overall scoring process and draft maps, with feedback on the specific projects, but also allowed for discussion of questions or concerns about GI in general. Municipal feedback during the meetings included the following:

- Caution that sanitary sewer alignments are often placed along the roadway centerline. When placing bioretention in road medians, care should be taken not to exacerbate inflow and infiltration challenges into the sanitary sewer system. Bioretention in road medians is an example of an easier to implement GI opportunity. The team reviewed available sanitary sewer alignment information in response to this comment and made adjustments on bioretention recommendation locations.
- Feedback on how municipalities would fund GI. Most municipalities indicated that they would use the available MMSD funding for GI implementation. Several municipalities indicated that, if city councils directed municipal staff to implement more GI, stormwater utility funding could be accessed to implement GI projects; currently however, additional funds are not available. A review of the available MMSD funding compared to municipal funding needs (see Table 4), indicates available funding is much less than the potential projects that exist. Table 4 only represents a small fraction of the overall number of projects. One smaller municipality said that many of their roads will be reconstructed within the next 10 years. Significant funding beyond what is available through the MMSD GI programs would be needed for the region to implement GI more broadly. As prior projects have found and as indicated in the survey results for this project, funding GI remains one of the biggest challenges to broader GI implementation.

FIGURE 18
Example GI Strategy Flow Chart Decision Process from Milwaukee Green Streets Plan



- Feedback on funding also extended to GI operation and maintenance. Several municipalities indicated they would have to inform their councils or boards about the cost of GI operation and maintenance before broader GI implementation could occur. However, additional costs may not apply in areas the municipality already maintains. For example, mowing may be replaced by maintaining bioretention plants, which may have the same maintenance costs. Municipalities often use general funds to pay for ongoing public works maintenance. As a result, if additional funds are not made available for GI maintenance, municipalities would be in competition internally between funding GI maintenance and providing other general fund services. Direct competition between GI maintenance and other city services could put GI function at risk over time. Consequently, adding information on GI operation and maintenance would be very beneficial if similar analysis are provided in the future.

Residential setting rain garden with tree plantings.

- Several municipalities expressed an interest in knowing how GI strategies compare when considering life-cycle costs (both capital as well as operation and maintenance costs). Generating present worth cost information for GI strategy options would allow comparing strategies, and would also allow comparison to other practices used to address water quality (detention ponds, street sweeping, etc.). Adding life cycle costs into the evaluation would be useful for future analysis.
- Milwaukee County expressed that they are not eligible for the MMSD Green Solutions funding program for municipalities. Yet, they have many projects that ranked highly from the analysis. Milwaukee County is eligible for other MMSD GI funding programs including the Green Infrastructure Partnership Program and Signature Series. Like other municipalities, Milwaukee County would rely upon grants for GI implementation. Many County projects were observed to have high visibility, with locations in parks and other heavy-use parking areas. Without a specific funding stream for GI, project opportunities will likely be passed over, making identification of funding sources that could apply to Milwaukee County beneficial for realizing broader GI implementation in the Menomonee River Watershed.

Several municipalities expressed a preference for bioretention over porous pavement because they did not have the equipment necessary to maintain porous pavement. As more GI implementation occurs, this concern may be reduced over time if appropriate equipment becomes readily available. However, in the meantime, GI implementation recommendations should consider municipal capabilities for maintenance. Collaboration opportunities with other entities that have maintenance equipment could potentially reduce this concern.

Many municipalities expressed interest in implementing more GI. A concern raised, especially for municipalities that would be implementing GI in new settings, is having pictures to share with residents on what a project would look like. Two municipalities expressed an interest in having GI photos for residential settings. Example photos have been added to this report in response to this request.

While not specifically mentioned in direct feedback, the project team would have preferred to have met with the municipalities at their offices. With meetings successfully scheduled with all 11 municipalities, the approach of conducting the one-on-one meetings at two locations worked well. However, it could provide additional value to municipalities if sufficient budget and time allowed for meetings at individual municipal offices.

7 Water Quality Benefits through Source Loading and Management Model Analysis

Parking lot with bioretention.

The project team provided an opportunity for the municipalities to model the water quality benefits using SLAMM. The SLAMM model provides pollutant reduction information for total suspended solids (TSS) and phosphorus (P) for stormwater runoff through BMPs, including GI practices. During the workshops, one-on-one meetings, and other interactions, municipal representatives said that knowing the water quality benefit GI provides would be useful. Municipalities indicated knowing the water quality benefit GI provides will be especially important when the municipalities find out what their TSS and P load allocations will be under a total maximum daily load (TMDL) analysis in progress.

While municipalities said they valued the water quality benefit information, not all municipalities have the in-house capability to use SLAMM and only two municipalities indicated a willingness to do the modeling. The municipalities were given the GI-recommended project information needed to run SLAMM. However, due to workload and other priorities, the SLAMM modeling was not completed during the project timeframe. This impacted the project's in-kind matching contributions.

Parking lot with porous pavement and bioretention.

Water quality benefits reported by the City of Milwaukee for projects they have modeled in SLAMM predicted a TSS pollutant reduction of 80 percent can occur with bioretention in street medians. P reduction varies with the amount of runoff reduction, but bioretention modeling has shown reductions of 60 percent. This reported modeling from other projects illustrates GI water quality benefits can be substantial.

With roads and parking lots known to contribute a significant amount of pollution, combining GI with planned road and parking lot CIP projects could provide significant water quality benefits to the region.

If this project methodology is repeated in additional municipalities, is the team recommends that a water quality benefits analysis be included for the projects because knowing the water quality benefits would clearly be valued by the municipalities.

SLAMM analysis conducted by municipalities as part of this project obtained the following results:

Porous alley SLAMM analysis for a project in Wauwatosa showed a total suspended solids (TSS) reduction of approximately 50 percent. This is consistent with the other Wauwatosa porous pavement project and WDNR modeling guidance and illustrates substantial TSS improvements can be achieved through GI.

8 Project Survey

Following the one-on-one meetings with the watershed municipalities, the project team administered an online survey to gather project feedback from the 11 municipalities. The goal of the survey was to gain feedback on how useful the project was for participants and how likely they will implement the recommendations. The survey also served to gain a greater understanding of municipal perspectives on general barriers to municipally-led GI projects and possible inducements that could foster more such projects.

The survey received 11 responses from representatives of 10 total municipalities, including Milwaukee County. The full set of questions and summarized responses can be found in Appendix B. Some of the most interesting and instructive findings from the survey are highlighted below.

One key objective of this project for Sweet Water, MMSD, and the entire project team was to raise awareness of key municipal staff on GI opportunities they could be considering as part of their routine capital projects. The second survey question asked “Has this project raised your awareness that there are GI opportunities with street and parking lot reconstruction projects [in your municipality]?” Six of eleven respondents (nearly 73%) chose “Definitely yes” or “Somewhat yes” as their response to this question, an indication that the project indeed was able to raise awareness of GI opportunities. One comment in this section of the survey read: “From a staff standpoint, it has allowed dialog regarding green infrastructure as projects arise.” Fostering that kind of dialog in the early stages of municipal capital project planning was precisely the aim of this project and the City of Milwaukee Green Streets Plan after which this project was modeled. Without awareness of the GI potential with street reconstruction projects, there will be missed implementation opportunities that won’t come around again until decades into the future when roads are once again reconstructed.

When asked (in the fourth survey question) how likely they thought it was that their municipality would implement the two GI opportunities provided to them through this project, five of the ten municipalities represented in the survey indicated it was as least somewhat likely. Some insights into why that number was not higher came through the responses to the survey’s fifth and sixth questions, covering perceived barriers to GI implementation. Nine of eleven respondents replied that there are barriers to implementing the two projects recommended for their municipalities. The top three specific barriers identified were funding, political support, and maintenance concerns. These results are not surprising or new, but they are quite useful in validating and building understanding region-wide (if not nationwide) of where attention and effort must be placed if the goal is to increase reliance on GI approaches for stormwater management.

Another positive feedback on the value of the project came in the form of responses to the survey’s ninth and tenth questions, which asked whether participants would recommend this approach to other municipalities in the region and why. Nine of eleven responded “yes,” citing the increased awareness a process like this brings and the heightened enthusiasm it can generate.

Some additional positive results of the survey came in the form of responses to question 14, which asked whether collaborative efforts like this one, spearheaded by Sweet Water, added value for participants. All eleven respondents replied that the project added value to their municipalities. One commenter noted “I

think projects like this will begin to lead us toward more affordable and successful green infrastructure projects."

One other important highlight from the survey comes from responses to question 11 regarding suggested improvements to the process followed in this project. In addition to noting that elected officials ought to be another key target audience for this kind of work, many respondents emphasized the importance of operation and maintenance costs as part of the information they will need to inform their GI implementation decisions. Future analysis that can include operation and maintenance costs and that would expand the analysis to include a total life-cycle cost analysis (capital as well as operation and maintenance costs) would allow GI implementation decisions to consider overall life-cycle costs to a municipality and to compare those for GI against those for more traditional infrastructure investments in an apples-to-apples way. One survey respondent said it well when they said "I think everyone would like to use green infrastructure more. It is a matter of funding… I think as these projects become more common, the costs may start to come down and we may determine where certain methods [practices] work best."

Finally, when asked what factors would drive them or their municipalities to consider implementing more GI, respondents made it clear that regulatory drivers, be it at the state or regional level, would be most likely to influence their decisions. Increased political and public support for GI would also play a role. Survey respondents indicated that they are motivated to pursue GI by the knowledge that GI improves water quality and by the ancillary benefits provided, including aesthetic improvement and improved drainage. Some pointed out that assistance with GI maintenance—including possible help with logistics, necessary equipment, and the costs—would factor into their decision-making.

The survey provided very useful information to the project team, and MMSD and Sweet Water in particular, who will use these findings to help guide future investments in encouraging the more widespread GI implementation across the region. The hope is that the survey results are also of use to the project's participants themselves as well as to municipal leaders and others from other geographies who may read this report.

9 Improvements for Future Analysis

Feedback from municipalities and observations of the project scoring process identified several potential improvements to the process. Some potential improvements could include the following:

- The information available for depth to groundwater and depth to bedrock was limited to less than or greater than 6 feet. This created little differentiation between projects because most projects had a depth of greater than 6 feet. However, even when the depth was less than 6 feet, it was uncertain if GI implementation was constrained or not since site-specific data might show GI is still practical. Developing more depth categories (i.e. 4, 5, 6, 7, 8, etc.) would expand the scoring values available, provide a range of potential implementation constraints, and bring more differentiation to the numerical scoring.
- Municipalities emphasized the importance of operation and maintenance costs to inform GI implementation decisions. Future analysis that can include operation and maintenance costs would provide additional value to municipalities.
- Related to operation and maintenance costs, expanding the analysis to include a total life-cycle cost analysis (capital as well as operation and maintenance costs) would allow GI implementation decisions to consider overall life-cycle costs to a municipality.
- Using ARC-GIS On-line to share and edit GIS data among the consultant, MMSD, and the municipalities could save time and share important GI implementation information valuable to all project participants.
- Municipalities consistently expressed interest in having water quality benefits quantified for GI projects. However, few municipalities committed to evaluating water quality benefits due to other priorities,

available in-house expertise, and uncertainty about how the outcome of the pending TMDL studies would impact their municipality. Completing a SLAMM water quality analysis as part of the project budget in the future would provide the benefit of communicating the water quality benefits of the GI project implementation.

- Several municipalities expressed appreciation of having the one-on-one meetings to learn more about GI and as an opportunity to educate other municipal staff. Several expressed that it would be valuable to share similar information to city councils and village boards, because clearly communicating the benefits of GI will be needed for public works officials when more significant levels of GI implementation occur.
- Meeting with other entities involved in road reconstruction would be beneficial. For example, some of the significant projects forthcoming in the City of Brookfield will be implemented by Waukesha County. Waukesha County is not a specific member of MMSD, but County road projects will impact the MMSD service area and provide water quality improvement opportunities. Including Waukesha, Ozaukee, and Washington counties in future discussions on GI within the MMSD service area would be beneficial.

10 Available Funding

All survey respondents listed GI funding as the most significant barrier to implementing GI. While the goal of this project is not to solve the funding question, some information on the level of funding needed has been identified through the project. For example, the median price for a GI project identified through this project is just under $100,000 (Table 4) and the project identified over $7 million in potential projects in the next several years without even considering all of the road reconstruction projects available in the Menomonee River Watershed.

Funding for 2015 from MMSD through the Green Solutions program totals $1.5 million and ranges from just over $500,000 for the City of Milwaukee, representing the largest recipient of funds, to $103,000 for Wauwatosa, the next largest recipient of funds, to $4,000 for Butler, as the recipient of the lowest amount of funding in the Menomonee River Watershed.

Other potential funding sources in 2015 include:

- MMSD GI Signature Series
- Fund for Lake Michigan
- WDNR and Coastal Zone Management Grants
- Municipal funding

While the level of funding would optionally to increase for broad-based GI implementation, implementing GI in concert with planned road and parking lot CIP projects allows for stretching available dollars through cost-effective implementation. The City of Milwaukee has indicated cost savings of 50 percent or greater by implementing GI in association with planned road reconstruction projects (Thur, 2015).

11 Conclusions

While the project successfully achieved the project vision of raising GI awareness, municipalities indicated funding is the biggest barrier to GI implementation. The project cost estimates provided insight into the available funding compared to funding needs for a typical project. Most municipalities can implement one or two of the recommended projects with the funding that is available over time.

A typical project costs just under $100,000 (Table 4), and the project identified over $7 million in ready available projects, with more potential projects to be considered. MMSD's 2015 Green Solutions funding level is $1.5 million, with funding levels by municipality varying from over $500,000 to under $5,000. Milwaukee County had a significant number of highly ranked potential projects, but has no specific funding as part of the MMSD's Green Solutions program. However, Milwaukee County does qualify for other GI funding sources. To significantly increase GI implementation, the region will need to consider how to realize increased local and regional funding not only for construction, but also for ongoing maintenance.

Improvements to the project evaluation process were documented, especially for evaluating the depth to groundwater and depth to bedrock implementation constraints. Recommended changes to evaluating the constraints could provide a broader differentiation in the project scores.

Through one-on-one meetings, the municipalities said that SLAMM water quality analysis would be beneficial but, due to either the lack of in-house capabilities or other constraints, the municipalities participated in a limited way for the water quality analysis. This impacted the project's overall in-kind matching contributions. Future analysis would benefit from municipalities including SLAMM water quality evaluation as part of the project scope.

Feedback from one-on-one meetings and the project survey proved that municipalities valued the project. The survey results indicated 8 out of 11 respondents found the project raised awareness of GI opportunities and 9 out of 11 survey respondents believe the project should be expanded to more municipalities. Based upon the project feedback, MMSD has included a draft budget request to expand the evaluation to the remaining 18 municipalities in the MMSD service area.

Other survey results indicated all respondents thought that Sweet Water provided a valuable service to the municipalities by envisioning this project. The survey also provided significant insight into barriers to widespread GI implementation, including the importance of funding, as well as understanding maintenance cost impacts to municipal budgets.

The project survey had good participation, with 10 out of 11 municipalities represented in the final survey results. This project had strong participation, making the findings representative of the municipalities in the Menomonee River Watershed.

12 References

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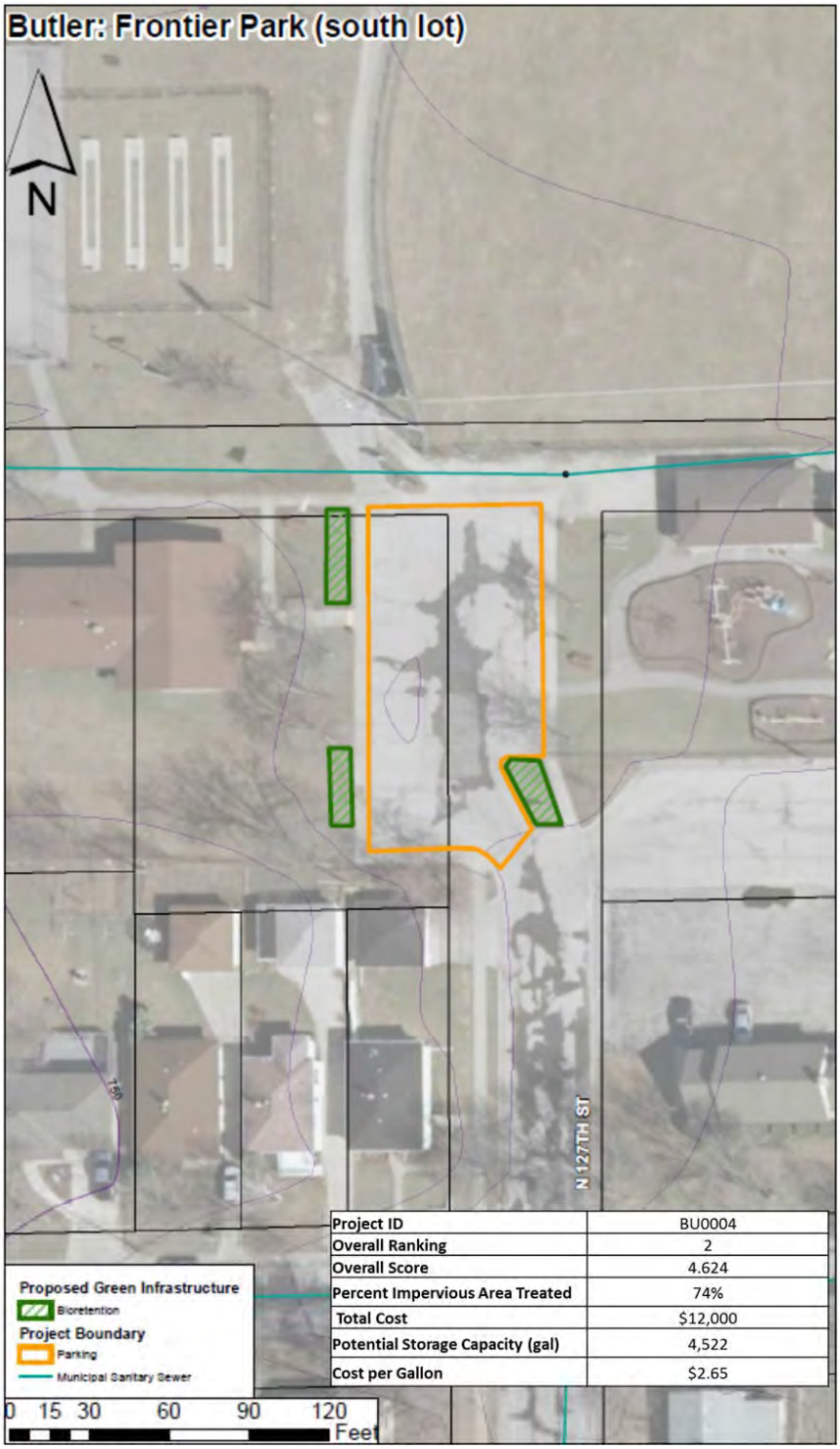
Appendix A
Maps

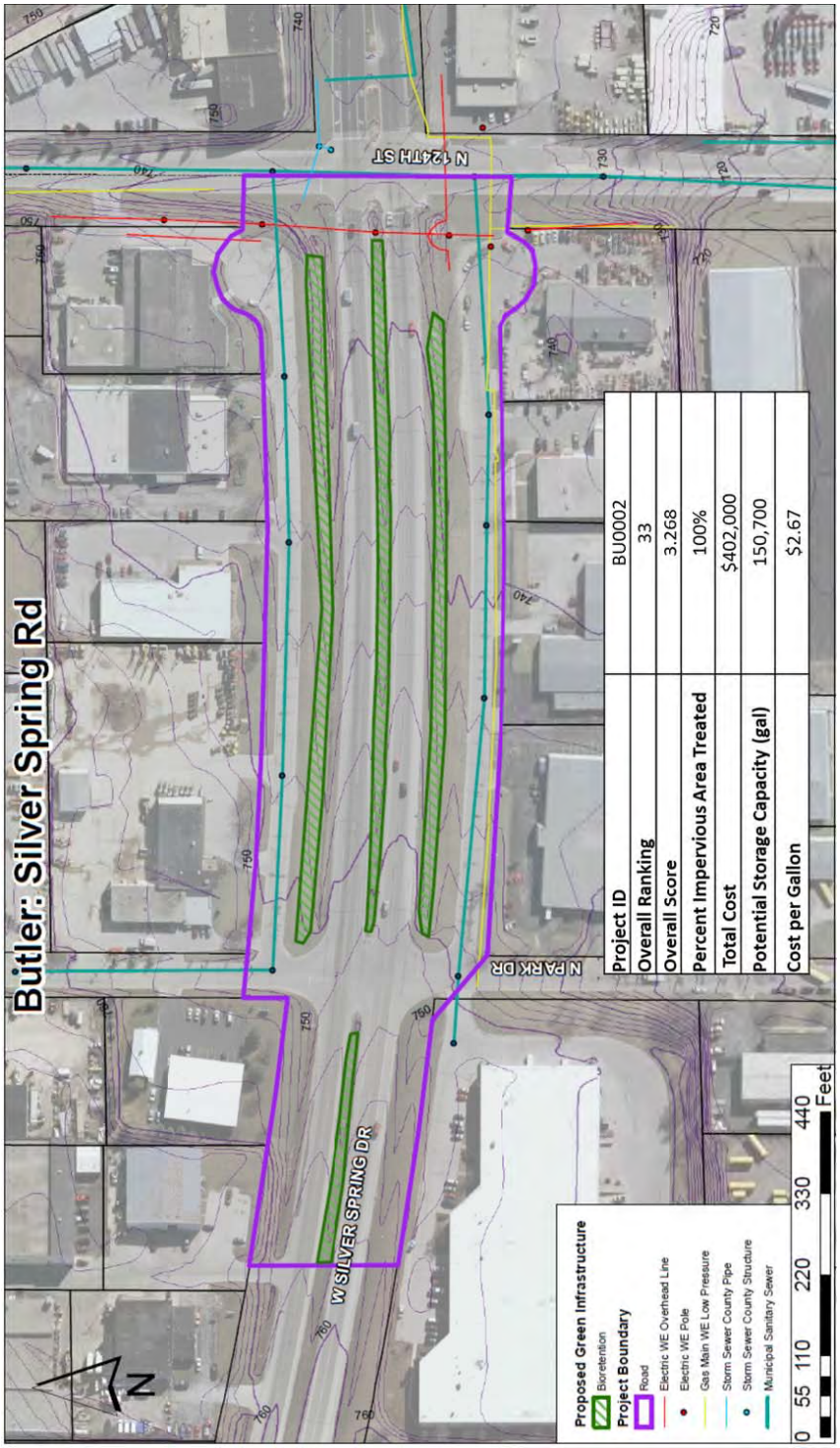
"No warranties, expressed or implied, are provided for this data/map, its use, or its interpretation. The Milwaukee Metropolitan Sewerage District (MMSD) provides data/maps "as is." The MMSD does not guarantee the quality, content, or accuracy of the information and is not responsible for any misuse or misrepresentation of this information or its derivatives. It is recommended that you carefully consider the accuracy and content of any electronic data, and that you contact the MMSD Facilities Information Department with any questions regarding appropriate use."



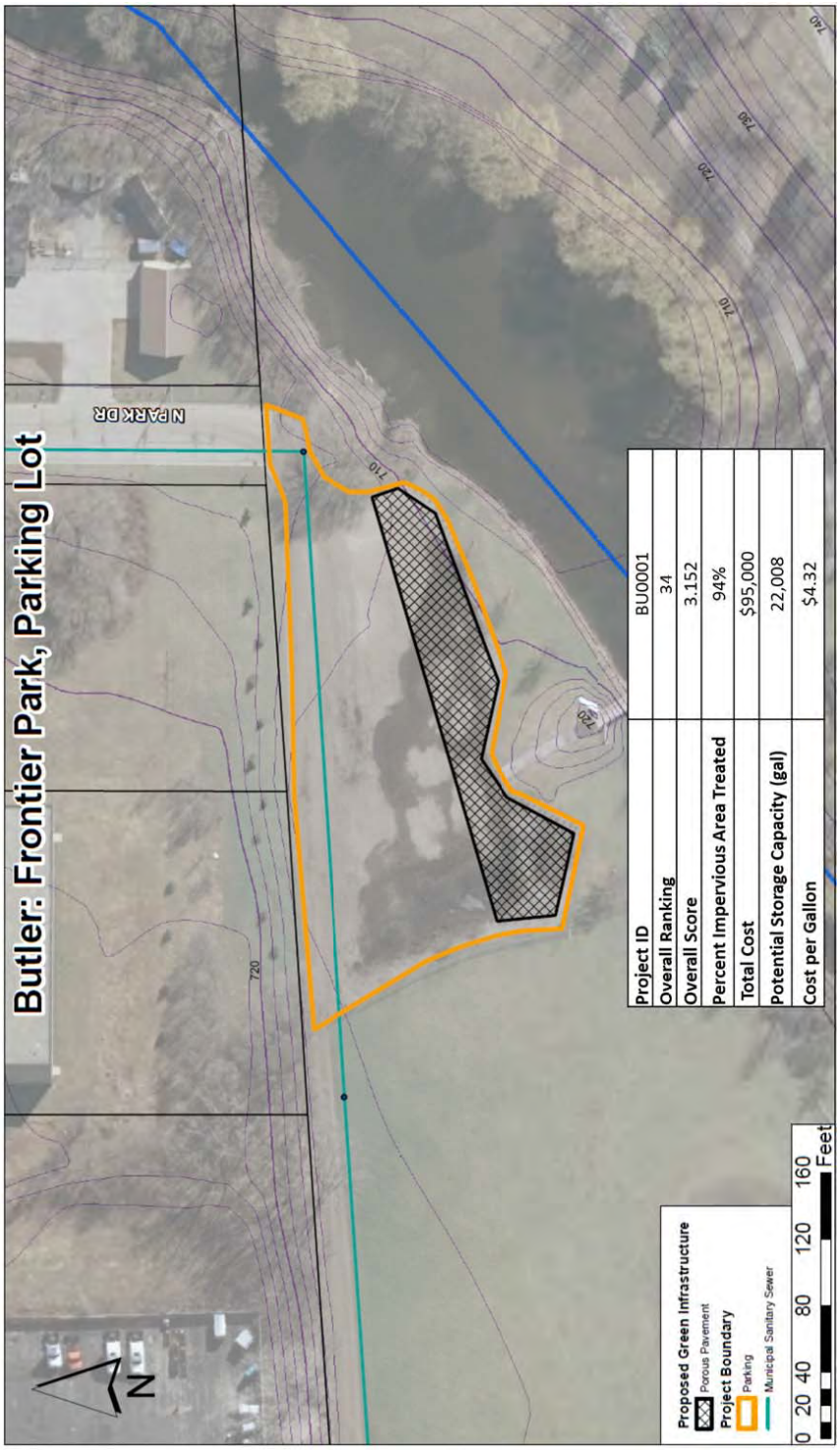
Project ID	BU0004
Overall Ranking	2
Overall Score	4.624
Percent Impervious Area Treated	74%
Total Cost	$12,000
Potential Storage Capacity (gal)	4,522
Cost per Gallon	$2.65

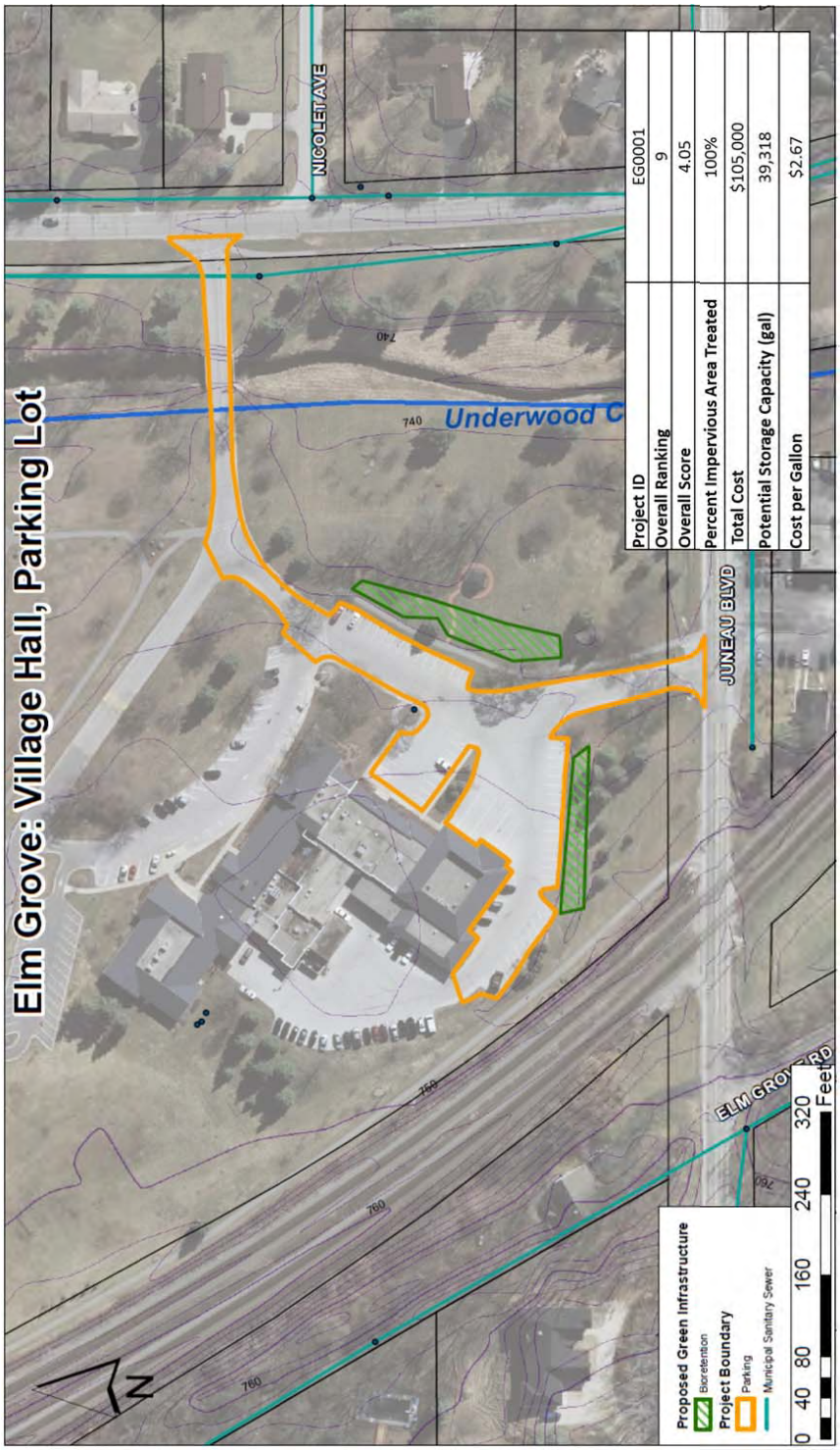
Project ID	BU0003
Overall Ranking	16
Overall Score	3.881
Percent Impervious Area Treated	48%
Total Cost	$27,000
Potential Storage Capacity (gal)	6,118
Cost per Gallon	$4.41

3

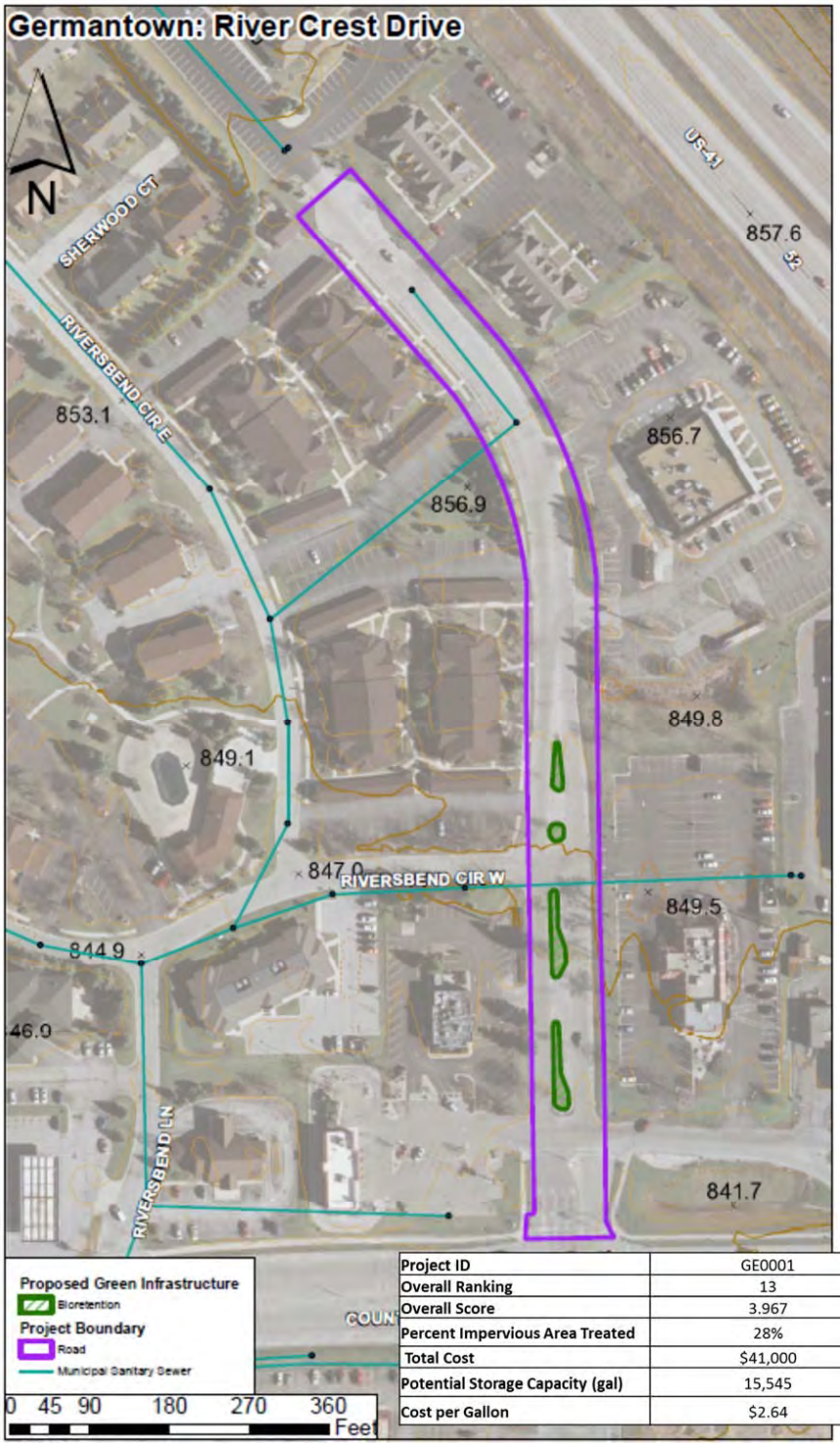


Project ID	BU0002
Overall Ranking	33
Overall Score	3.268
Percent Impervious Area Treated	100%
Total Cost	$402,000
Potential Storage Capacity (gal)	150,700
Cost per Gallon	$2.67


Butler: Frontier Park, Parking Lot
N PARK DR
720
710
720
710
720
730
740
N
Proposed Green Infrastructure
Porous Pavement
Project Boundary
Parking
Municipal Sanitary Sewer
0 20 40 80 120 160
Feet
Project ID BU0001
Overall Ranking 34
Overall Score 3.152
Percent Impervious Area Treated 94%
Total Cost $95,000
Potential Storage Capacity (gal) 22,008
Cost per Gallon $4.32

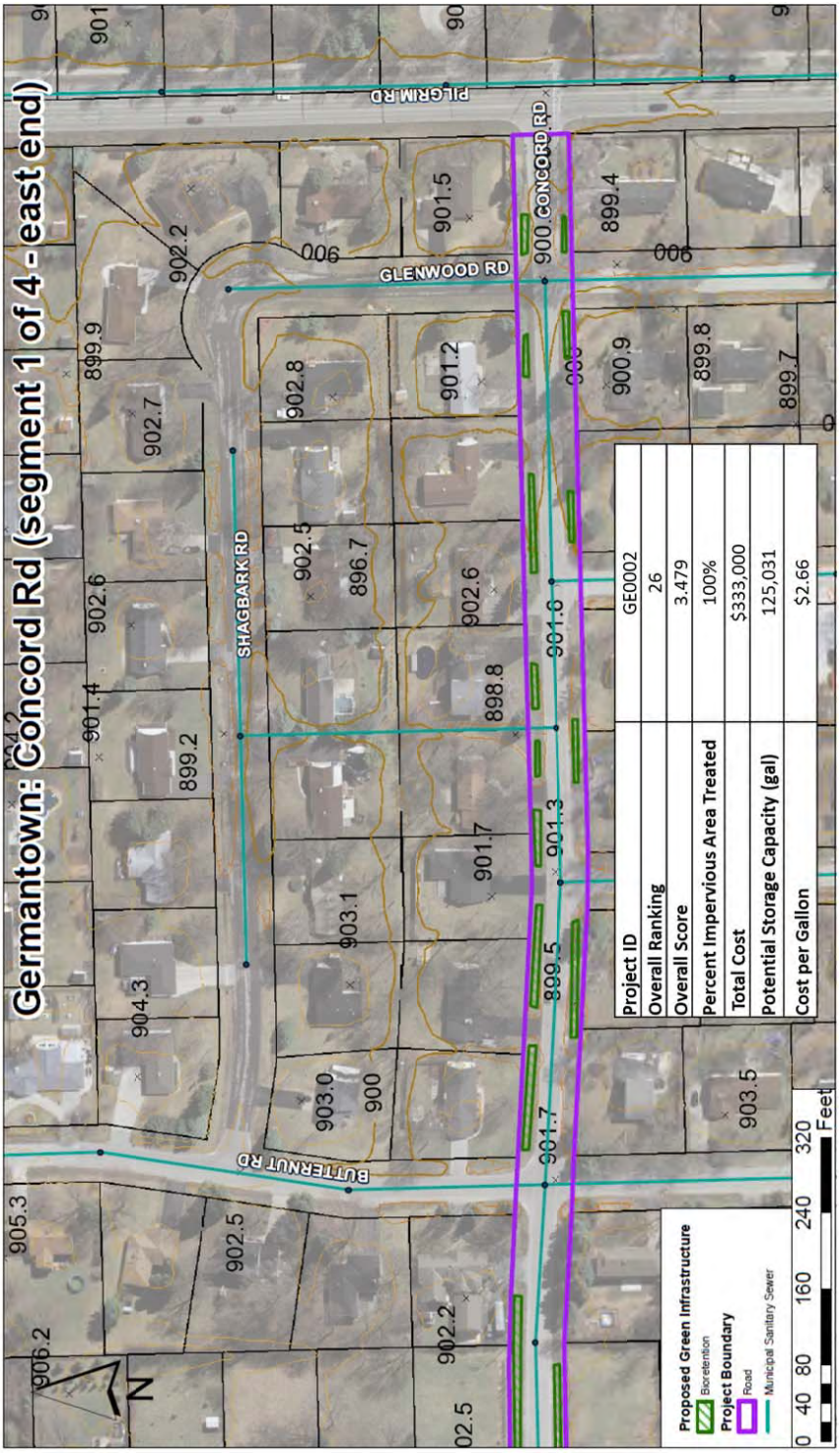


Project ID	EG0001
Overall Ranking	9
Overall Score	4.05
Percent Impervious Area Treated	100%
Total Cost	$105,000
Potential Storage Capacity (gal)	39,318
Cost per Gallon	$2.67



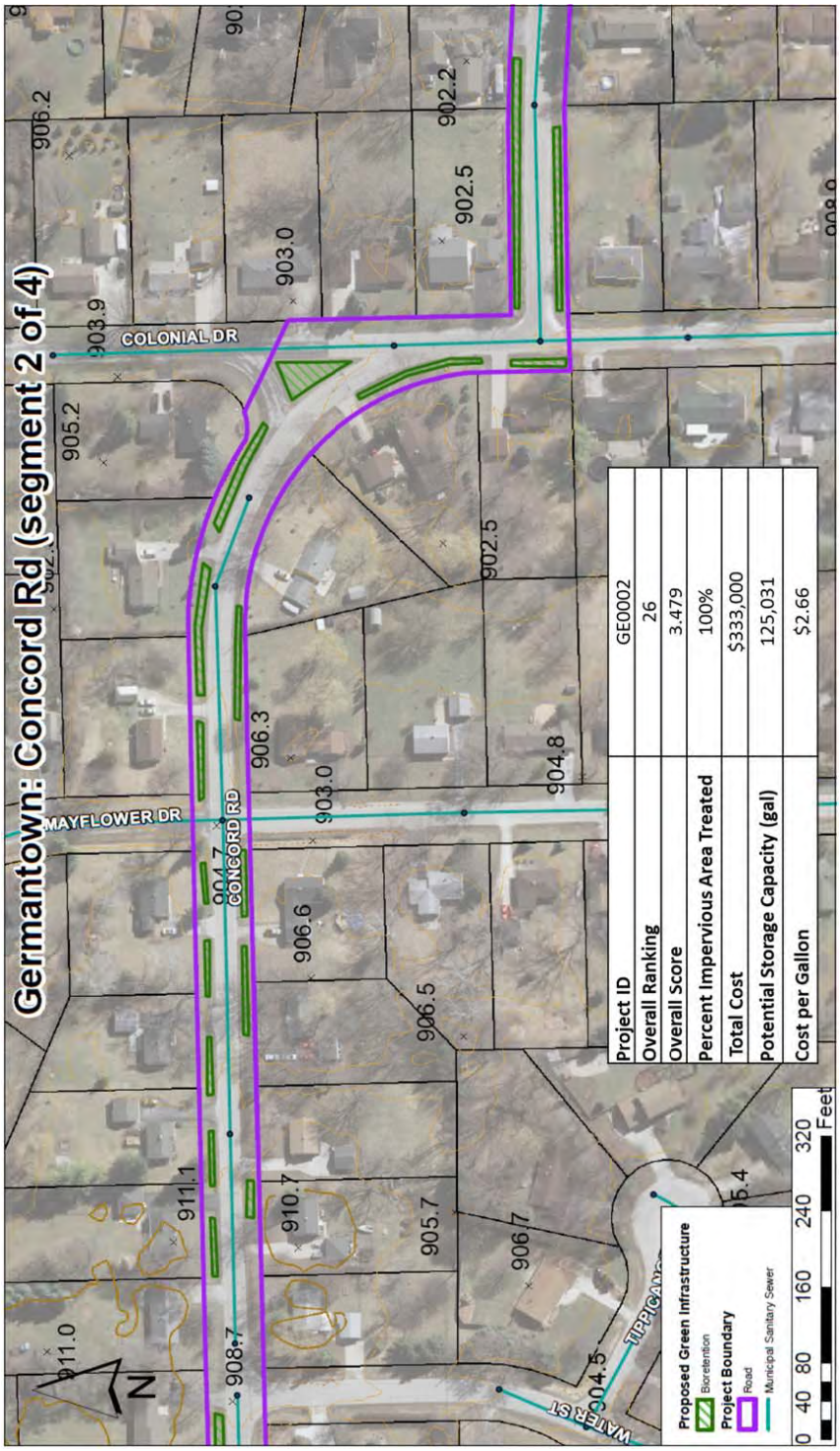
Project ID	GE0001
Overall Ranking	13
Overall Score	3.967
Percent Impervious Area Treated	28%
Total Cost	$41,000
Potential Storage Capacity (gal)	15,545
Cost per Gallon	$2.64

11

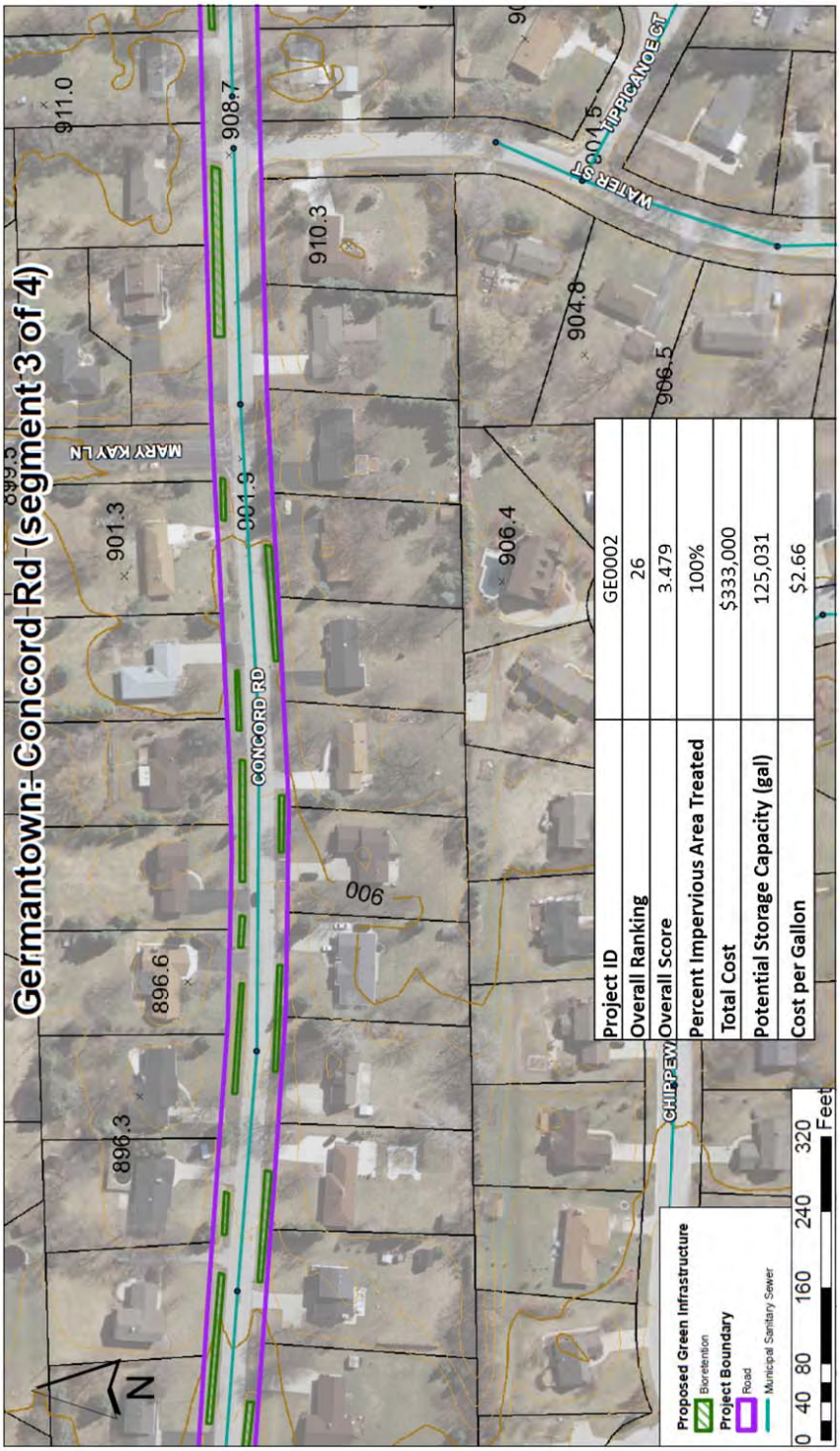


Project ID	GE0002
Overall Ranking	26
Overall Score	3.479
Percent Impervious Area Treated	100%
Total Cost	$333,000
Potential Storage Capacity (gal)	125,031
Cost per Gallon	$2.66

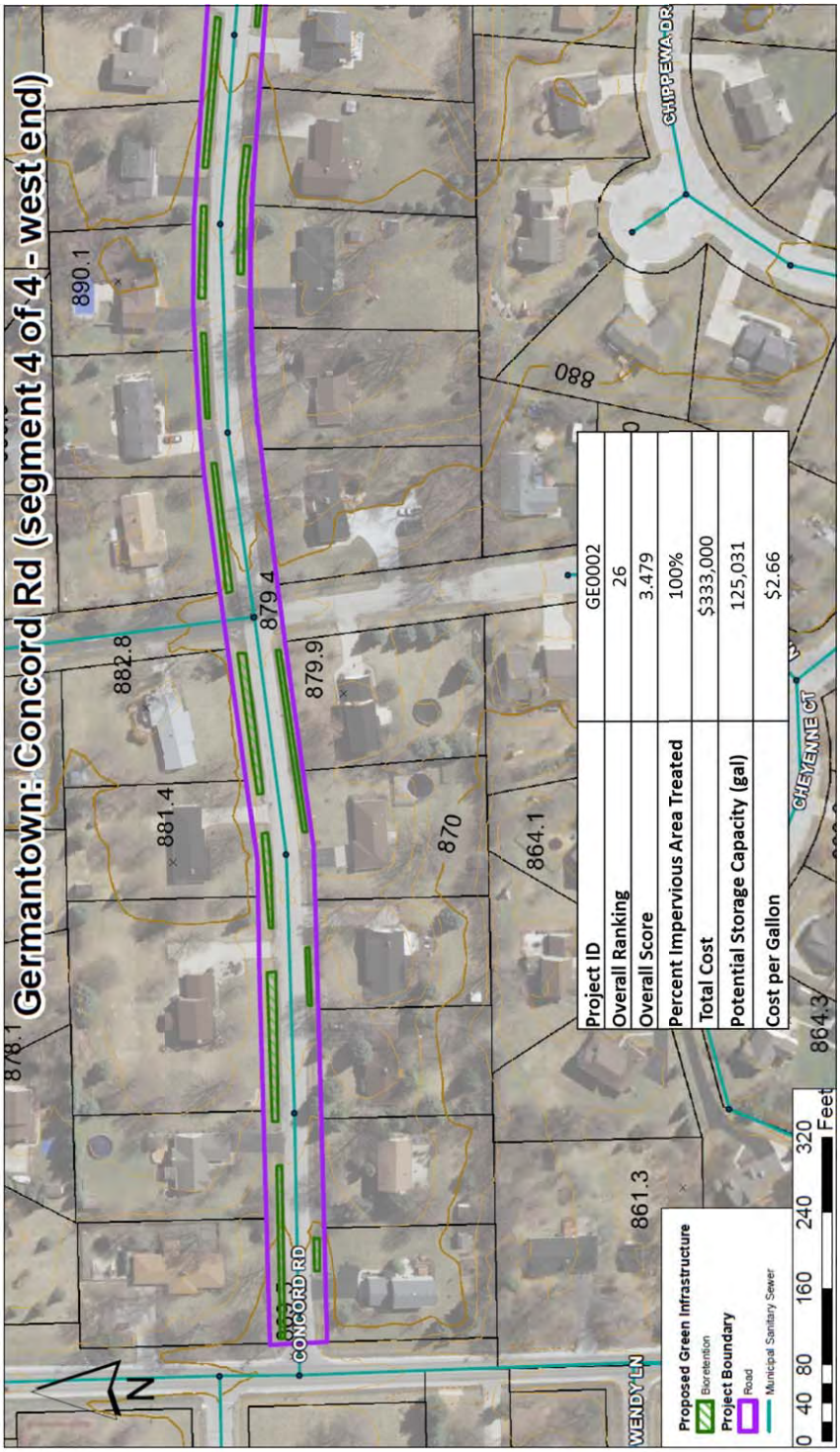
13


Germantown: Concord Rd (segment 2 of 4)
COLONIAL DR
MAYFLOWER DR
CONCORD RD
WALLER ST
TIPPICANOE
N
Proposed Green Infrastructure
Bioretention
Project Boundary
Road
Municipal Sanitary Sewer
0 40 80 160 240 320 Feet
Project ID GE0002
Overall Ranking 26
Overall Score 3.479
Percent Impervious Area Treated 100%
Total Cost $333,000
Potential Storage Capacity (gal) 125,031
Cost per Gallon $2.66

15

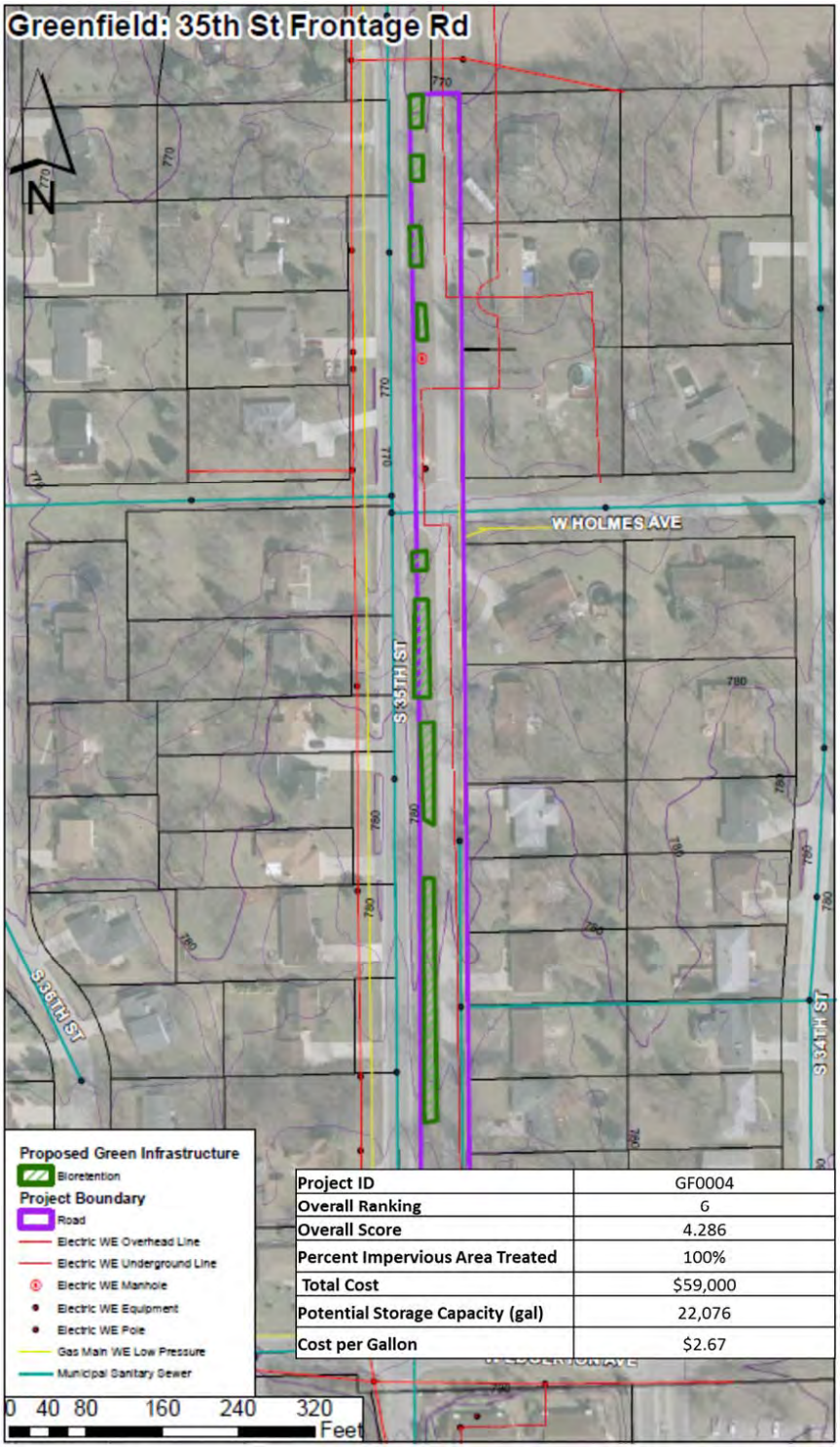

Germantown: Concord Rd (segment 3 of 4)
N
MARY KAY LN
CONCORD RD
WATER ST
TIPPICANOE CT
CHIPPEWA
911.0
908.7
901.3
901.3
910.3
896.6
896.3
906.4
904.8
906.5
904.5
900
Project ID
GE0002
Overall Ranking
26
Overall Score
3.479
Percent Impervious Area Treated
100%
Total Cost
$333,000
Potential Storage Capacity (gal)
125,031
Cost per Gallon
$2.66
Proposed Green Infrastructure
Bioretention
Project Boundary
Road
Municipal Sanitary Sewer
0 40 80 160 240 320
Feet

17



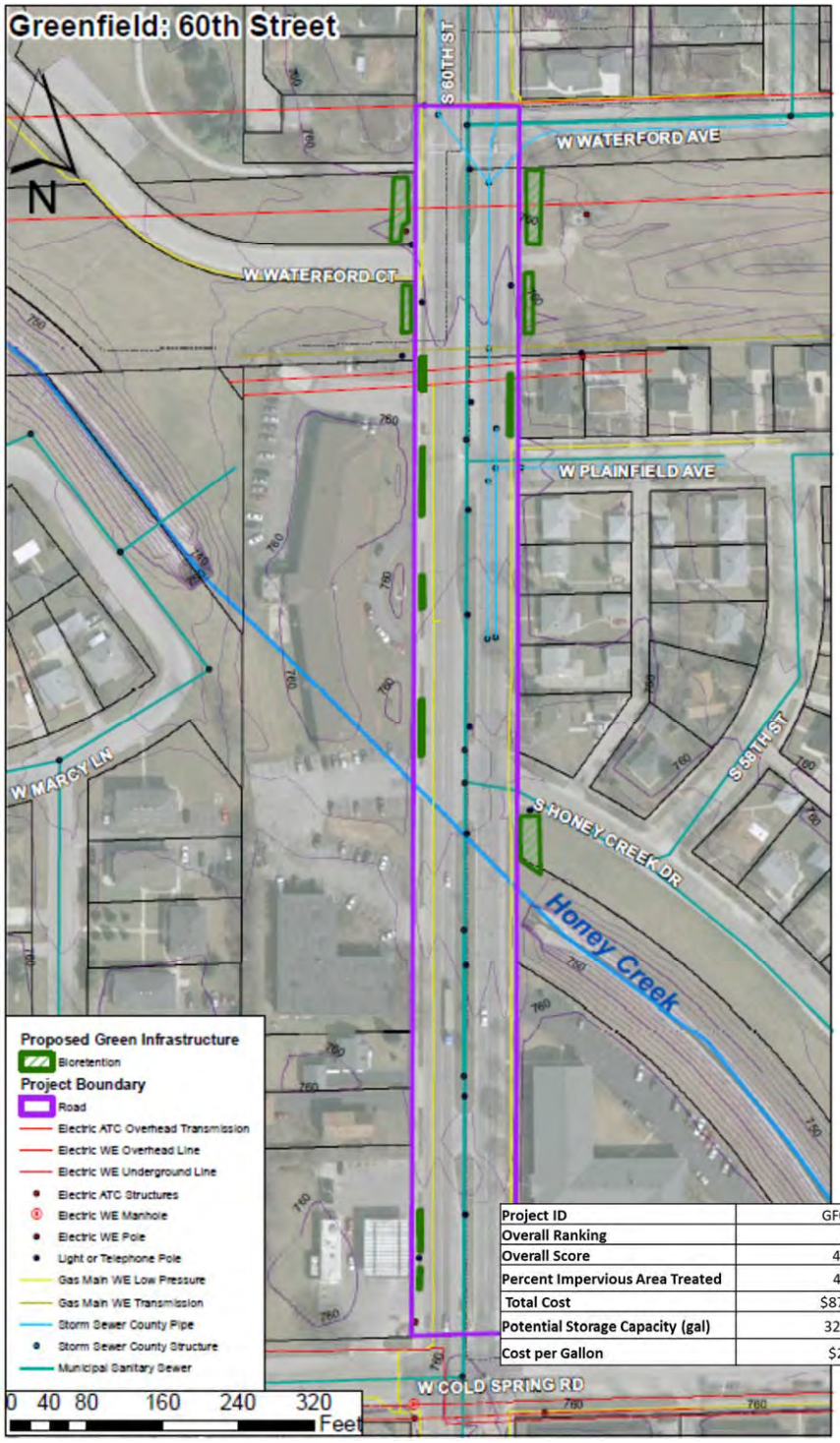
Project ID	GE0002
Overall Ranking	26
Overall Score	3.479
Percent Impervious Area Treated	100%
Total Cost	$333,000
Potential Storage Capacity (gal)	125,031
Cost per Gallon	$2.66

19



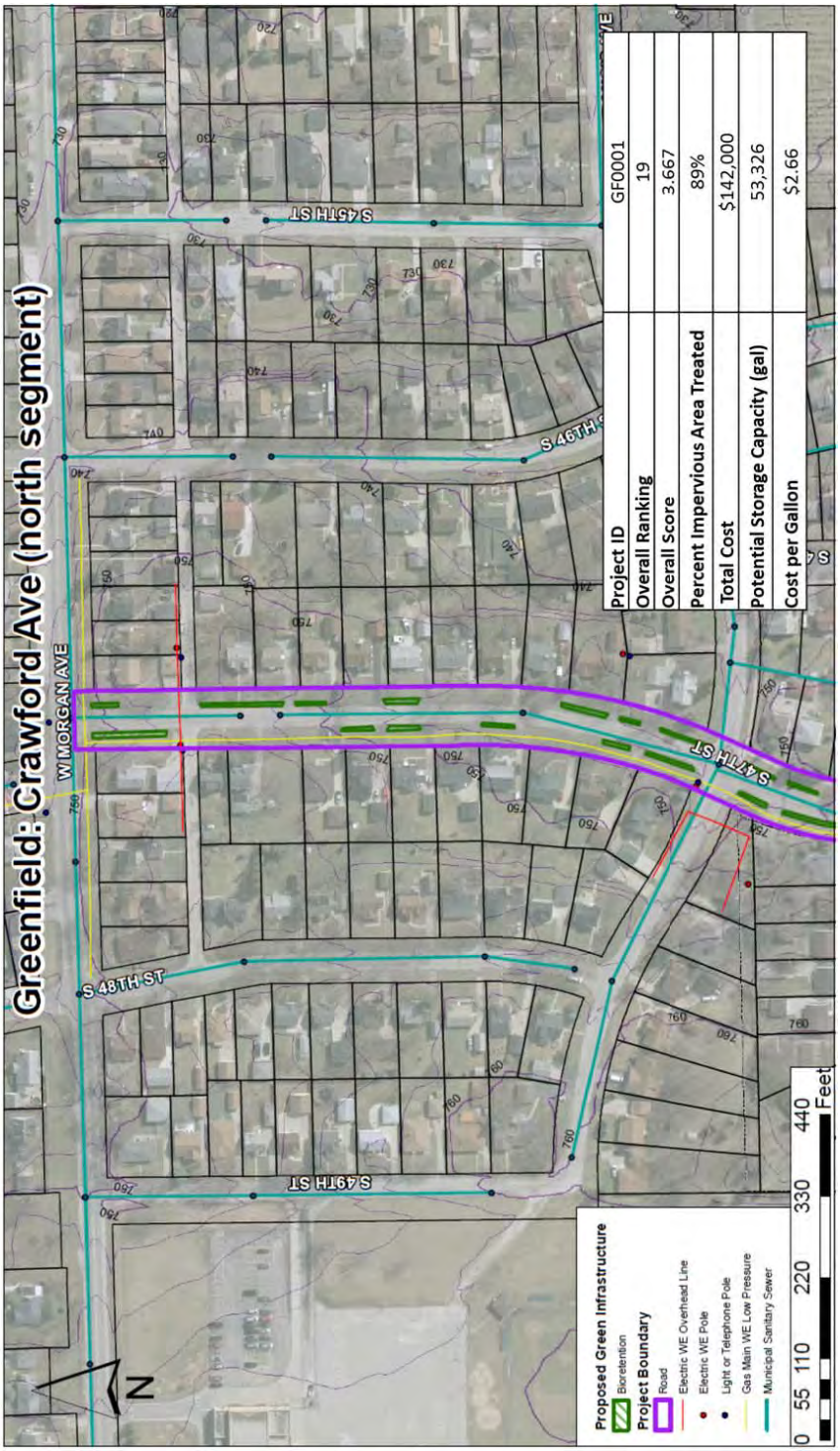
Project ID	GF0004
Overall Ranking	6
Overall Score	4.286
Percent Impervious Area Treated	100%
Total Cost	$59,000
Potential Storage Capacity (gal)	22,076
Cost per Gallon	$2.67

21



Project ID	GF0002
Overall Ranking	8
Overall Score	4.15
Percent Impervious Area Treated	45%
Total Cost	$87,000
Potential Storage Capacity (gal)	32,727
Cost per Gallon	$2.66

23

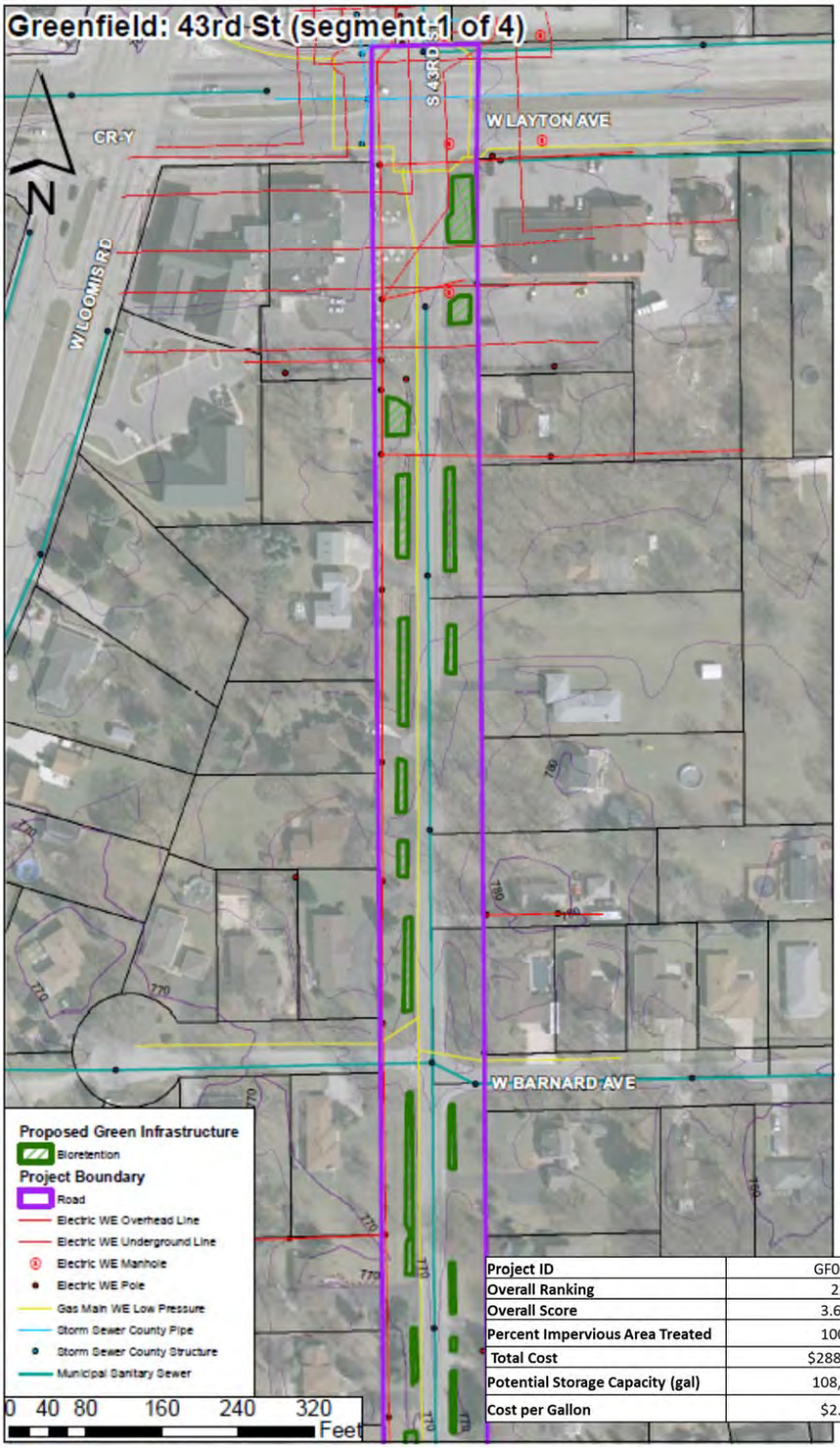


Project ID	GF0001
Overall Ranking	19
Overall Score	3.667
Percent Impervious Area Treated	89%
Total Cost	$142,000
Potential Storage Capacity (gal)	53,326
Cost per Gallon	$2.66

25

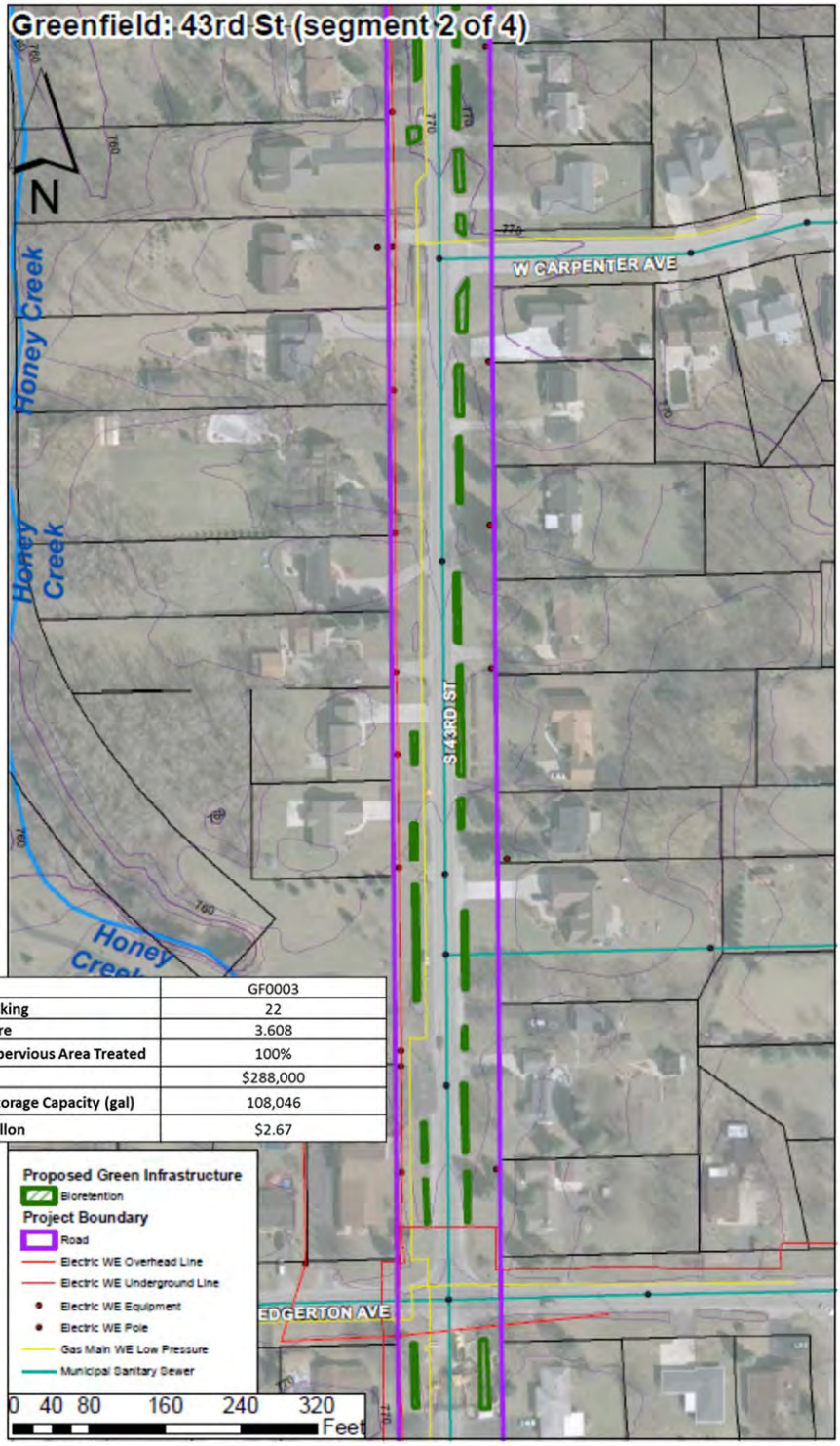
Greenfield: Crawford Ave (south segment)
Project ID GF0001
Overall Ranking 19
Overall Score 3.667
Percent Impervious Area Treated 89%
Total Cost $142,000
Potential Storage Capacity (gal) 53,326
Cost per Gallon $2.66
S 46TH ST
W WILBUR AVE
S 47TH ST
W CRAWFORD AVE
S 48TH ST
S 45TH ST
Proposed Green Infrastructure
Bioretention
Project Boundary
Road
Electric WE Overhead Line
Electric WE Pole
Light or Telephone Pole
Gas Main WE Low Pressure
Municipal Sanitary Sewer
0 55 110 220 330 440
Feet
N

27



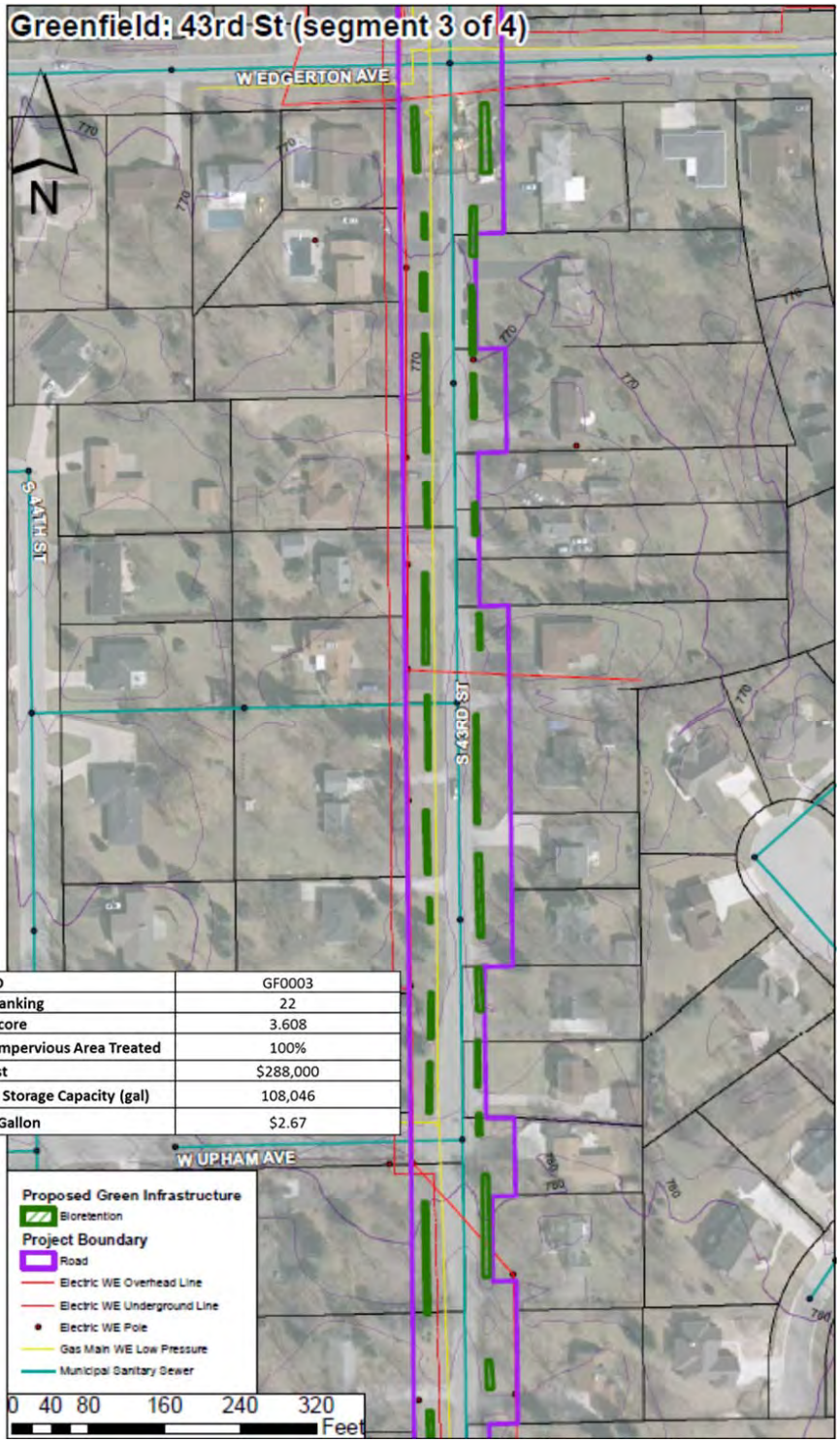
Project ID	GF0003
Overall Ranking	22
Overall Score	3.608
Percent Impervious Area Treated	100%
Total Cost	$288,000
Potential Storage Capacity (gal)	108,046
Cost per Gallon	$2.67

29



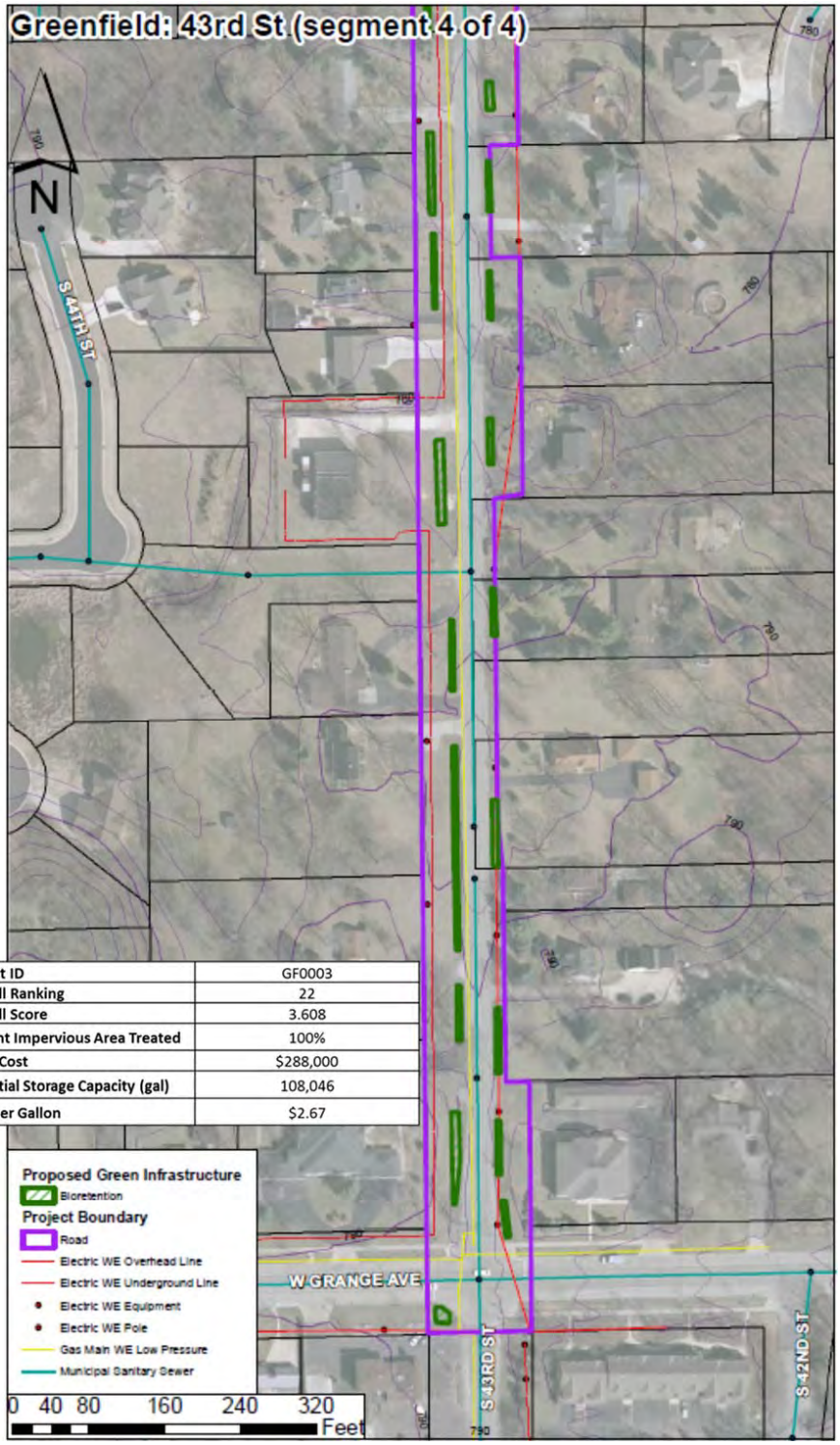
Project ID	GF0003
Overall Ranking	22
Overall Score	3.608
Percent Impervious Area Treated	100%
Total Cost	$288,000
Potential Storage Capacity (gal)	108,046
Cost per Gallon	$2.67

31



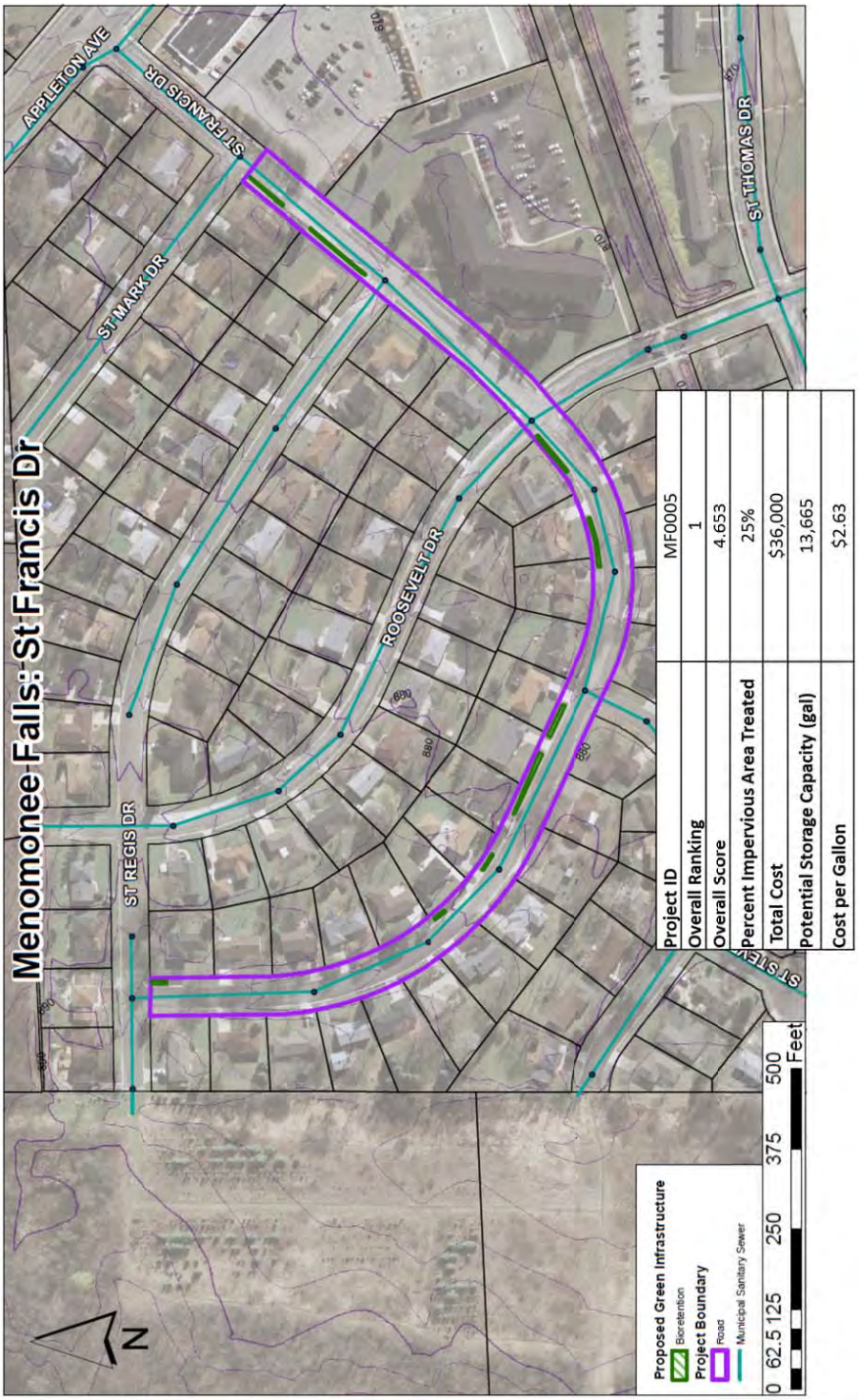
Project ID	GF0003
Overall Ranking	22
Overall Score	3.608
Percent Impervious Area Treated	100%
Total Cost	$288,000
Potential Storage Capacity (gal)	108,046
Cost per Gallon	$2.67

33



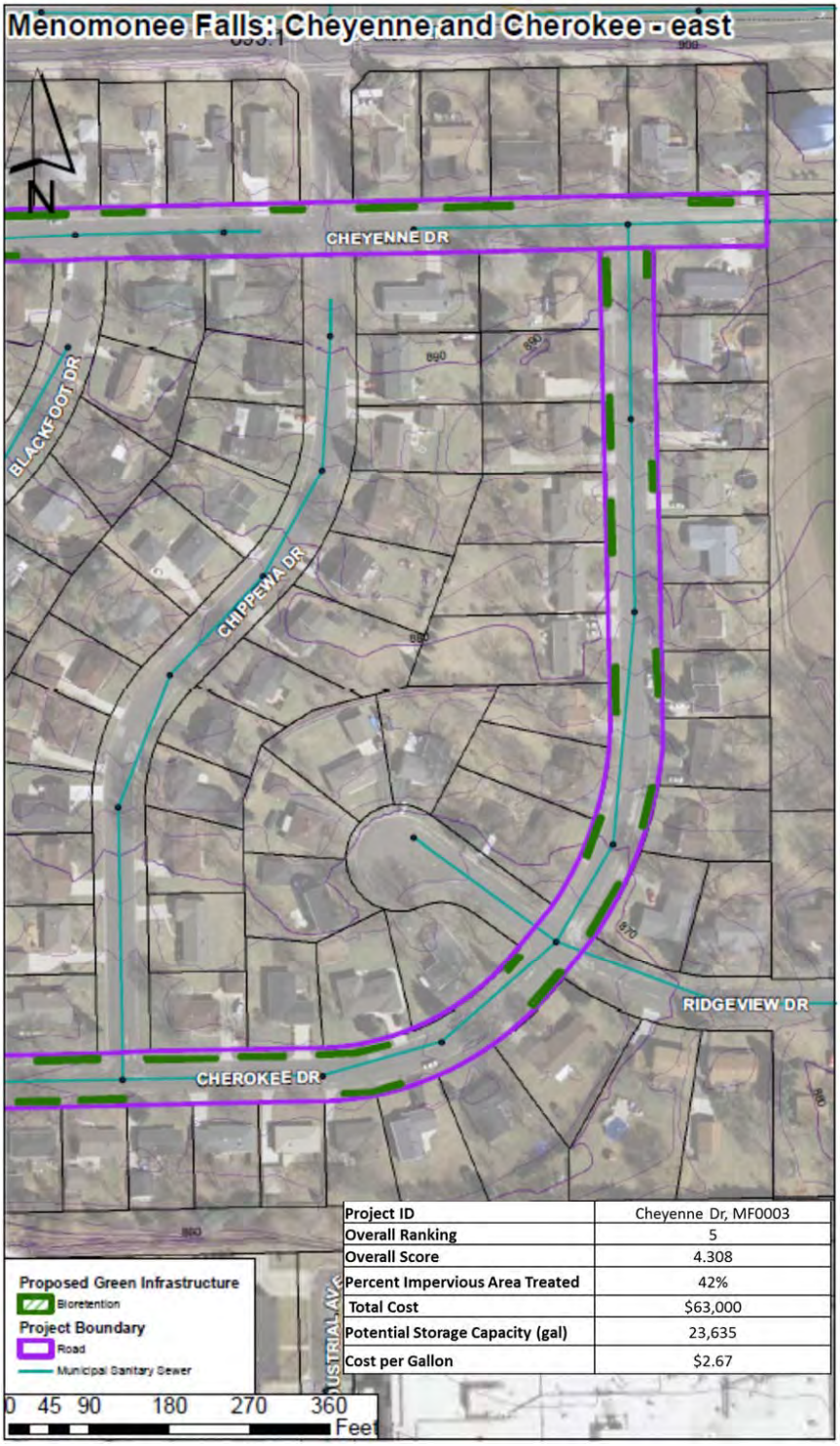
Project ID	GF0003
Overall Ranking	22
Overall Score	3.608
Percent Impervious Area Treated	100%
Total Cost	$288,000
Potential Storage Capacity (gal)	108,046
Cost per Gallon	$2.67

35



Project ID	MF0005
Overall Ranking	1
Overall Score	4.653
Percent Impervious Area Treated	25%
Total Cost	$36,000
Potential Storage Capacity (gal)	13,665
Cost per Gallon	$2.63

37

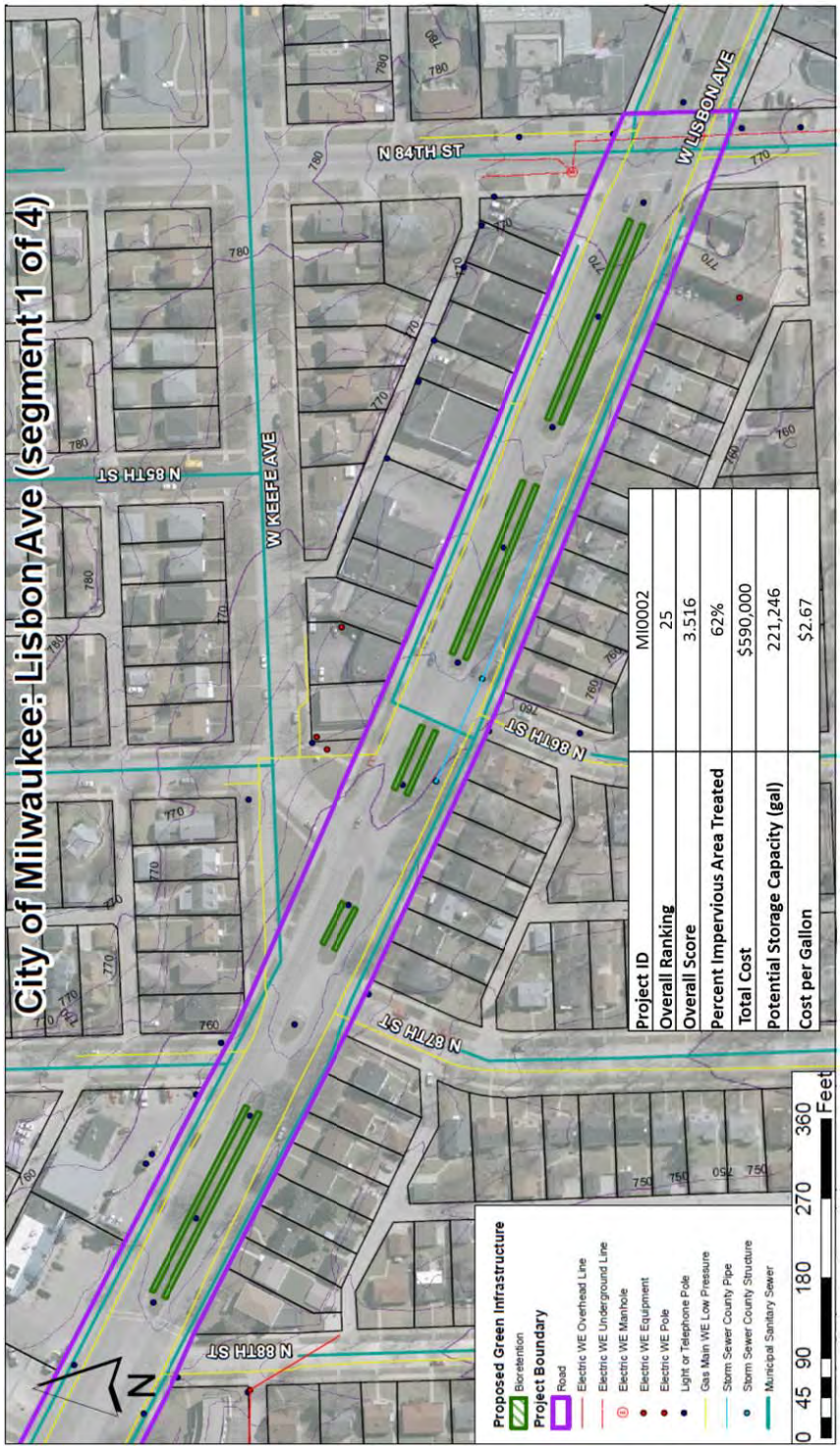


Project ID	Cheyenne Dr, MF0003
Overall Ranking	5
Overall Score	4.308
Percent Impervious Area Treated	42%
Total Cost	$63,000
Potential Storage Capacity (gal)	23,635
Cost per Gallon	$2.67

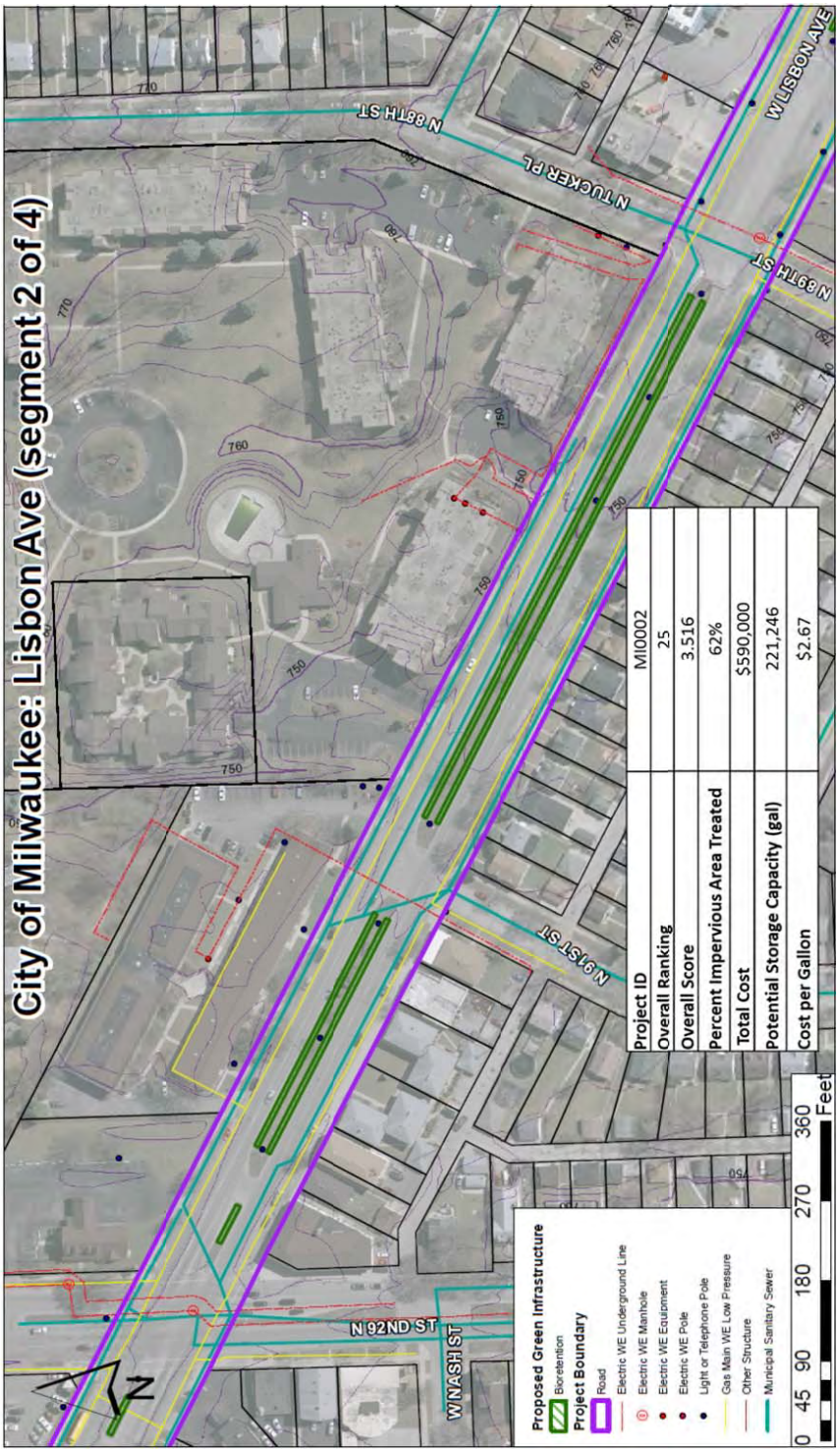
39

Project ID	Cherokee Dr, MF0002
Overall Ranking	10
Overall Score	3.986
Percent Impervious Area Treated	64%
Total Cost	$103,000
Potential Storage Capacity (gal)	38,526
Cost per Gallon	$2.67

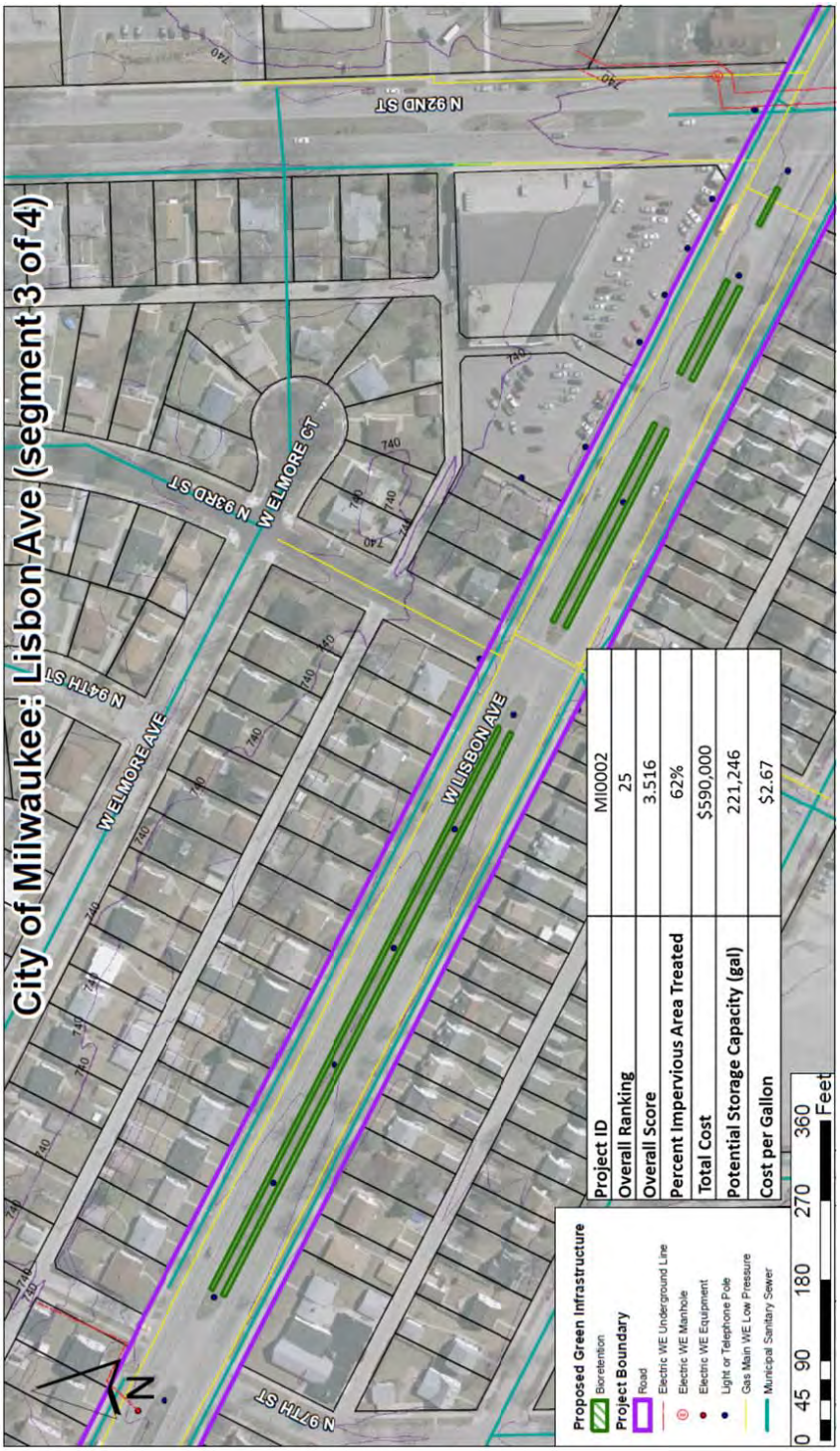
41


City of Milwaukee: Lisbon Ave (segment 1 of 4)
N 85TH ST
W KEEFE AVE
N 84TH ST
W LISBON AVE
N 86TH ST
N 87TH ST
N 88TH ST
N
Proposed Green Infrastructure
Bioretention
Project Boundary
Road
Electric WE Overhead Line
Electric WE Underground Line
Electric WE Manhole
Electric WE Equipment
Electric WE Pole
Light or Telephone Pole
Gas Main WE Low Pressure
Storm Sewer County Pipe
Storm Sewer County Structure
Municipal Sanitary Sewer
0 45 90 180 270 360
Feet
Project ID MI0002
Overall Ranking 25
Overall Score 3.516
Percent Impervious Area Treated 62%
Total Cost $590,000
Potential Storage Capacity (gal) 221,246
Cost per Gallon $2.67

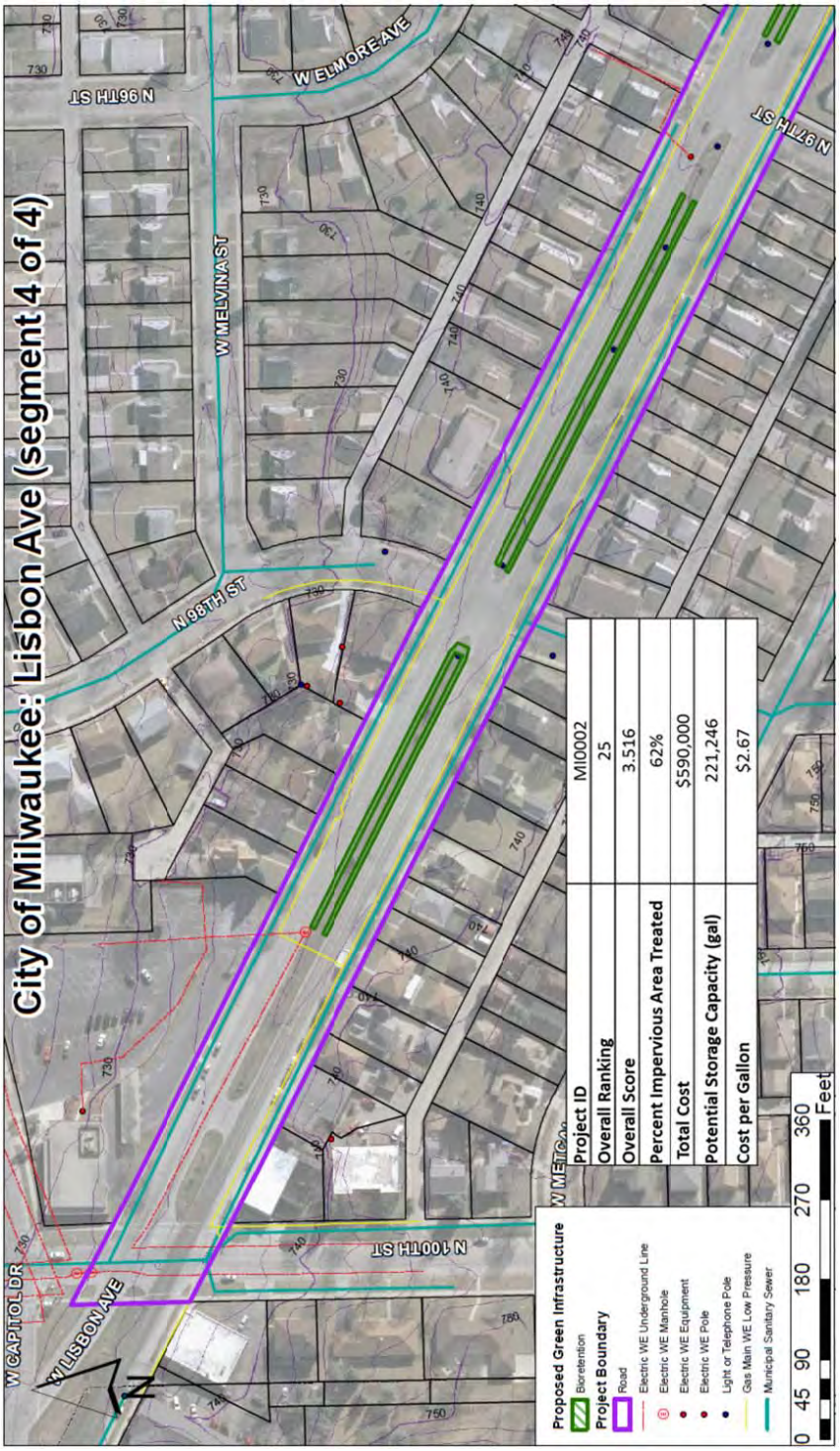
43


City of Milwaukee: Lisbon Ave (segment 2 of 4)
N 88TH ST
N TUCKER PL
W LISBON AVE
N 89TH ST
N 91ST ST
N 92ND ST
W NASH ST
N
Proposed Green Infrastructure
Bioretention
Project Boundary
Road
Electric WE Underground Line
Electric WE Manhole
Electric WE Equipment
Electric WE Pole
Light or Telephone Pole
Gas Main WE Low Pressure
Other Structure
Municipal Sanitary Sewer
0 45 90 180 270 360
Feet
Project ID | MI0002
Overall Ranking | 25
Overall Score | 3.516
Percent Impervious Area Treated | 62%
Total Cost | $590,000
Potential Storage Capacity (gal) | 221,246
Cost per Gallon | $2.67

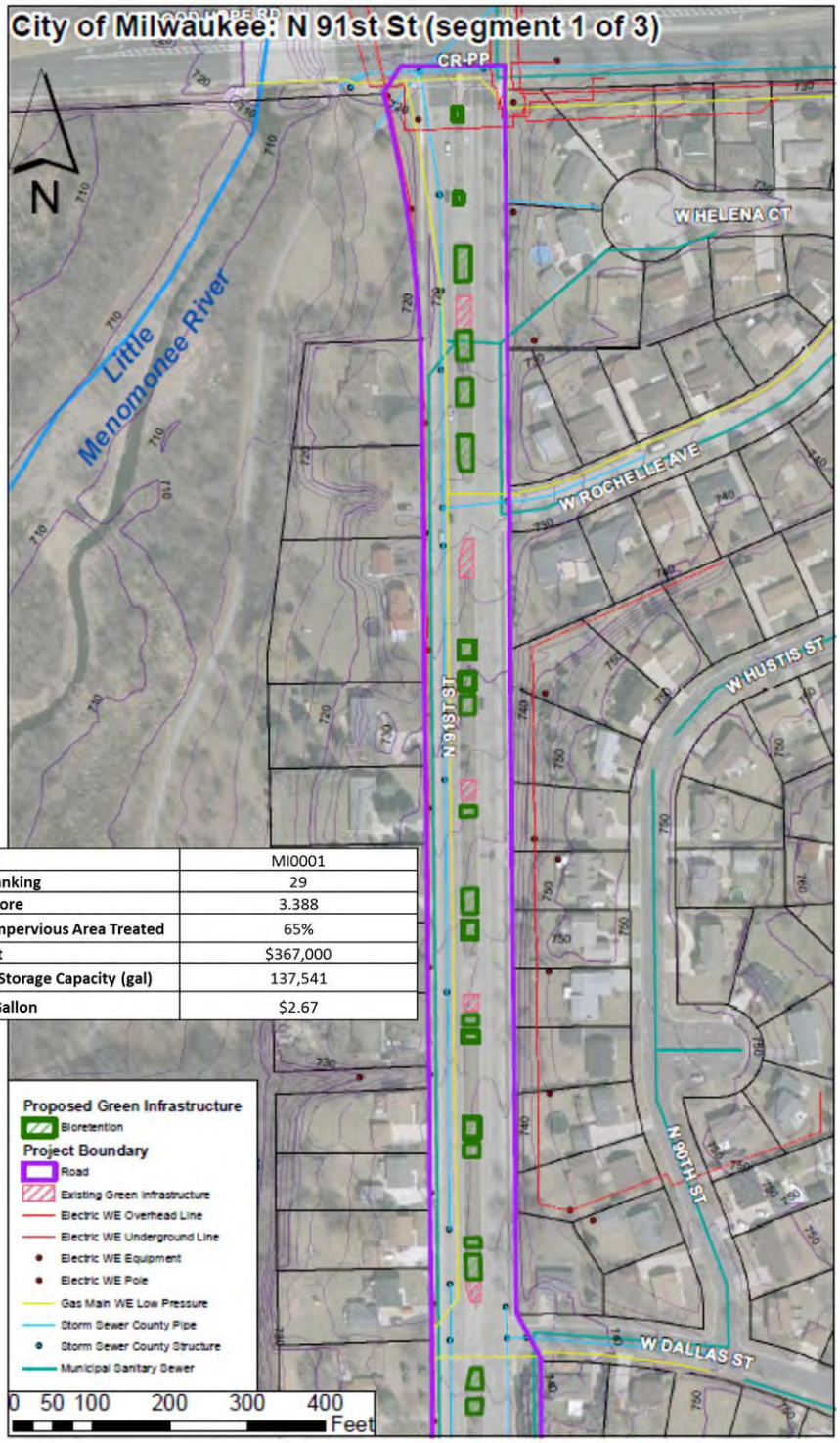
45


City of Milwaukee: Lisbon Ave (segment 3 of 4)
N 92ND ST
W ELMORE CT
N 93RD ST
N 94TH ST
W ELMORE AVE
W LISBON AVE
N 97TH ST
740
Project ID
MI0002
Overall Ranking
25
Overall Score
3.516
Percent Impervious Area Treated
62%
Total Cost
$590,000
Potential Storage Capacity (gal)
221,246
Cost per Gallon
$2.67
Proposed Green Infrastructure
Bioretention
Project Boundary
Road
Electric WE Underground Line
Electric WE Manhole
Electric WE Equipment
Light or Telephone Pole
Gas Main WE Low Pressure
Municipal Sanitary Sewer
0 45 90 180 270 360
Feet
N

47

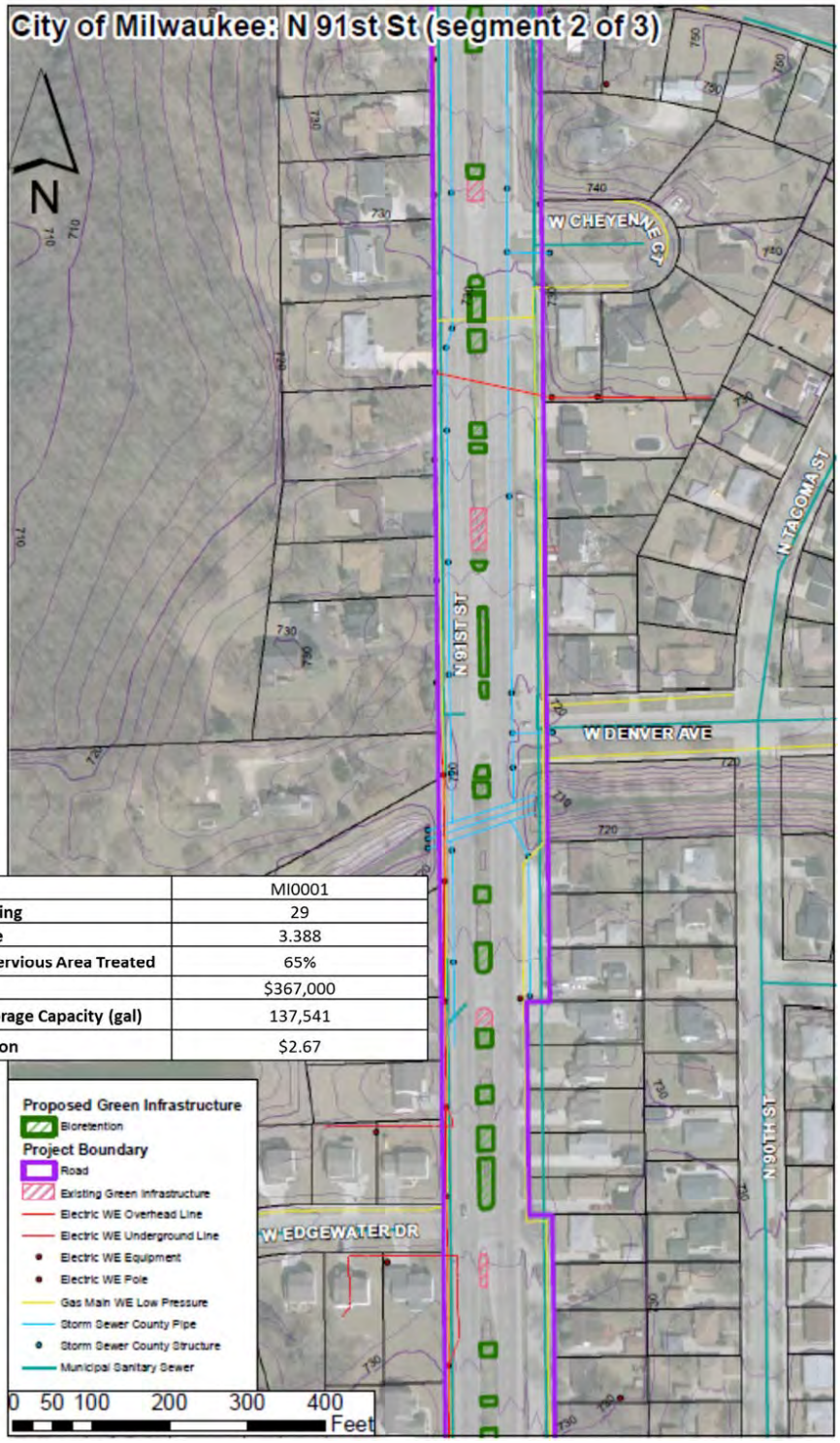

City of Milwaukee: Lisbon Ave (segment 4 of 4)
W CAPITOL DR
W LISBON AVE
N 100TH ST
N 98TH ST
W MELVINA ST
N 96TH ST
W ELMORE AVE
N 97TH ST
Proposed Green Infrastructure
Bioretention
Project Boundary
Road
Electric WE Underground Line
Electric WE Manhole
Electric WE Equipment
Electric WE Pole
Light or Telephone Pole
Gas Main WE Low Pressure
Municipal Sanitary Sewer
0 45 90 180 270 360
Feet
Project ID MI0002
Overall Ranking 25
Overall Score 3.516
Percent Impervious Area Treated 62%
Total Cost $590,000
Potential Storage Capacity (gal) 221,246
Cost per Gallon $2.67

49



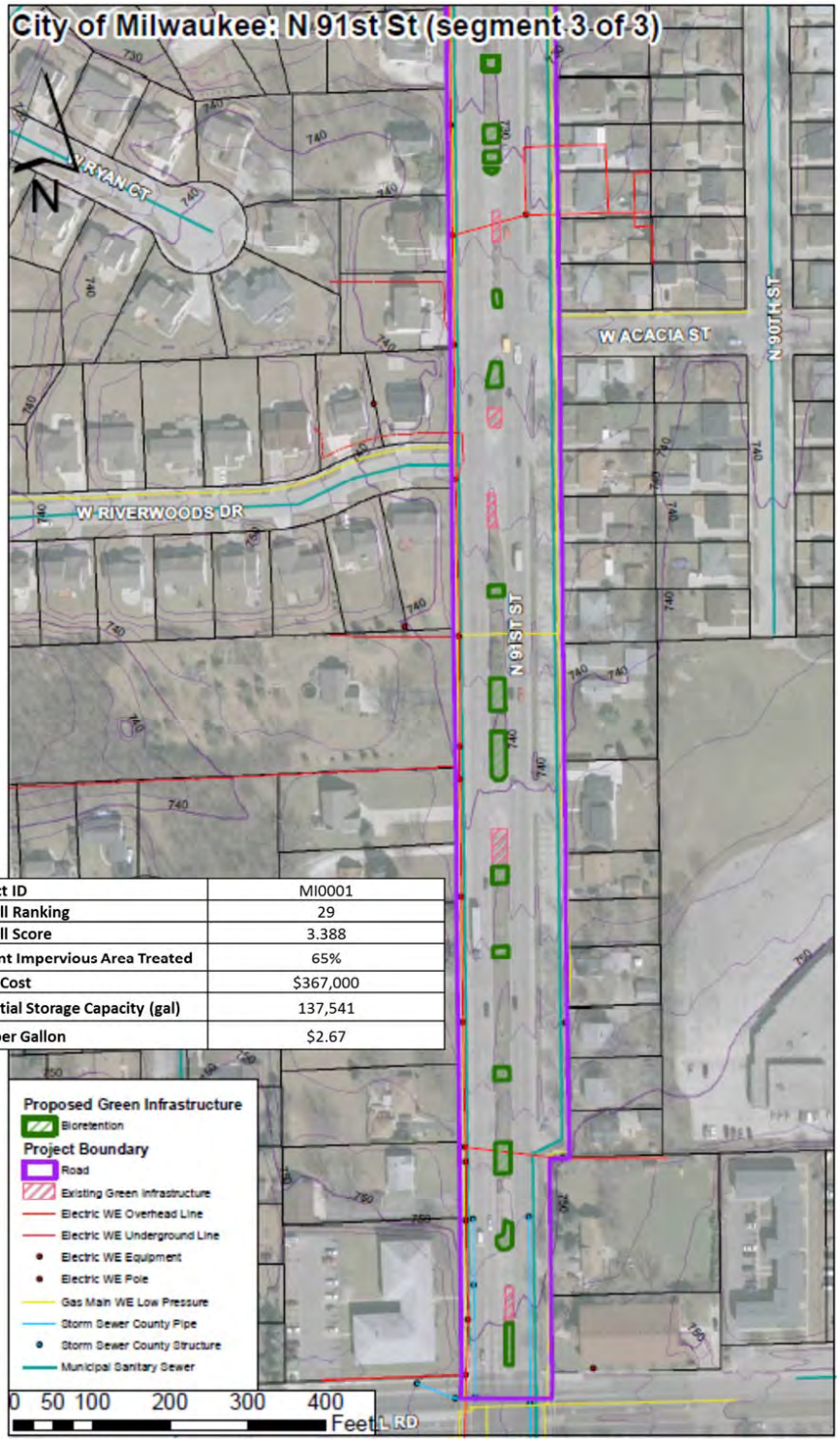
Project ID	MI0001
Overall Ranking	29
Overall Score	3.388
Percent Impervious Area Treated	65%
Total Cost	$367,000
Potential Storage Capacity (gal)	137,541
Cost per Gallon	$2.67

51



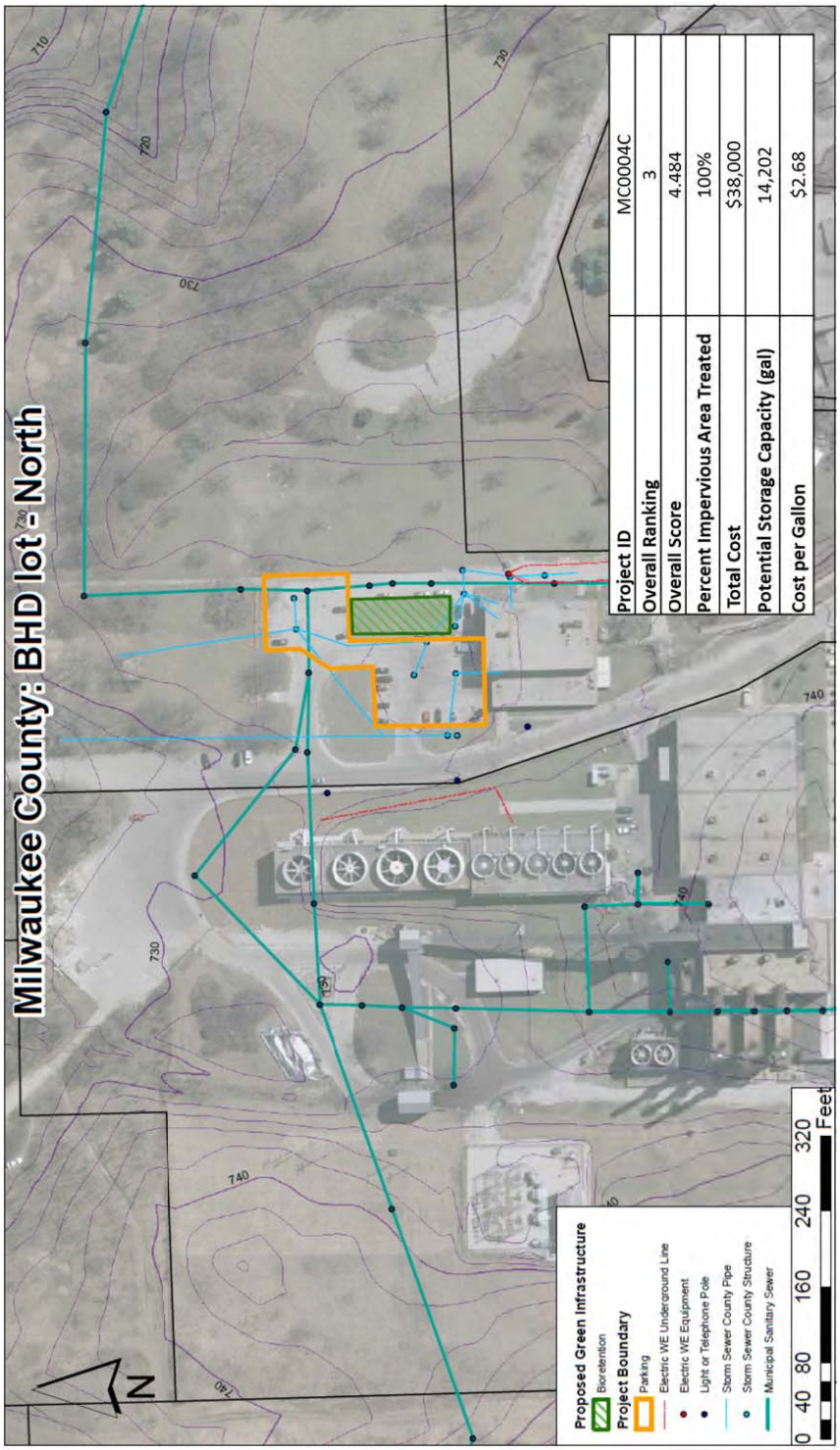
Project ID	MI0001
Overall Ranking	29
Overall Score	3.388
Percent Impervious Area Treated	65%
Total Cost	$367,000
Potential Storage Capacity (gal)	137,541
Cost per Gallon	$2.67

53

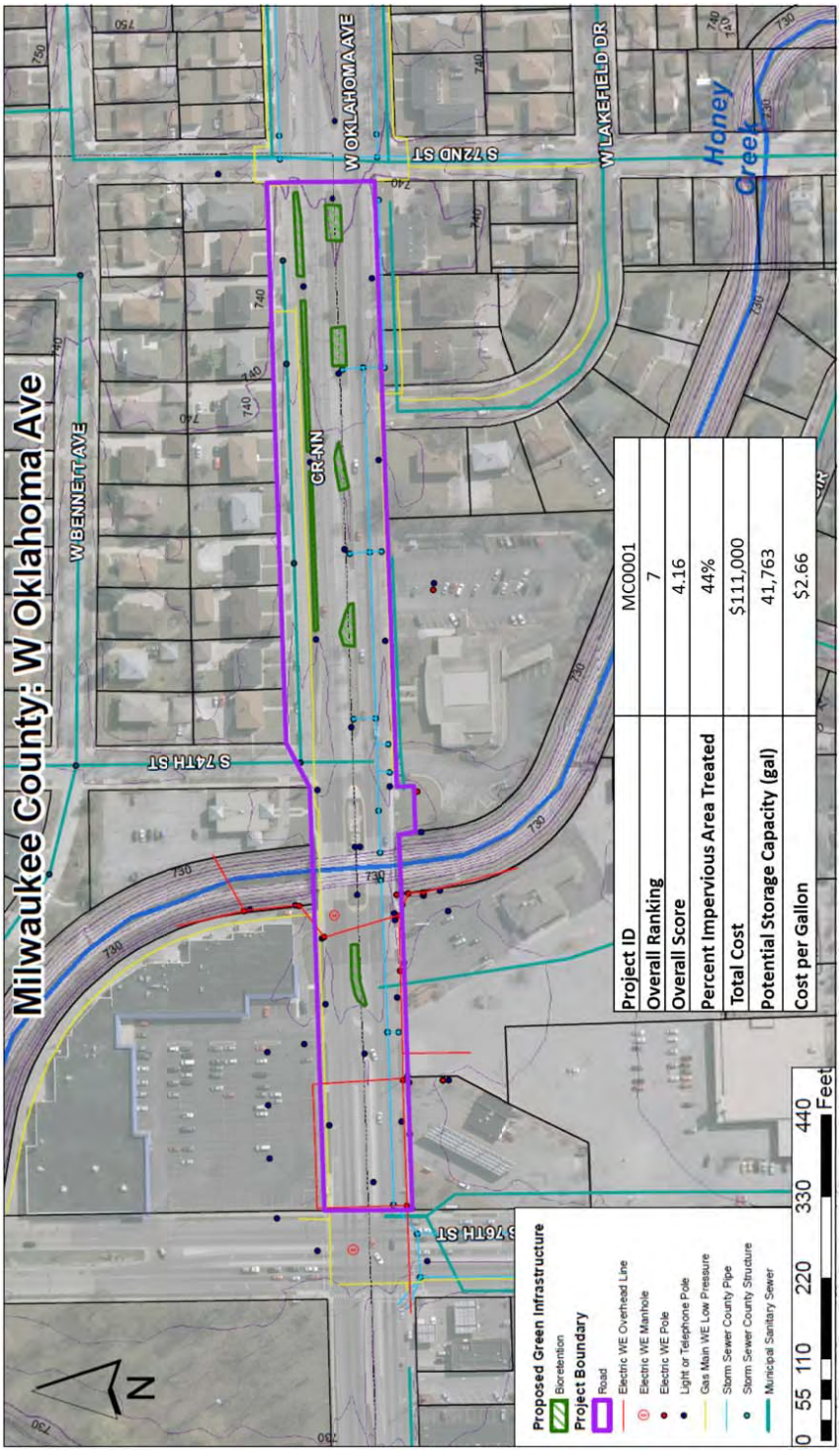


Project ID	MI0001
Overall Ranking	29
Overall Score	3.388
Percent Impervious Area Treated	65%
Total Cost	$367,000
Potential Storage Capacity (gal)	137,541
Cost per Gallon	$2.67

55

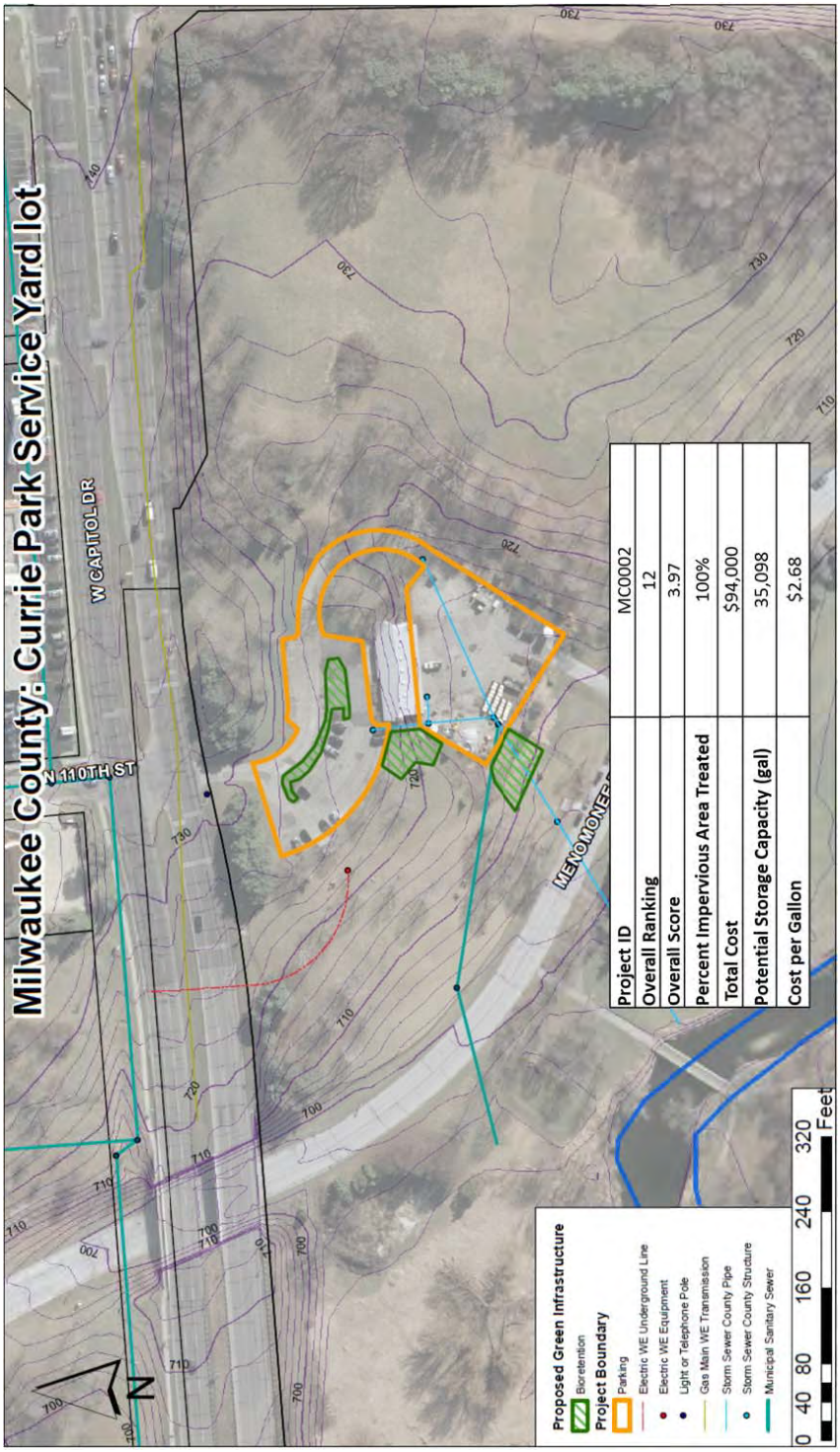

Milwaukee County: BHD lot - North
Project ID
MC0004C
Overall Ranking
3
Overall Score
4.484
Percent Impervious Area Treated
100%
Total Cost
$38,000
Potential Storage Capacity (gal)
14,202
Cost per Gallon
$2.68
Proposed Green Infrastructure
Bioretention
Project Boundary
Parking
Electric WE Underground Line
Electric WE Equipment
Light or Telephone Pole
Storm Sewer County Pipe
Storm Sewer County Structure
Municipal Sanitary Sewer
0 40 80 160 240 320
Feet
N
710
720
730
740

57

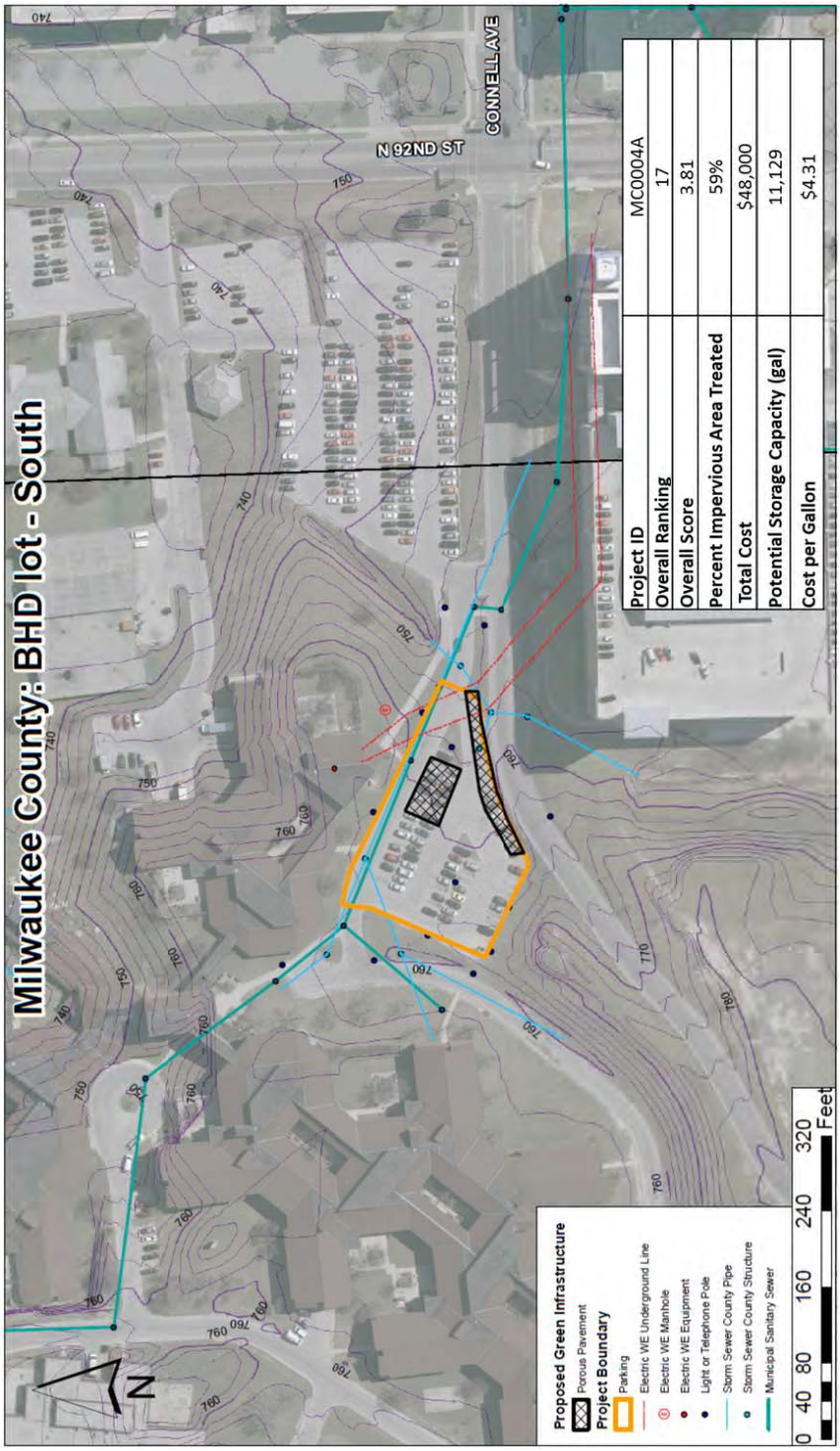


Project ID	MC0001
Overall Ranking	7
Overall Score	4.16
Percent Impervious Area Treated	44%
Total Cost	$111,000
Potential Storage Capacity (gal)	41,763
Cost per Gallon	$2.66

59

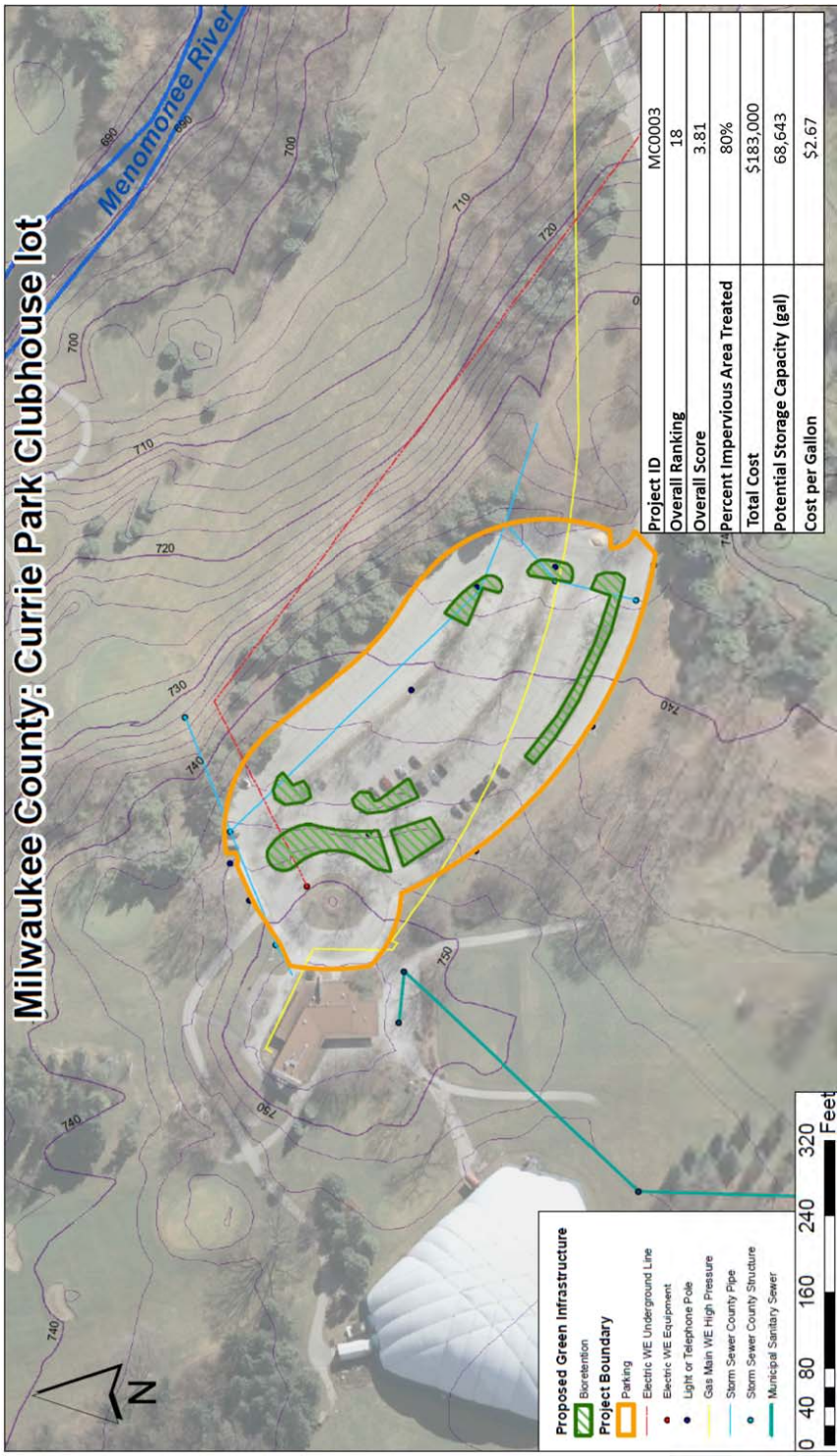

Milwaukee County: Currie Park Service Yard lot
N 110TH ST
W CAPITOL DR
MENOMONEE
Proposed Green Infrastructure
Bioretention
Project Boundary
Parking
Electric WE Underground Line
Electric WE Equipment
Light or Telephone Pole
Gas Main WE Transmission
Storm Sewer County Pipe
Storm Sewer County Structure
Municipal Sanitary Sewer
0 40 80 160 240 320
Feet
N
Project ID MC0002
Overall Ranking 12
Overall Score 3.97
Percent Impervious Area Treated 100%
Total Cost $94,000
Potential Storage Capacity (gal) 35,098
Cost per Gallon $2.68

61



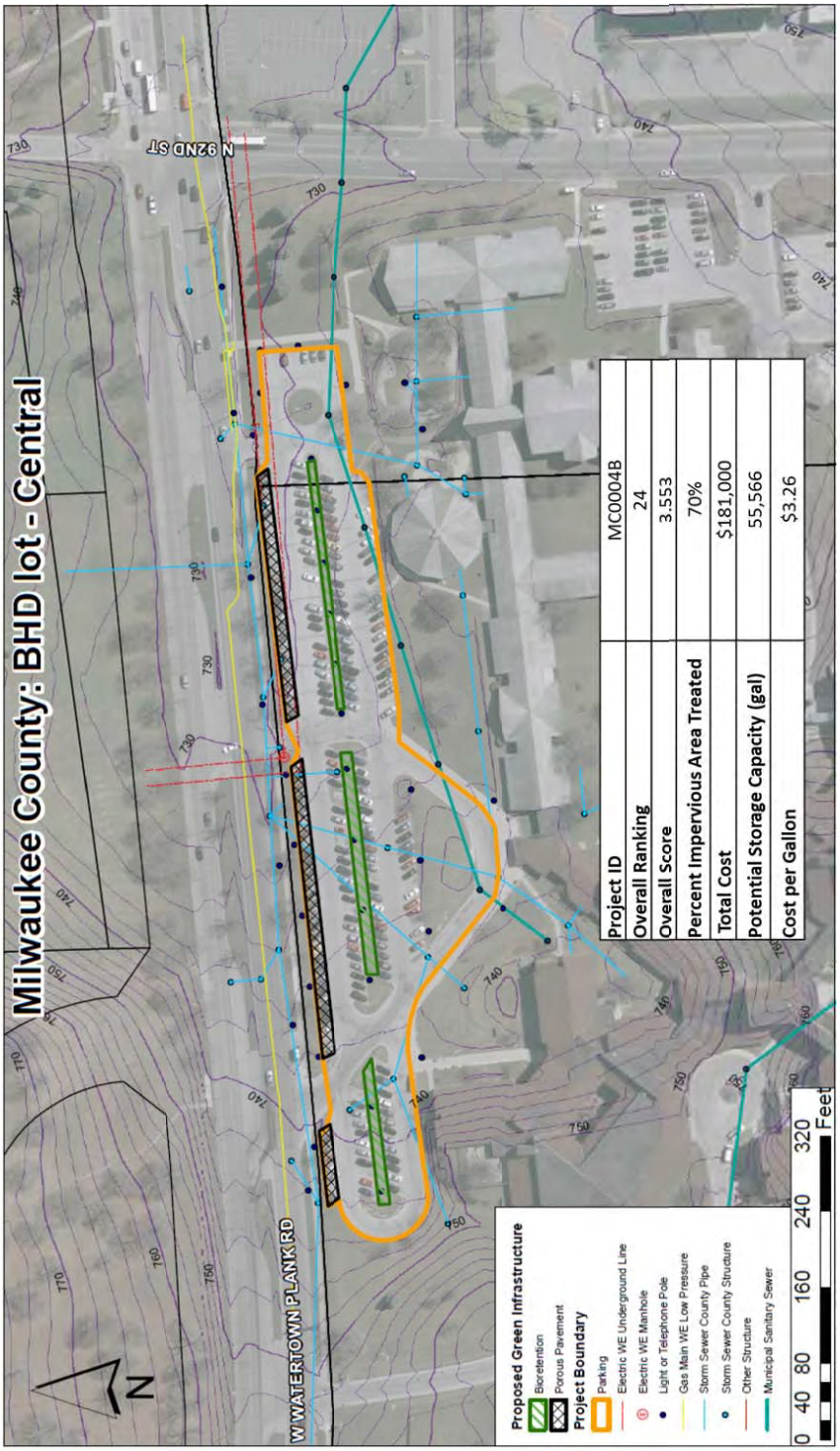
Project ID	MC0004A
Overall Ranking	17
Overall Score	3.81
Percent Impervious Area Treated	59%
Total Cost	$48,000
Potential Storage Capacity (gal)	11,129
Cost per Gallon	$4.31

63

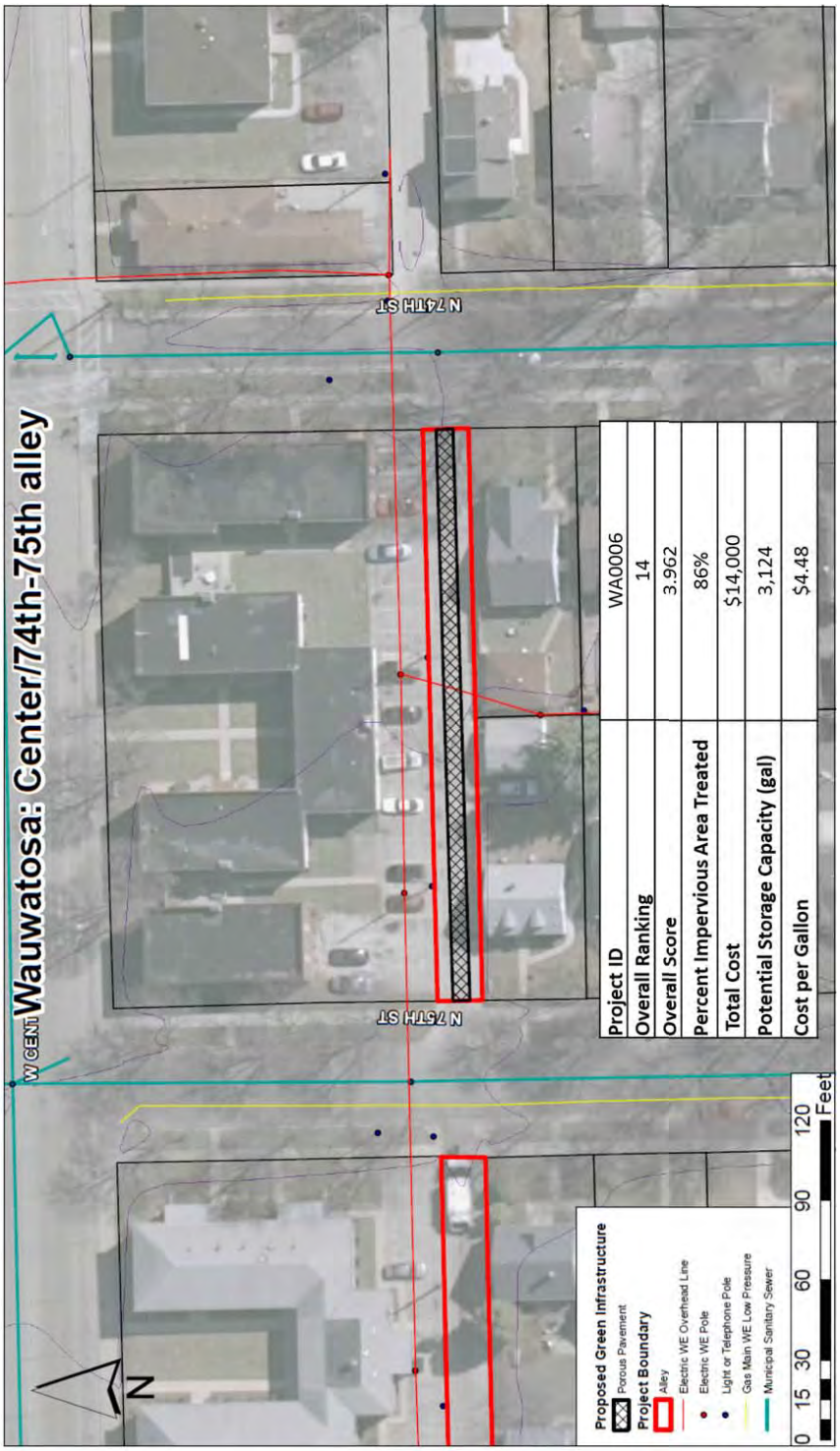


Project ID	MC0003
Overall Ranking	18
Overall Score	3.81
Percent Impervious Area Treated	80%
Total Cost	$183,000
Potential Storage Capacity (gal)	68,643
Cost per Gallon	$2.67

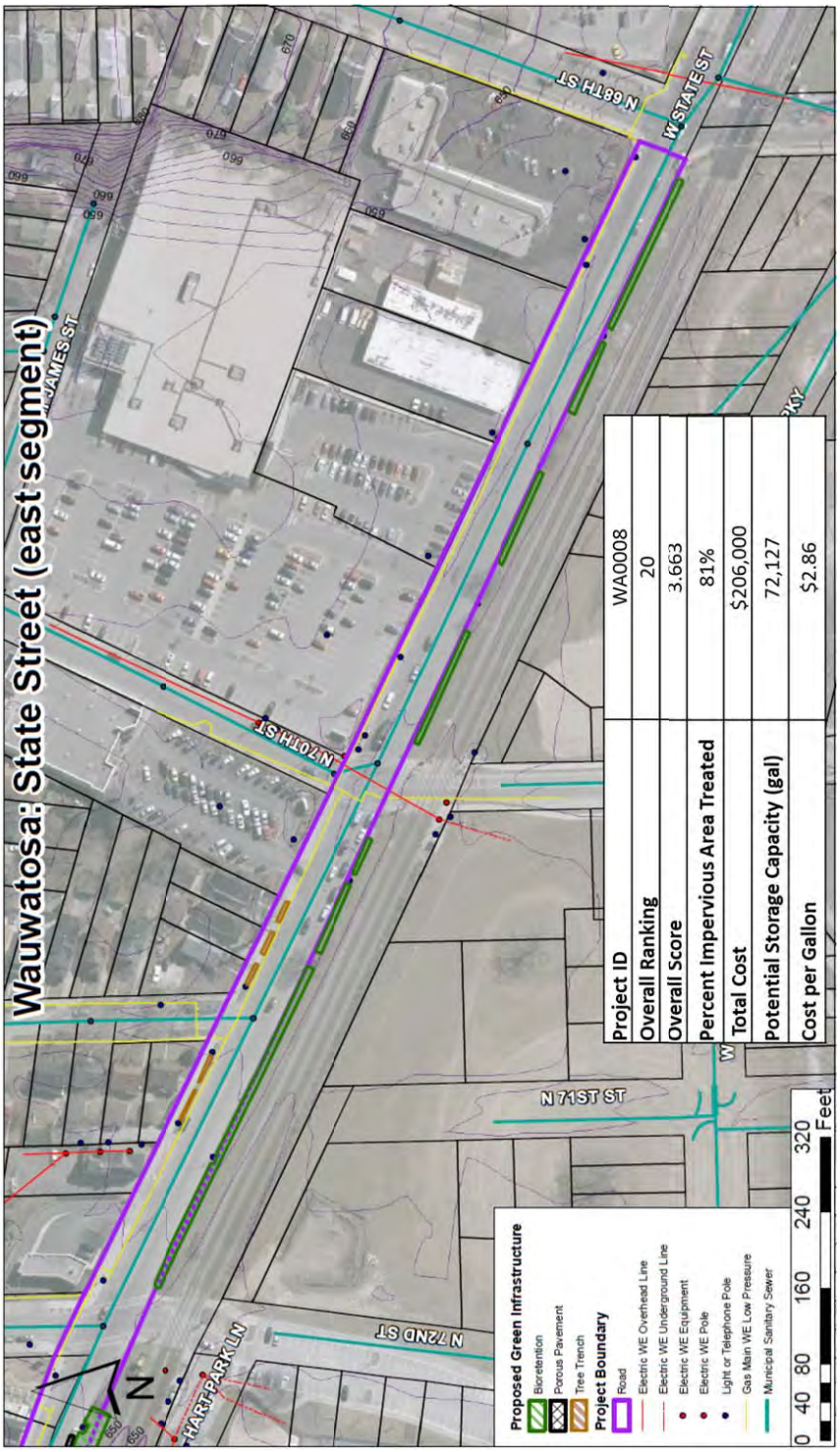
65

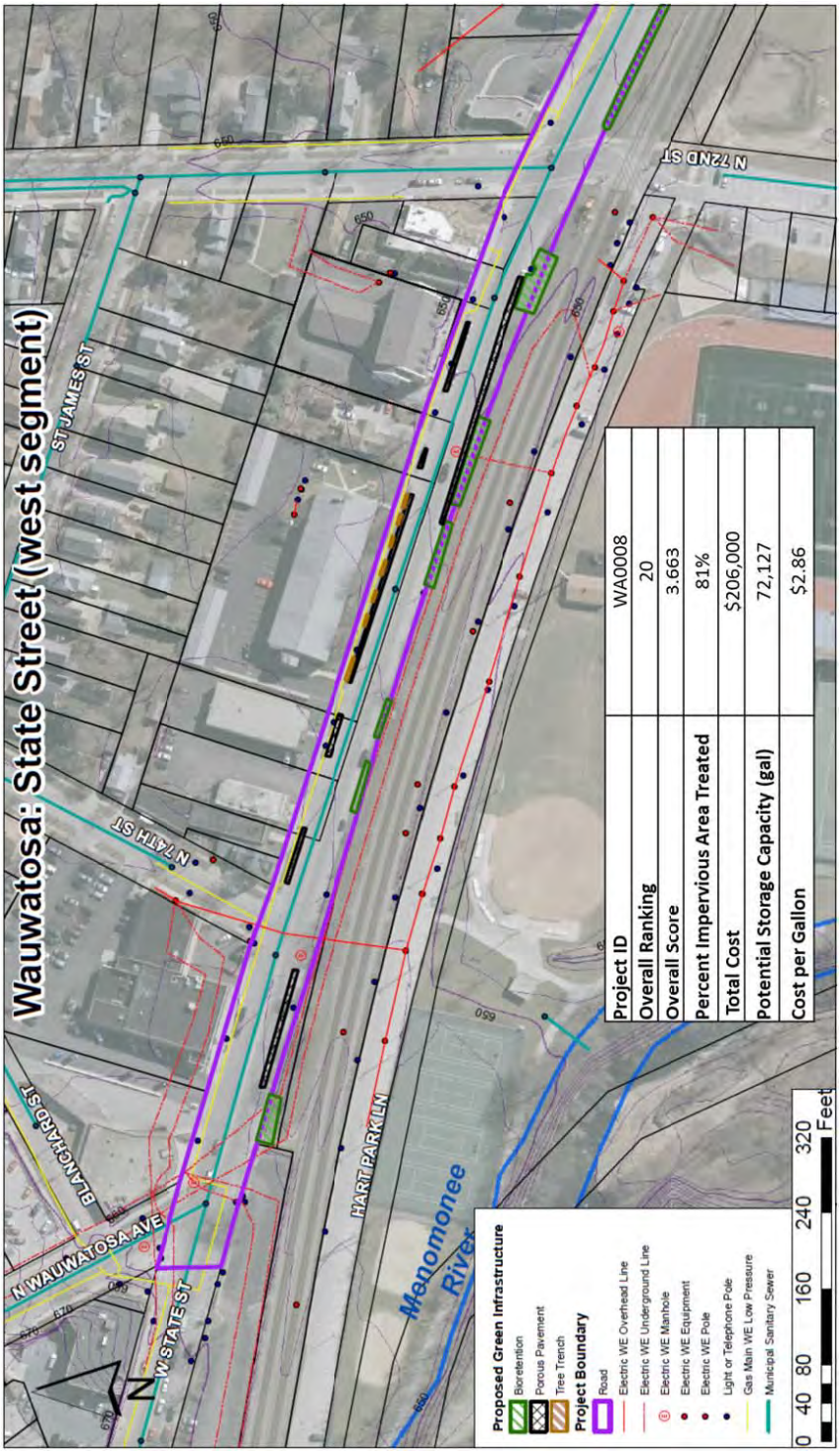

Milwaukee County: BHD lot - Central
N 92ND ST
W WATERTOWN PLANK RD
N
Proposed Green Infrastructure
Bioretention
Porous Pavement
Project Boundary
Parking
Electric WE Underground Line
Electric WE Manhole
Light or Telephone Pole
Gas Main WE Low Pressure
Storm Sewer County Pipe
Storm Sewer County Structure
Other Structure
Municipal Sanitary Sewer
0 40 80 160 240 320
Feet
Project ID MC0004B
Overall Ranking 24
Overall Score 3.553
Percent Impervious Area Treated 70%
Total Cost $181,000
Potential Storage Capacity (gal) 55,566
Cost per Gallon $3.26

67

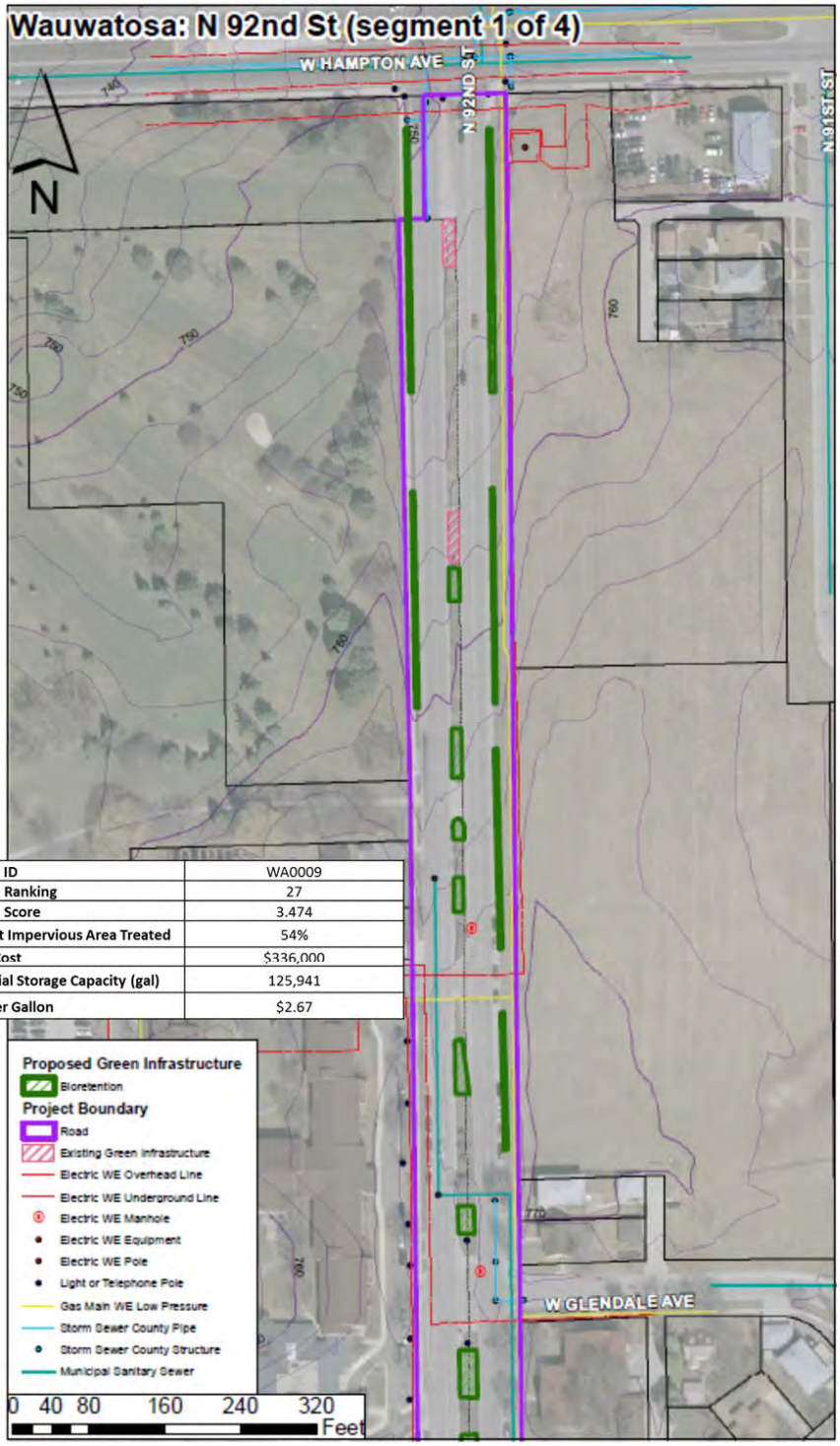

Wauwatosa: Center/74th-75th alley
W CENT
N 75TH ST
N 74TH ST
N
Proposed Green Infrastructure
Porous Pavement
Project Boundary
Alley
Electric WE Overhead Line
Electric WE Pole
Light or Telephone Pole
Gas Main WE Low Pressure
Municipal Sanitary Sewer
0 15 30 60 90 120
Feet
Project ID WA0006
Overall Ranking 14
Overall Score 3.962
Percent Impervious Area Treated 86%
Total Cost $14,000
Potential Storage Capacity (gal) 3,124
Cost per Gallon $4.48

69


Wauwatosa: State Street (east segment)
Project ID
WA0008
Overall Ranking
20
Overall Score
3.663
Percent Impervious Area Treated
81%
Total Cost
$206,000
Potential Storage Capacity (gal)
72,127
Cost per Gallon
$2.86
Proposed Green Infrastructure
Bioretention
Porous Pavement
Tree Trench
Project Boundary
Road
Electric WE Overhead Line
Electric WE Underground Line
Electric WE Equipment
Electric WE Pole
Light or Telephone Pole
Gas Main WE Low Pressure
Municipal Sanitary Sewer
0 40 80 160 240 320 Feet
N
N JAMES ST
N 70TH ST
N 68TH ST
W STATE ST
N 71ST ST
N 72ND ST
HART PARK LN

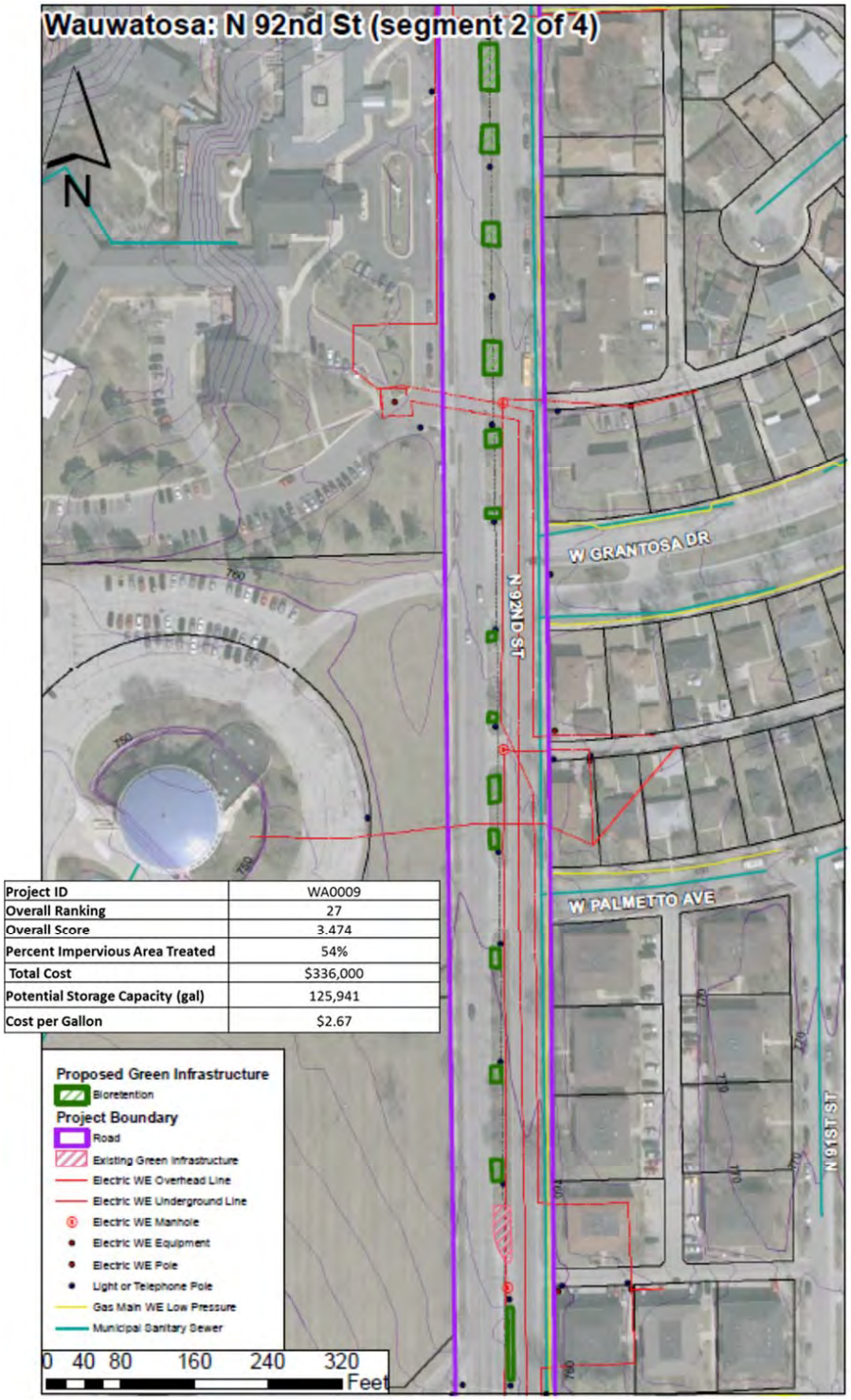

Wauwatosa: State Street (West segment)
ST JAMES ST
N 74TH ST
BLANCHARD ST
N WAUWATOSA AVE
W STATE ST
HARTI PARK LN
N 72ND ST
Menomonee River
Proposed Green Infrastructure
Bioretention
Porous Pavement
Tree Trench
Project Boundary
Road
Electric WE Overhead Line
Electric WE Underground Line
Electric WE Manhole
Electric WE Equipment
Electric WE Pole
Light or Telephone Pole
Gas Main WE Low Pressure
Municipal Sanitary Sewer
0 40 80 160 240 320
Feet
Project ID WA0008
Overall Ranking 20
Overall Score 3.663
Percent Impervious Area Treated 81%
Total Cost $206,000
Potential Storage Capacity (gal) 72,127
Cost per Gallon $2.86

73



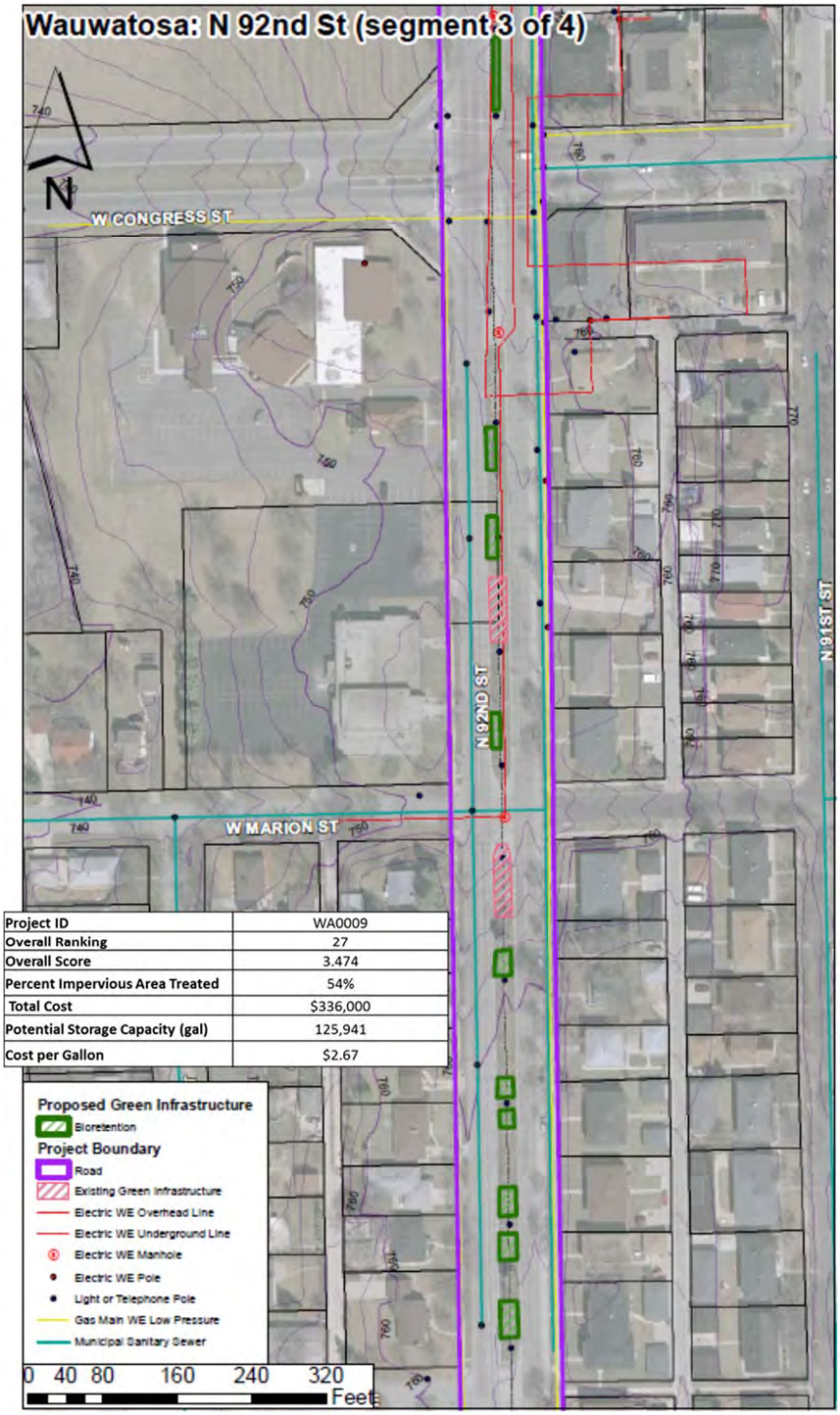
Project ID	WA0009
Overall Ranking	27
Overall Score	3.474
Percent Impervious Area Treated	54%
Total Cost	$336,000
Potential Storage Capacity (gal)	125,941
Cost per Gallon	$2.67

75



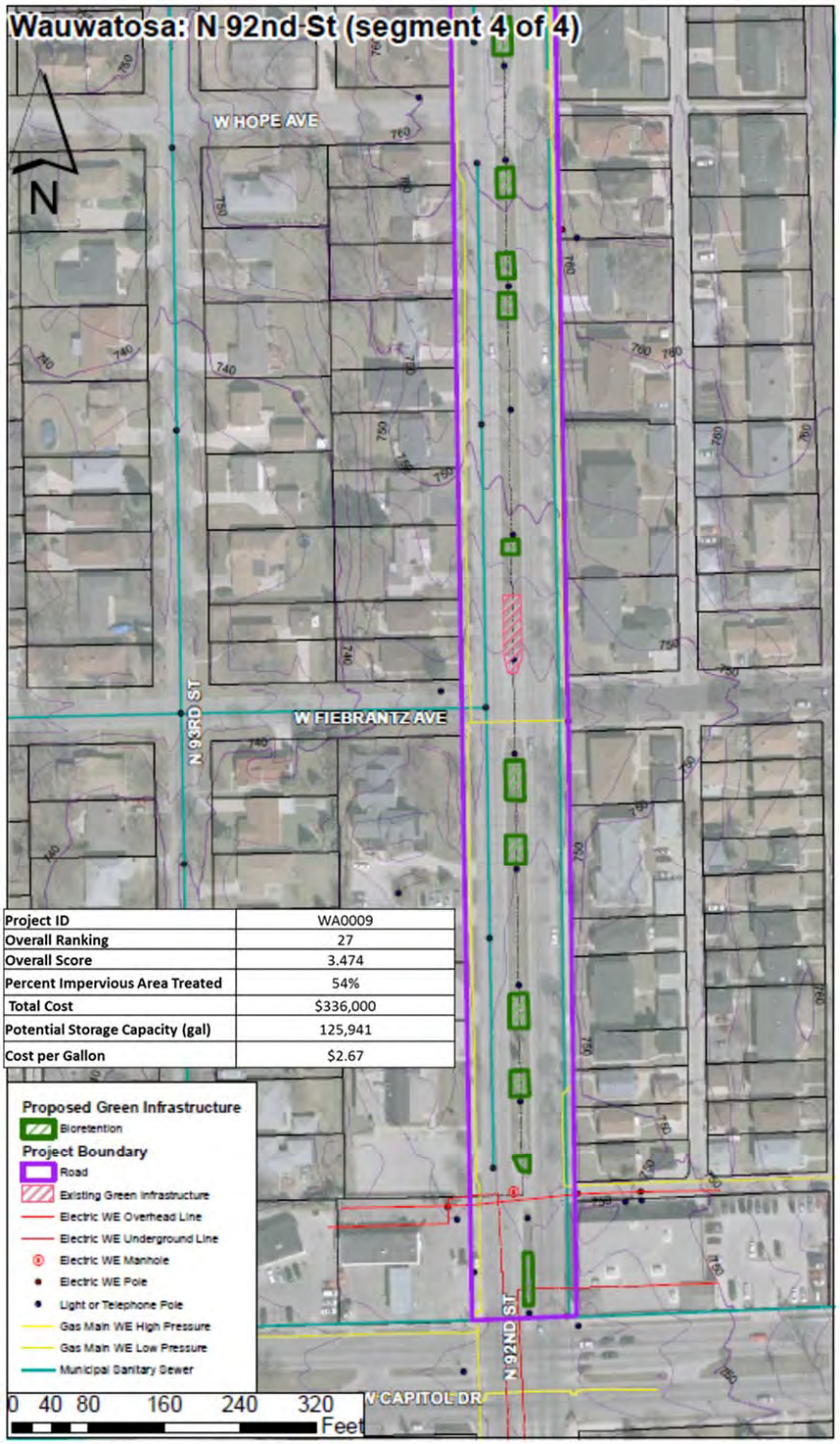
Project ID	WA0009
Overall Ranking	27
Overall Score	3.474
Percent Impervious Area Treated	54%
Total Cost	$336,000
Potential Storage Capacity (gal)	125,941
Cost per Gallon	$2.67

77



Project ID	WA0009
Overall Ranking	27
Overall Score	3.474
Percent Impervious Area Treated	54%
Total Cost	$336,000
Potential Storage Capacity (gal)	125,941
Cost per Gallon	$2.67

79

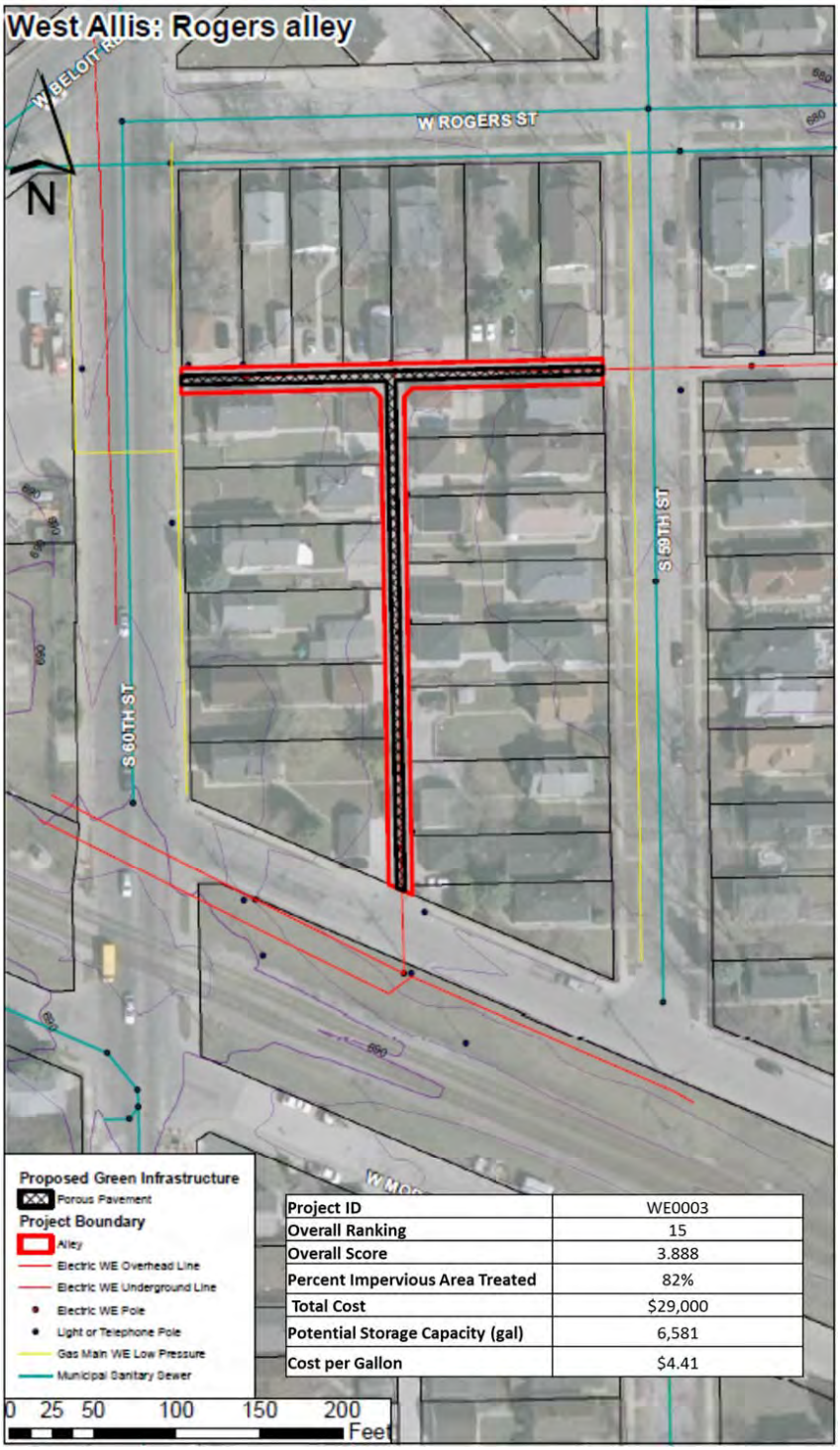


Project ID	WA0009
Overall Ranking	27
Overall Score	3.474
Percent Impervious Area Treated	54%
Total Cost	$336,000
Potential Storage Capacity (gal)	125,941
Cost per Gallon	$2.67

81

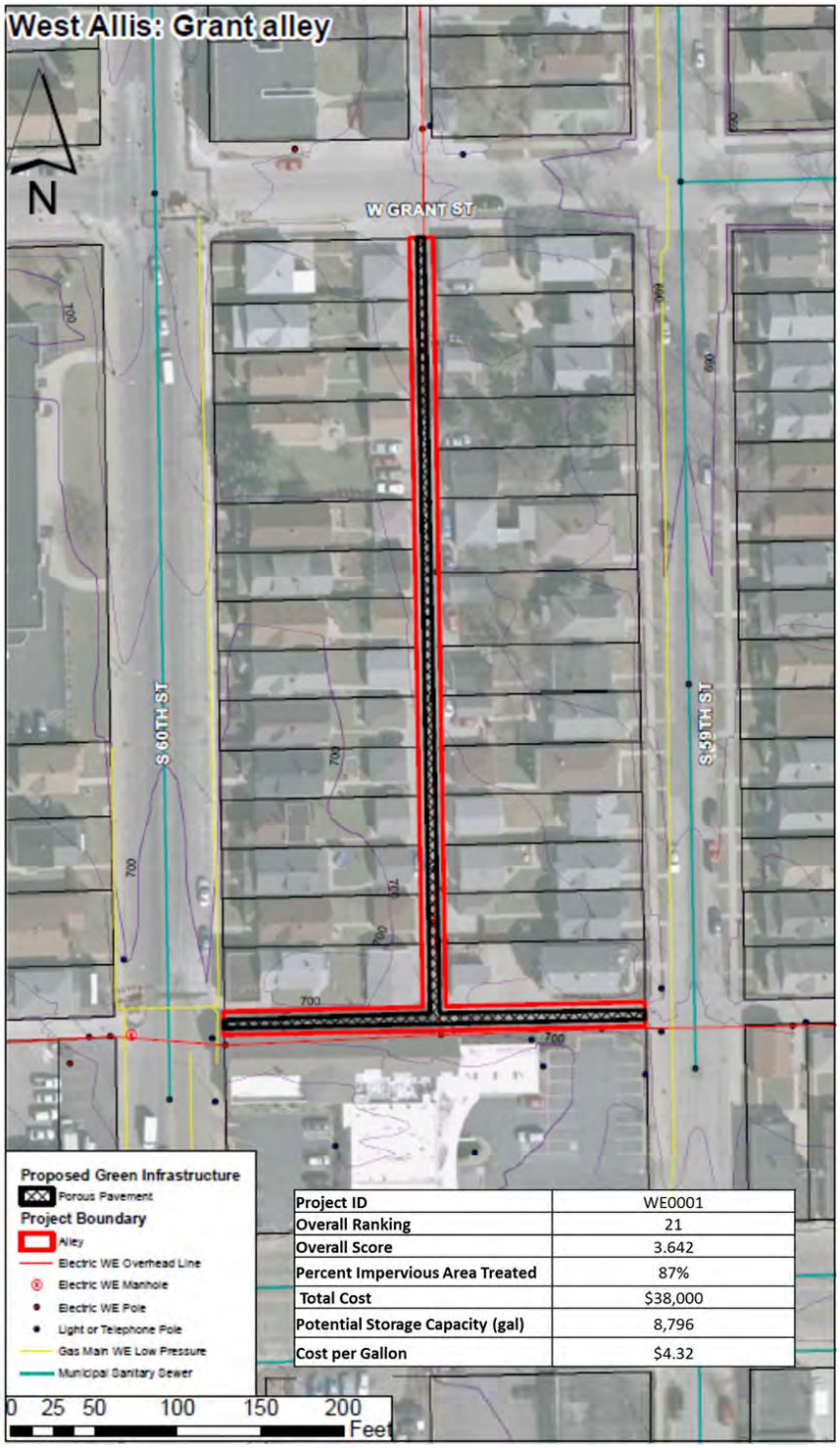
Project ID	WE0005
Overall Ranking	4
Overall Score	4.448
Percent Impervious Area Treated	38%
Total Cost	$37,000
Potential Storage Capacity (gal)	13,787
Cost per Gallon	$2.68

83



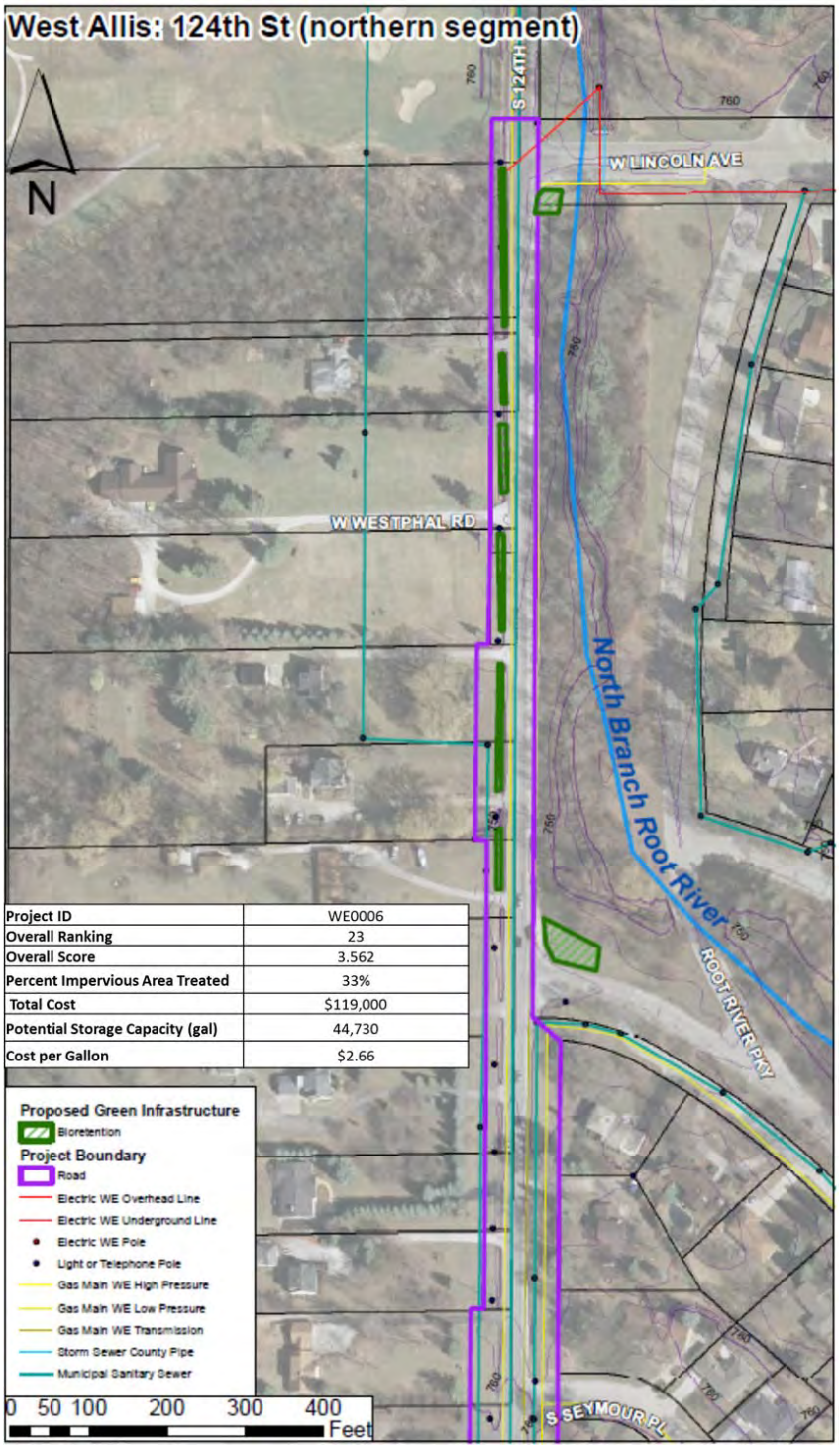
Project ID	WE0003
Overall Ranking	15
Overall Score	3.888
Percent Impervious Area Treated	82%
Total Cost	$29,000
Potential Storage Capacity (gal)	6,581
Cost per Gallon	$4.41

85

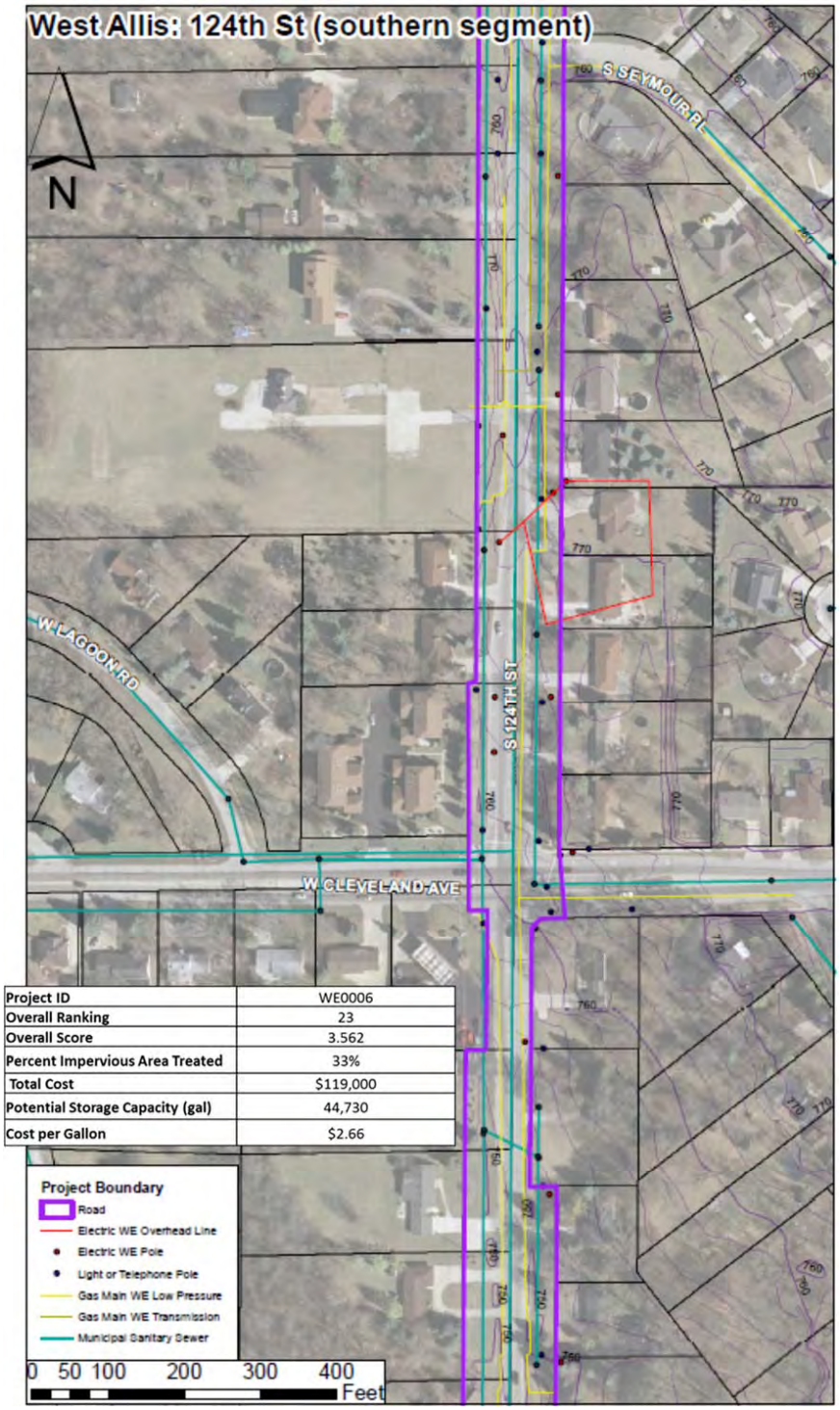


Project ID	WE0001
Overall Ranking	21
Overall Score	3.642
Percent Impervious Area Treated	87%
Total Cost	$38,000
Potential Storage Capacity (gal)	8,796
Cost per Gallon	$4.32

87

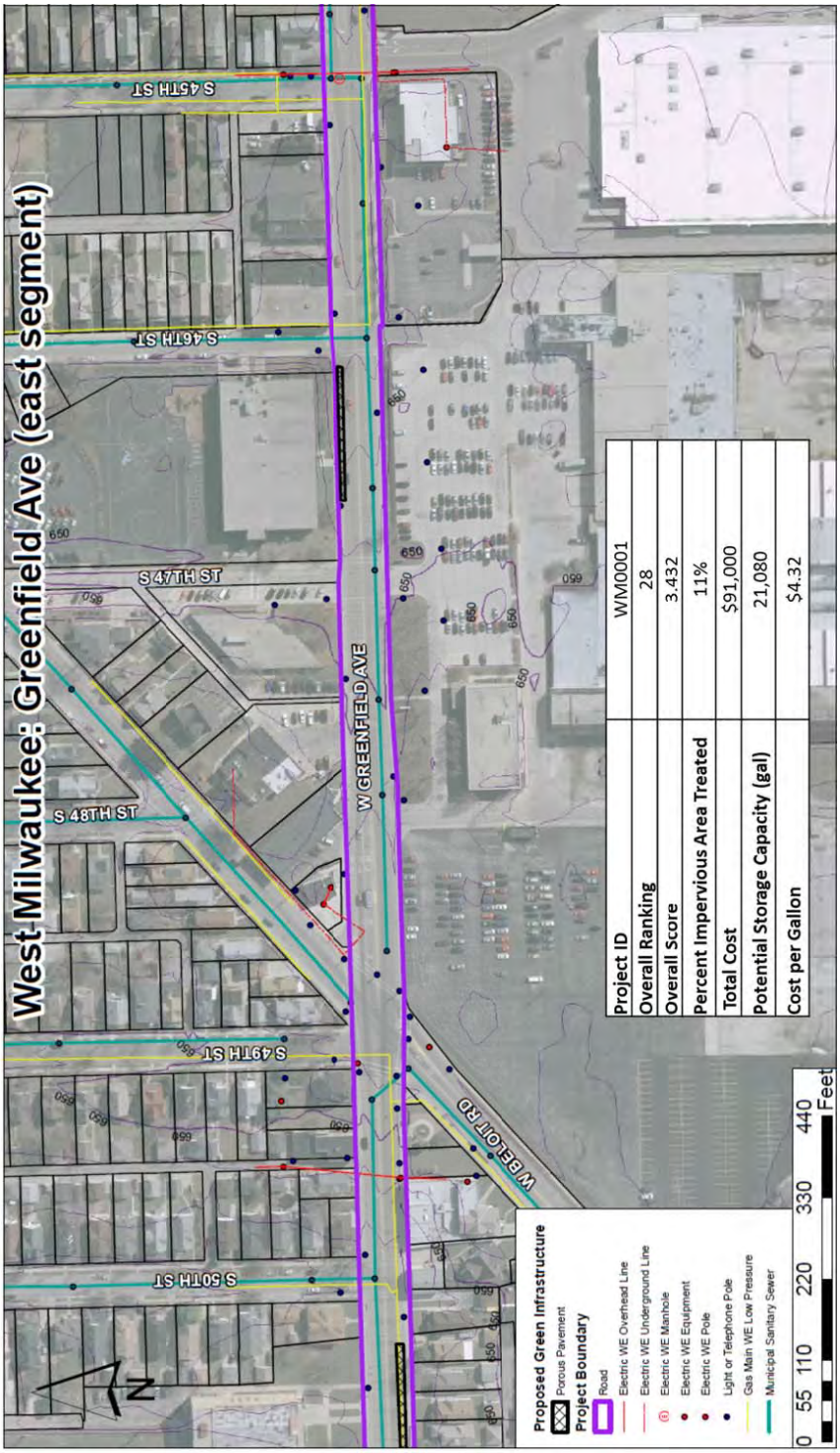

West Allis: 124th St (northern segment)
N
S 124TH
W LINCOLN AVE
W WESTPHAL RD
North Branch Root River
ROOT RIVER PKY
S SEYMOUR PL
760
Project ID | WE0006
Overall Ranking | 23
Overall Score | 3.562
Percent Impervious Area Treated | 33%
Total Cost | $119,000
Potential Storage Capacity (gal) | 44,730
Cost per Gallon | $2.66
Proposed Green Infrastructure
Bioretention
Project Boundary
Road
Electric WE Overhead Line
Electric WE Underground Line
Electric WE Pole
Light or Telephone Pole
Gas Main WE High Pressure
Gas Main WE Low Pressure
Gas Main WE Transmission
Storm Sewer County Pipe
Municipal Sanitary Sewer
0 50 100 200 300 400
Feet

89

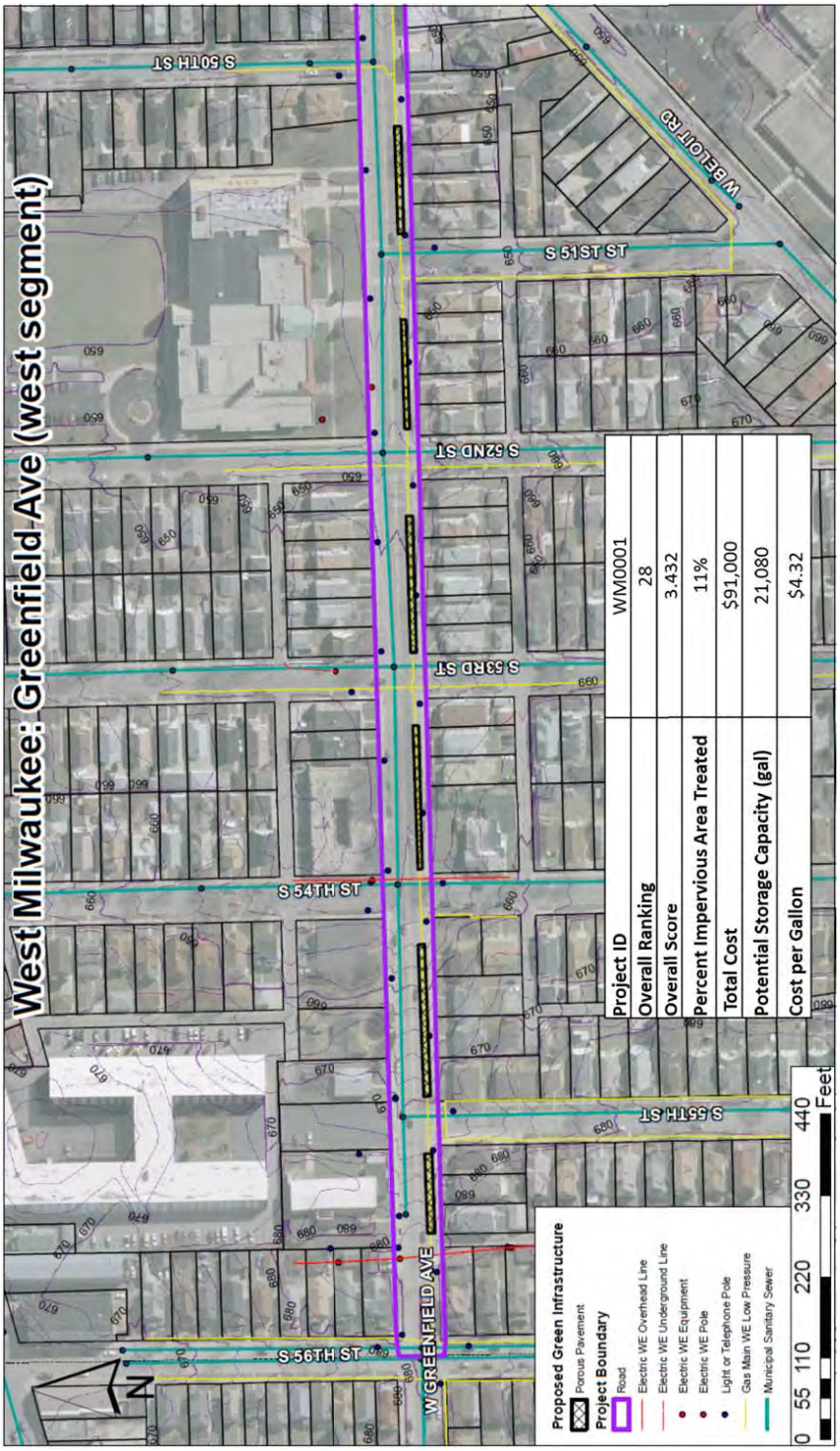


Project ID	WE0006
Overall Ranking	23
Overall Score	3.562
Percent Impervious Area Treated	33%
Total Cost	$119,000
Potential Storage Capacity (gal)	44,730
Cost per Gallon	$2.66

91

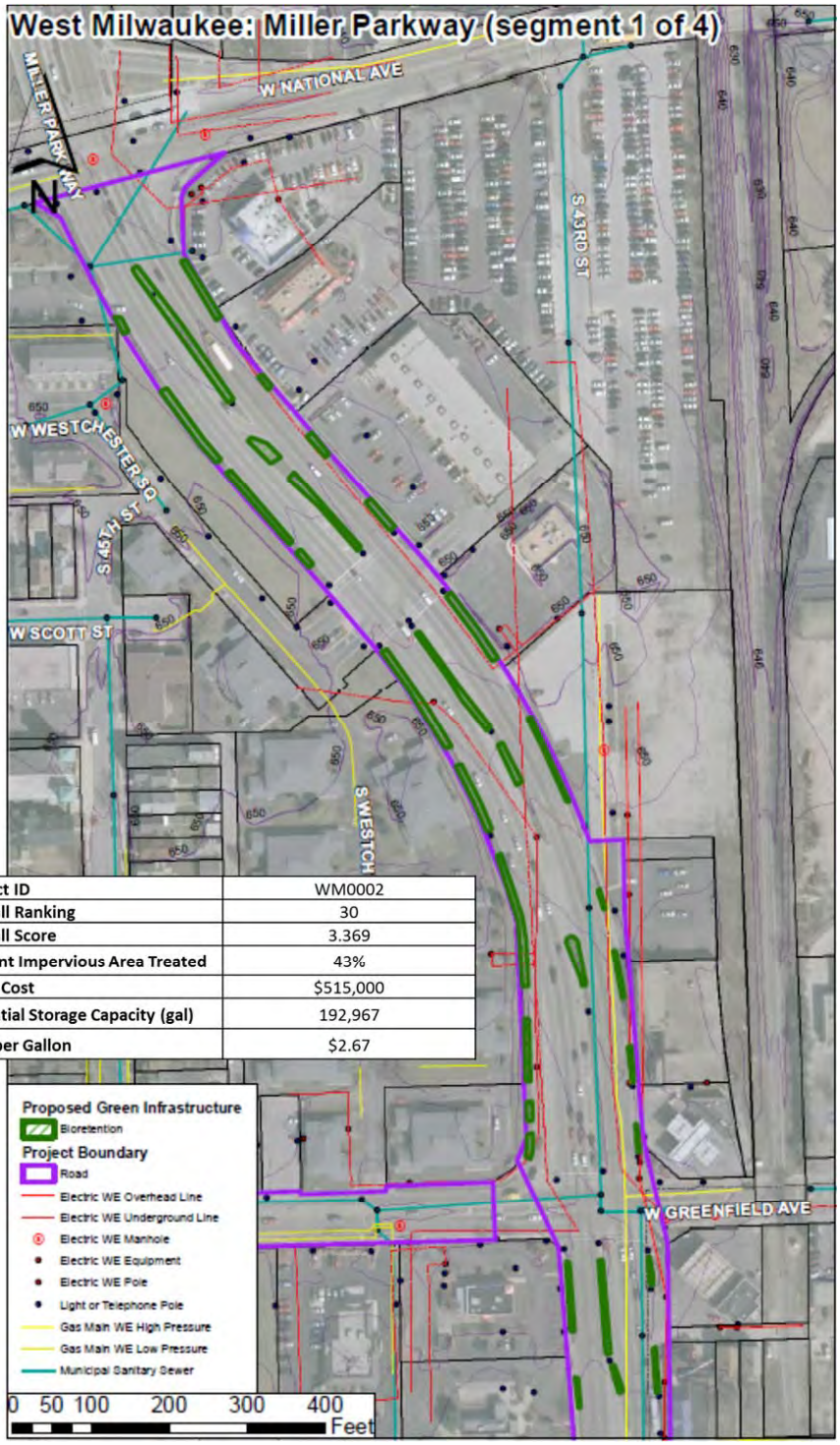

West Milwaukee: Greenfield Ave (east segment)
S 45TH ST
S 46TH ST
S 47TH ST
S 48TH ST
S 49TH ST
S 50TH ST
W GREENFIELD AVE
W BELOIT RD
650
660
Project ID | WM0001
Overall Ranking | 28
Overall Score | 3.432
Percent Impervious Area Treated | 11%
Total Cost | $91,000
Potential Storage Capacity (gal) | 21,080
Cost per Gallon | $4.32
Proposed Green Infrastructure
Porous Pavement
Project Boundary
Road
Electric WE Overhead Line
Electric WE Underground Line
Electric WE Manhole
Electric WE Equipment
Electric WE Pole
Light or Telephone Pole
Gas Main WE Low Pressure
Municipal Sanitary Sewer
0 55 110 220 330 440
Feet
N

93



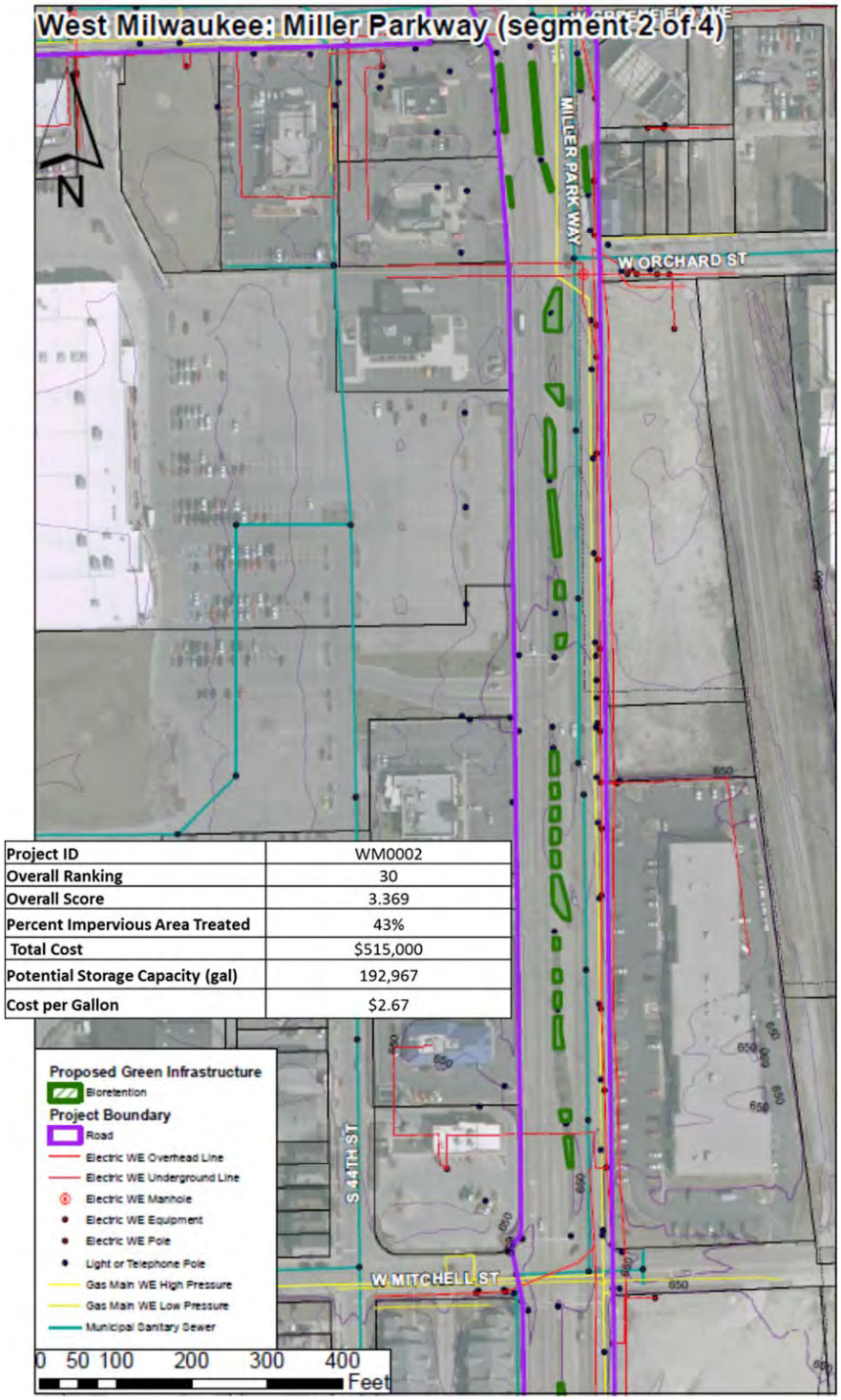
Project ID	WM0001
Overall Ranking	28
Overall Score	3.432
Percent Impervious Area Treated	11%
Total Cost	$91,000
Potential Storage Capacity (gal)	21,080
Cost per Gallon	$4.32

95



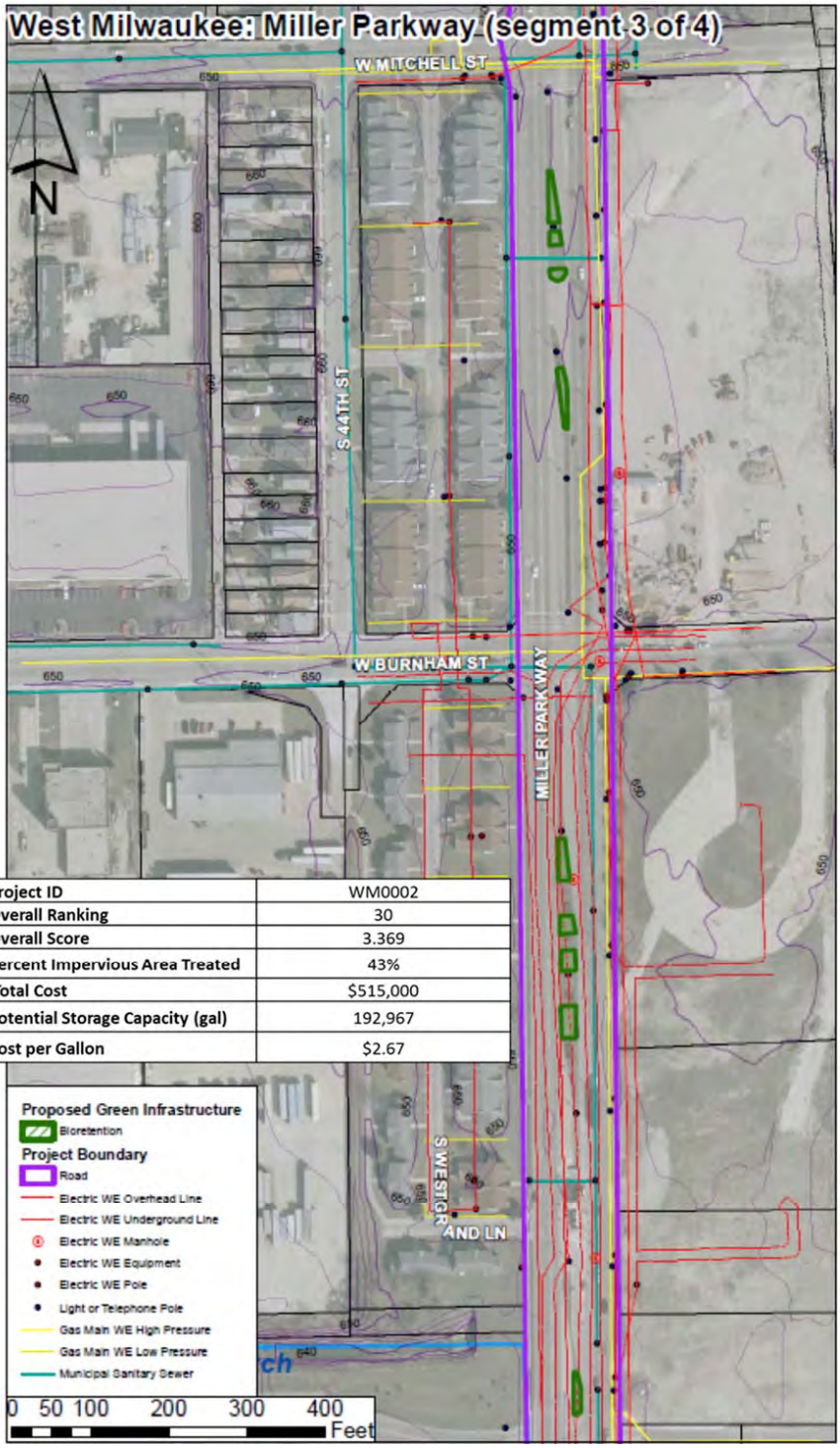
Project ID	WM0002
Overall Ranking	30
Overall Score	3.369
Percent Impervious Area Treated	43%
Total Cost	$515,000
Potential Storage Capacity (gal)	192,967
Cost per Gallon	$2.67

97



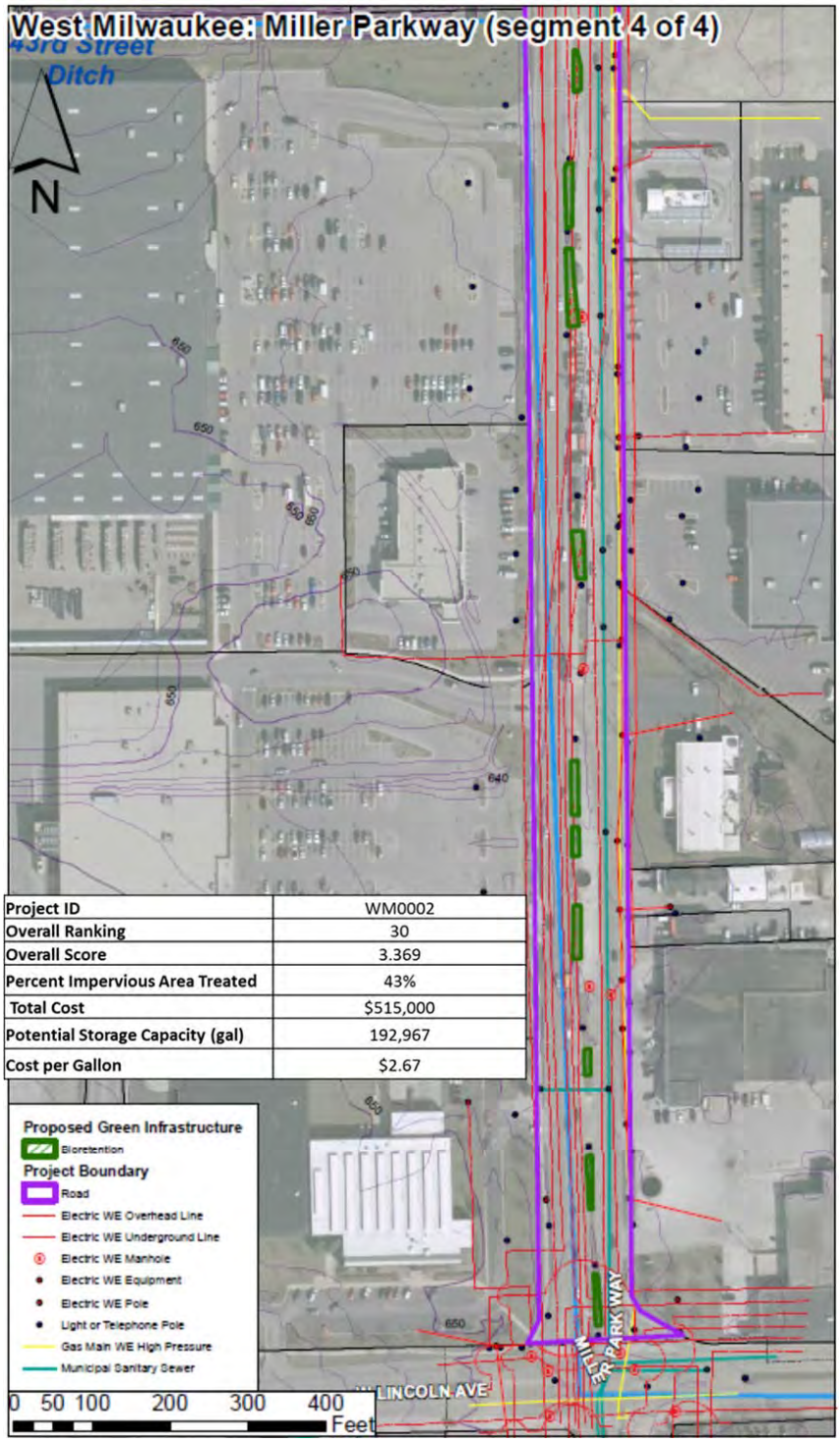
Project ID	WM0002
Overall Ranking	30
Overall Score	3.369
Percent Impervious Area Treated	43%
Total Cost	$515,000
Potential Storage Capacity (gal)	192,967
Cost per Gallon	$2.67

99



Project ID	WM0002
Overall Ranking	30
Overall Score	3.369
Percent Impervious Area Treated	43%
Total Cost	$515,000
Potential Storage Capacity (gal)	192,967
Cost per Gallon	$2.67

101



Project ID	WM0002
Overall Ranking	30
Overall Score	3.369
Percent Impervious Area Treated	43%
Total Cost	$515,000
Potential Storage Capacity (gal)	192,967
Cost per Gallon	$2.67

103

Appendix B
Survey Questions and Responses

mark.mittag@gmail.com Edit this form

11 responses

View all responses Publish analytics

Summary

Name and organization

RIchard Paul Village of Elm Grove

Jeff Nettesheim, Menomonee Falls Utilities

Maggie Anderson, City of Wauwatosa

Tim Barbeau, Village of Butler

Tim Thur - City of Milwaukee DPW

Joe Burtch, City of West Allis

Stevan Keith, Milwaukee County

Theresa Caven, City of Brookfield

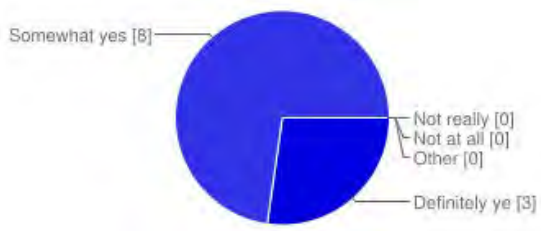
Tom Grisa, City of Brookfield

Eric Bartlein - Village of Germantown

Greenfield

EVALUATING THIS PROJECT

1. Did you find this project useful?



Definitely yes	3	27.3%
Somewhat yes	8	72.7%
Not really	0	0%
Not at all	0	0%

Other	**0**	0%

Comment (1):

It was good to have a third party involved in the identification and suggestions related to potential GI solutions.

The project did a nice job of identifying potential opportunities for GI. If the objective was to raise awareness vs develop a project, then I think it was successful

The project was not directly useful for West Allis, but it provided a connection to what is going on with the other Municipalities. The real benefit will be when we can share experiences with different types of projects done by other communities.

I appreciated the tips on how to prioritize green infrastructure projects. A few of the recommendations gave us confirmation on green infrastructure we had already included in our CIP.

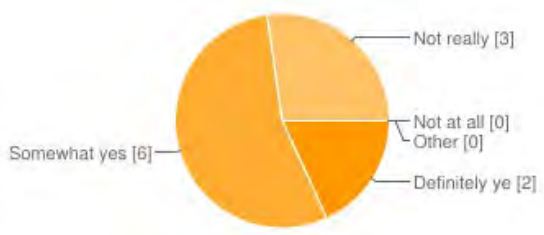
City of Milwaukee has previously developed a methodology to look at including green infrastructure as part of its capital paving program.

Great insight into planning future projects that could may a more effective impact on the bigger picture.

It gave us awareness of how these GI practices can be fit into the streetscape.

I don't think anything new or innovative was provided for the projects. Basically it was just a listing of the types of green infrastructure that could be included on certain projects with approximate costs identified. This can be helpful as municipalities proceed with the work, but costs were very high for what you get in water quality improvements.

2. Has this project raised your awareness that there are green infrastructure opportunities with street and parking lot reconstruction projects?



Definitely yes	**2**	18.2%
Somewhat yes	**6**	54.5%
Not really	**3**	27.3%
Not at all	**0**	0%
Other	**0**	0%

Comment (2):

We do look at opportunities when possible, but the fact that there was a focus was evidently more advantageous.

I believe the only problem with green infrastructure projects is that they are not financially sustainable at this time. I think as Municipalities experience the successes and failures of projects, it will provide better methods and bang for you buck on future projects.

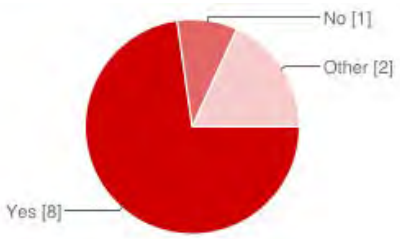
City of Milwaukee has previously developed a methodology to look at including green infrastructure as part of its capital paving program.

From a staff standpoint it has allowed dialogue regarding GI as projects arise. Not the same reaction for the local elected officials. It can be a hard sell to the elected officials if they do not see the immediate benefit and if the up front costs make the GI solution cost prohibitive.

I was aware of the types of GI available and nothing new or innovative was presented.

We are a large and somewhat silo'd operation. As a result, not all of the property owners could attend the presentation, so I'm unsure if all of the people who needed to become more aware have read & understand the information

3. Has this project provided your community with at least two potential green infrastructure projects that could be implemented?



Yes	**8**	72.7%
No	**1**	9.1%
Other	**2**	18.2%

Comment (3):

Certainly there is potential to construct something akin to the concepts at these sites

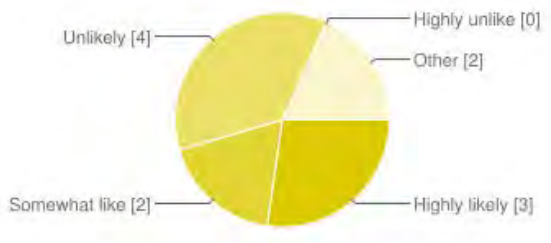
Absolutely an option on one, but the only other project that is in our community is under jurisdiction of the county.

City of Milwaukee has previously developed a methodology to look at including green infrastructure as part of its capital paving program.

The recommendations for alleys are included in our CIP.

I can show a plan sheet to make others aware of the potential to add this.

4. How likely is it that your community will implement the two green infrastructure opportunities?



Highly likely	**3**	27.3%
Somewhat likely	**2**	18.2%
Unlikely	**4**	36.4%
Highly unlikely	**0**	0%
Other	**2**	18.2%

Comment (4):

Likely we will implement the one project that pertains directly to the Village's grounds.

County may choose to use GI or other technologies. I was surprised to hear a team representative bash retention ponds as if they were not GI or somehow a terrible water quality feature. Ponds are quite cost-effective, very effective in improving water quality and can be an amenity that is quite attractive.

Property owners could weigh the added costs of GI vs using the funds to build/repair something else. There is no over-arching directive from the higher levels of admin to spend more than is necessary to comply with state, regional (MMSD) or local rules. Also, for highways projects, they rely largely on state funds and they may not feel compelled to add GI if WisDOT is not promoting/funding that type of work

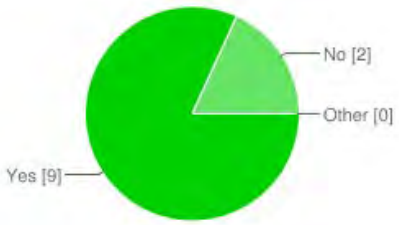
The projects indicated in the study were limited to the Menomonee River watershed. West Allis drains to Root River and the KK River as well and we see opportunities in those watersheds. The information on the possible projects was good and will be used, but it may be in different locations.

City of Milwaukee has an annual program for the installation of green infrastructure.

I am gradually getting the Engineering Dept. and others to see that this will need to be done and can be done.

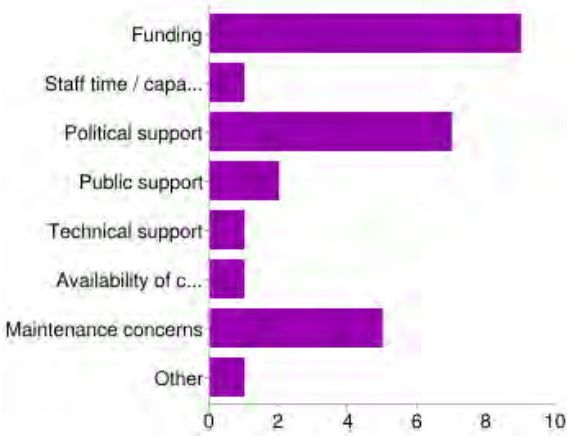
Due to limited physical space in the road rights of way for GI solutions and the fact that there may be no political will to implement a GI solution, makes it unlikely that something will be implemented. However, the discussions will continue as part of educating the staff and elected officials as success stories form other communities become more apparent.

5. Are there barriers to implementing the two projects recommended for your community?



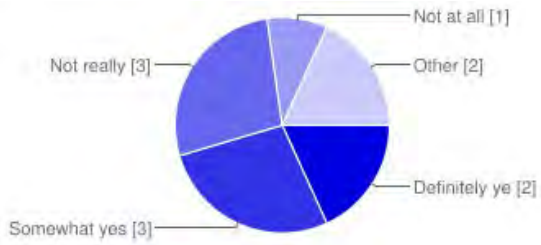
Yes	**9**	81.8%
No	**2**	18.2%
Other	**0**	0%

6. If you said "yes" regarding barriers in #5, please select the top 3 barriers for your community.



Funding	**9**	100%
Staff time / capacity	**1**	11.1%
Political support	**7**	77.8%
Public support	**2**	22.2%
Technical support	**1**	11.1%
Availability of construction standard details	**1**	11.1%
Maintenance concerns	**5**	55.6%
Other	**1**	11.1%

7. If resources were available, would you want more street and parking lot projects evaluated for green infrastructure opportunities in your community?



Definitely yes	**2**	18.2%
Somewhat yes	**3**	27.3%
Not really	**3**	27.3%
Not at all	**1**	9.1%
Other	**2**	18.2%

Comment (7):

unsure. Owners are expressing concerns about the O&M aspects. Even if matching funds were available for construction, owners may balk on any GI that is over&above min required due to O&M concerns

This would be matter for the administrator to provide direction on whether additional opportunities should be evaluated. The implementation and success of a project in a surrounding community could lead to further investigation.

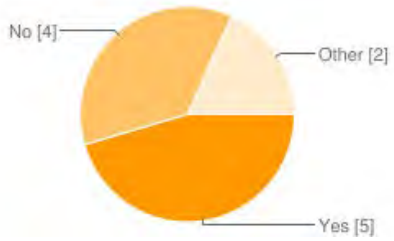
We know there is a lot of opportunities where green infrastructure could be constructed. The funding for this is not there. The green infrastructure adds a significant amount to the cost of a project.

City of Milwaukee has previously developed a methodology to look at including green infrastructure as part of its capital paving program.

As long as it does not pertain to porous pavement, since we are not equipped with the proper equipment to maintain that type of GI.

It gives us alternatives that our staff probably isn't cognizant of yet. It would help to create the culture that this is required and is to be part of the thought process.

8.Would you like to see your municipality include green infrastructure screening, like the process used in this project, as a standard step in the street / parking lot capital improvement planning process?



Yes	**5**	45.5%
No	**4**	36.4%
Other	**2**	18.2%

Comment (8):

It doesn't hurt.

We do look at the possibility of adding green infrastructure on all of our projects. The only funding we have available is our allocation from MMSD. This is only enough to provide a very small scale project.

We already use a screening tool in our capital planning process. Not nearly as sophisticated, but it's broader in scope to address more areas of sustainability - to consider energy, recycling, etc. However, unless the land owner department expresses desire in having GI added to their projects, the persons who prepare the capital estimates may not be inclined to include it. So there are several key levels that affect how GI can be incorporated

We need to include this in our thinking as we have with municipal utilities, pedestrian and bike traffic etc.

9. Would you recommend the green infrastructure opportunities evaluation process for streets and parking lots be expanded to other communities in the region?

Yes	**9**	81.8%
No	**0**	0%
Other	**2**	18.2%

Comment (9):

I think it brings awareness to communities regarding green infrastructure.

Sure

This process could be used by all communities to find opportunities to include green infrastructure as part of their capital paving work.

10. What are the strengths of the process used in this project?

It was a good way to heighten awareness and to share experiences of past projects.

gathering information as a group allows input from various size communities with varied political support. If one community can successfully complete a project, that community has a close audience to convince others to participate.

In general, a good approach to look at the 5-year CIP for opportunities, and to develop some conceptual plans with conceptual-level costs

Individuals had focus on this initiative which allowed for more comprehensive options.

Process builds enthusiasm.

The data analysis and use of GIS.

11. What suggestions do you have for improving the process used in this project?

Can't think of any at this time,.

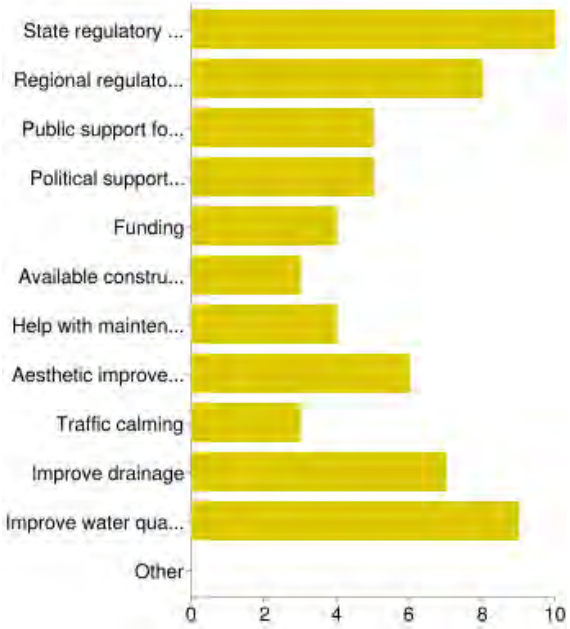
Closer collaboration with local officials.

Consider O&M costs Evaluate the decision-making process how GI gets incorporated into capital projects

It would be nice to have a "menu" of BMPs to choose from that would show the benefit, cost, maintenance, etc. of each BMP. For instance, if you install this BMP, it will cost $30,000 and will reduce TSS 40% for 0.25 acres and maintenance will be annual cleaning. Information like that would help in planning a project.

GREEN INFRASTRUCTURE ACROSS THE REGION

12. Why would you consider implementing more green infrastructure on public property in your community?



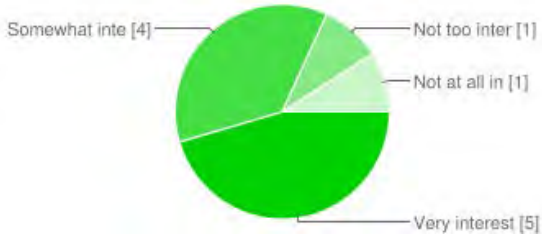
State regulatory requirements (TMDLs, NR 151, etc.)	**10**	90.9%
Regional regulatory requirements (MMSD Chapter 13, etc.)	**8**	72.7%
Public support for green infrastructure	**5**	45.5%
Political support for green infrastructure	**5**	45.5%
Funding	**4**	36.4%
Available construction standard details	**3**	27.3%
Help with maintenance (logistics, equipment, costs, etc.)	**4**	36.4%
Aesthetic improvement	**6**	54.5%
Traffic calming	**3**	27.3%
Improve drainage	**7**	63.6%
Improve water quality	**9**	81.8%
Other	**0**	0%

Comment (12):

I think everyone would like to use green infrastructure more. It is a matter of funding such a costly project. I think as these projects become more common, the costs may start to come down and we may determine where certain methods work best.

The Village has long been a leader in storm water detention/retention basin requirements, we just need to educate and have a few successful pilot projects.

13. What is your level of interest in learning more about green infrastructure operation and maintenance for public works departments (including how other communities are addressing these issues)?



Very interested	**5**	45.5%
Somewhat interested	**4**	36.4%
Not too interested	**1**	9.1%
Not at all interested	**1**	9.1%

Comment (13):

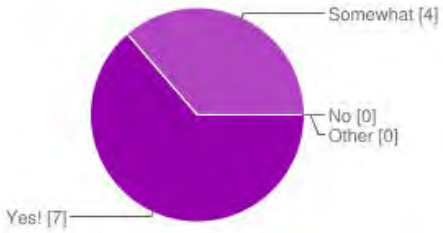
I feel I am already up on the latest GI.

With more green infrastructure getting installed, it will change the way DPWs have to provide maintenance.

We need to convene a group of local govt folks to discuss O&M

I need to have answers for questions that others have as to the level of effort these practices require for O&M.

14. Sweet Water (Southeastern Wisconsin Watersheds Trust, Inc.) was instumental in obtaining the grant that funded this project, with the goal of providing practical, useful outputs that can lead to implementable green infrastructure projects benefitting the Menomonee River Watershed. Does this kind of effort led / coordinated by Sweet Water add value to your community?



Yes!	**7**	63.6%
Somewhat	**4**	36.4%
No	**0**	0%
Other	**0**	0%

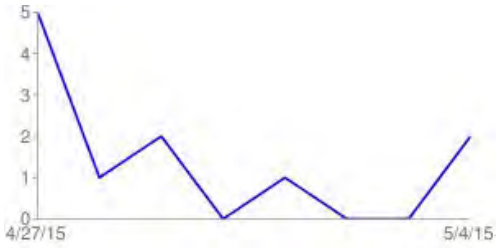
Comment (14):

SWWT offers value already, this is nice that this type of project can be brought to us

from those who can obtain grants.

I think projects like this will begin to lead us toward more affordable and successful green infrastructure projects.

Number of daily responses



Appendix C
GI Criteria Analysis Table

TABLE C-1
GI Criteria Analysis Table

ObjectID	Municipality	Project ID	Location	Municipality	Ground Slope (percent)	Depth to Groundwater (feet)	Depth to Bedrock (feet)	Benefit Rankings (percentile)	Opportunity Rankings (percentile)	Parking Lanes (2) on Road	Project Impervious Area Size	Existing Tree Canopy (percent)	Best Professional Judgement Review	Average GIS Score	Cost	Cost Rank	Cost Score	Cost Per Gallon	Efficiency Score	Overall Score	Overall Rank	By Municipality
1	BR	BR0001	North Ave_124th to Pilgrim Rd	Brookfield	4.40	5	5	3.932107	2.91372	1	5	5	3	3.92	$ 1,972,000.00	1	1	$ 2.67	5	3.31	31	1
3	BR	BR0002	North Ave_Pilgrim Rd to Calhoun Rd	Brookfield	4.48	5	5	3.352192	2.694484	1	5	5	3	3.84	$ 783,000.00	2	1	$ 2.67	5	3.28	32	2
30	BU	BU0001	Parking Lot N of Meno River at FrontierPrk	Butler	4.26	1	5	1.739745	4.094767	5	2	5	3	3.45	$ 95,000.00	18	3	$ 4.32	3	3.15	34	4
58	BU	BU0002	Silver Spring Drive in Butler	Butler	4.40	5	5	1.739745	4.094767	1	5	5	3	3.80	$ 402,000.00	5	1	$ 2.67	5	3.27	33	3
64	BU	BU0003	N 127th - Lancaster to Colfax	Butler	4.96	5	5	1.739745	4.094767	5	1	3	3	3.64	$ 27,000.00	31	5	$ 4.41	3	3.88	16	2
63	BU	BU0004	Parking Lot S of river at 127th St	Butler	5.00	5	5	1.739745	4.094767	5	1	5	3	3.87	$ 12,000.00	34	5	$ 2.65	5	4.62	2	1
60	EG	EG0001	13600 Juneau Blvd, Elm Grove	Elm Grove	4.86	5	5	3.54314	2.934936	5	3	5	3	4.15	$ 105,000.00	16	3	$ 2.67	5	4.05	9	1
7	EG	EG0002	North Ave_124th to Pilgrim Rd	Elm Grove	4.40	5	5	3.932107	2.91372	1	5	5	3	3.92	$ -	35	1	-	1	1.97	37	2
31	GE	GE0001	Rivercrest Drive_N of County Line Rd	Germantown	5.00	1	1	1.633663	1.463932	5	3	5	3	2.90	$ 41,000.00	25	4	$ 2.64	5	3.97	13	1
32	GE	GE0002	Concord Rd from Division Rd to Pilgrim Rd	Germantown	4.84	5	5	1.633663	1.463932	1	4	5	3	3.44	$ 333,000.00	8	2	$ 2.66	5	3.48	26	2
33	GF	GF0001	Crawford Ave btwn 45th and Morgan Ave	Greenfield	4.54	5	5	3.528996	1.944837	3	3	5	5	4.00	$ 142,000.00	13	2	$ 2.66	5	3.67	19	3
34	GF	GF0002	60th St from Cold Spring to Waterford Ave	Greenfield	4.98	5	5	3.373409	4.70297	5	4	5	3	4.45	$ 87,000.00	21	3	$ 2.66	5	4.15	8	2
36	GF	GF0003	43rd St from W Grange Ave to Layton Ave	Greenfield	4.96	5	5	3.783593	2.673267	1	4	5	3	3.82	$ 288,000.00	9	2	$ 2.67	5	3.61	22	4
38	GF	GF0004	35th Frontage from Edgerton to N of Holmes	Greenfield	4.94	5	5	3.87553	2.899576	1	2	5	5	3.86	$ 59,000.00	23	4	$ 2.67	5	4.29	6	1
53	MC	MC0001	West Oklahoma Ave from 72nd to 76th Street	Milwaukee County	4.88	5	5	4.137199	4.314003	5	4	5	3	4.48	$ 111,000.00	15	3	$ 2.66	5	4.16	7	2
14	MC	MC0002	Capitol Dr and 110th St	Milwaukee County	4.04	5	5	3.514851	4.632249	5	2	5	1	3.91	$ 94,000.00	19	3	$ 2.68	5	3.97	12	3
17	MC	MC0003	3535 N Mayfair Rd	Milwaukee County	4.72	5	5	3.514851	4.632249	5	4	5	3	4.43	$ 183,000.00	11	2	$ 2.67	5	3.81	18	5
55	MC	MC0004A	Watertown Plank Road and 92nd Street	Milwaukee County	4.74	5	5	4.745403	3.394625	5	2	5	5	4.43	$ 48,000.00	24	4	$ 4.31	3	3.81	17	4
54	MC	MC0004B	Watertown Plank Road and 92nd Street	Milwaukee County	4.80	5	5	4.745403	3.394625	5	4	5	5	4.66	$ 181,000.00	12	2	$ 3.26	4	3.55	24	6

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ObjectID	Municipality	Project ID	Location	Municipality	Ground Slope (percent)	Depth to Groundwater (feet)	Depth to Bedrock (feet)	Benefit Rankings (percentile)	Opportunity Rankings (percentile)	Parking Lanes (2) on Road	Project Impervious Area Size	Existing Tree Canopy (percent)	Best Professional Judgement Review	Average GIS Score	Cost	Cost Rank	Cost Score	Cost Per Gallon	Efficiency Score	Overall Score	Overall Rank	By Municipality
56	MC	MC0004C	Watertown Plank Road and 92nd Street	Milwaukee County	4.94	5	5	4.745403	3.394625	5	2	5	5	4.45	$ 38,000.00	26	4	$ 2.68	5	4.48	3	1
18	MC	MC0005	12020 W Bradley Rd	Milwaukee County	5.00	5	5	3.656294	4.158416	5	4	5	1	4.20	$ -	35	1	-	1	2.07	35	7
19	MC	MC0006	12020 W Bradley Rd	Milwaukee County	4.92	5	5	3.656294	4.158416	5	3	5	1	4.08	$ -	35	1	-	1	2.03	36	8
8	MF	MF0001	Arthur Ave_MenomAve to Appleton Ave	Menomonee Falls	3.82	3	5	3.055163	3.302687	5	2	5	1	3.46	$ -	35	1	-	1	1.82	45	5
9	MF	MF0002	CherokeeDr_CheyenneDr to Water St	Menomonee Falls	4.94	5	5	1.69024	2.998586	5	3	5	3	3.96	$ 103,000.00	17	3	$ 2.67	5	3.99	10	3
11	MF	MF0003	CheyenneDr_Village StandPipe to Cherokee Dr	Menomonee Falls	4.64	5	5	1.69024	2.998586	5	3	5	3	3.93	$ 63,000.00	22	4	$ 2.67	5	4.31	5	2
12	MF	MF0004	MayAve_ArthurAve to Fleet Ave	Menomonee Falls	3.82	1	5	3.055163	3.302687	5	2	5	5	3.69	$ -	35	1	-	1	1.90	40	4
13	MF	MF0005	St.FrancisDr_St Mark Dr to W St. Regis Dr	Menomonee Falls	4.94	5	5	1.69024	2.998586	5	3	5	3	3.96	$ 36,000.00	29	5	$ 2.63	5	4.65	1	1
61	MI	MI0001	N 91st btwn Mill Rd and Good Hope Rd	Milwaukee	4.52	5	5	3.981612	4.978784	1	5	5	3	4.16	$ 367,000.00	6	1	$ 2.67	5	3.39	29	2
62	MI	MI0002	W Lisbon btwn 84th and 100th	Milwaukee	4.98	5	5	4.893918	3.069307	5	5	5	3	4.55	$ 590,000.00	3	1	$ 2.67	5	3.52	25	1
48	WA	WA0001	N 113th St btwn North Ave and 75'S of Clark St	Wauwatosa	4.06	5	5	3.437058	1.711457	3	3	3	3	3.47	$ -	35	1	-	1	1.82	44	9
49	WA	WA0002	Harding Blvd btwn 96th and 97th	Wauwatosa	4.68	5	5	4.462518	3.769448	5	2	1	1	3.55	$ -	35	1	-	1	1.85	43	8
50	WA	WA0003	Harding Blvd btwn 97th and City Limits	Wauwatosa	4.98	5	5	4.462518	3.769448	5	3	1	1	3.69	$ -	35	1	-	1	1.90	39	5
23	WA	WA0004	Alley btwn Elm Lawn St and 85th_N of Watrtwn Plk	Wauwatosa	4.78	5	5	4.745403	3.394625	3	1	5	1	3.66	$ -	35	1	-	1	1.89	41	6
51	WA	WA0005	Allewy between W. of Robertson_N of Gridley Ave	Wauwatosa	5.00	5	5	4.632249	3.74116	3	1	5	3	3.93	$ 22,000.00	32	5	$ 4.34	3	3.98	11	1
25	WA	WA0006	Alley btwn 74thAnd75th_S of Center	Wauwatosa	5.00	5	5	4.992928	2.970297	3	1	5	3	3.88	$ 14,000.00	33	5	$ 4.48	3	3.96	14	2
26	WA	WA0007	Alley btwn 75thAnd76th_S of Center	Wauwatosa	4.74	5	5	4.992928	2.970297	3	1	5	1	3.63	$ -	35	1	-	1	1.88	42	7
20	WA	WA0008	State St_68th to Wauwatosa Ave	Wauwatosa	4.94	1	5	4.922207	3.041018	3	4	5	5	3.99	$ 206,000.00	10	2	$ 2.86	5	3.66	20	3

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52	WA	WA0009	N 92nd btwn Capitol Dr and Hampton Ave	Wauwatosa	4.72	5	5	4.561528	2.51768	5	5	5	3	4.42	$ 336,000.00	7	1	$ 2.67	5	3.47	27	4
39	WE	WE0001	Alley between 59th and 60th_S of Grant St	West Allis	4.86	5	5	4.398868	4.07355	3	1	5	3	3.93	$ 38,000.00	26	4	$ 4.32	3	3.64	21	3
40	WE	WE0002	Alley between 65th and 66th_S of Lapham St	West Allis	3.20	5	5	4.830269	2.835926	3	1	5	1	3.43	$ -	35	1	-	1	1.81	46	6
42	WE	WE0003	Alley between 59th and 60th_S of Rogers St	West Allis	5.00	5	5	4.533239	1.442716	3	1	5	3	3.66	$ 29,000.00	30	5	$ 4.41	3	3.89	15	2
43	WE	WE0004	85th St btwn Washington and Greenfield Ave	West Allis	4.68	5	5	4.420085	4.024045	5	2	3	1	3.79	$ -	35	1	-	1	1.93	38	5
44	WE	WE0005	89th St btwn National Ave and Lincoln Ave	West Allis	4.66	5	5	4.420085	4.024045	5	3	5	3	4.34	$ 37,000.00	28	4	$ 2.68	5	4.45	4	1
45	WE	WE0006	124th St btwn Lincoln Ave and Oklahoma Ave	West Allis	4.70	5	5	3.097595	2.38331	1	4	5	3	3.69	$ 119,000.00	14	2	$ 2.66	5	3.56	23	4
46	WM	WM0001	Greenfield Ave btwn Miller Park way and 56th	West Milwaukee	4.66	5	5	4.653465	3.338048	3	5	5	3	4.29	$ 91,000.00	20	3	$ 4.32	3	3.43	28	1
47	WM	WM0002	Miller Park Way from National to W Lincoln Ave	West Milwaukee	4.96	5	5	4.653465	3.338048	1	5	5	3	4.11	$ 515,000.00	4	1	$ 2.67	5	3.37	30	2

APPENDIX E. INTERFLUVE MENOMONEE AND KINNICKINNIC RIVERS FINAL CONCEPT DESIGN REPORT

Upper Menomonee and Kinnickinnic Rivers

Final Concept Design Report

Submitted to
Linda Reid/Cheryl Nenn
Southeastern Wisconsin Watersheds Trust, Inc.
600 E Greenfield Ave
Milwaukee, WI, 53204

Submitted by
Inter-Fluve, Inc.

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December 9th, 2015

EXECUTIVE SUMMARY

This report outlines the data analysis and design approach in the creation of concept plans for river restoration in select reaches of the Menomonee and Kinnickinnic Rivers in the Milwaukee metropolitan area. The project was funded by a grant from the Fund for Lake Michigan. The overall goal for the project is to develop concept designs and cost estimates for targeted projects in the Menomonee River and Kinnickinnic River basins. Sweetwater (Southeast Wisconsin Watershed Trust) intends to advance select projects toward final design and construction.

The Project Partner science team included representatives from Milwaukee Riverkeeper, Sweetwater, Clean Wisconsin, the Milwaukee Metropolitan Sewerage District (MMSD), the Wisconsin Department of Natural Resources (WIDNR), the Southeast Wisconsin Regional Planning Commission (SEWRPC), local consulting firms, Milwaukee County, and Inter-Fluve.

A geomorphic assessment was completed previously in 2003, which included examination of all rivers and tributaries in Milwaukee County (Inter-Fluve 2004). Review of previous data for this project showed nearly 200 potential restoration projects, including bank erosion repair, fish passage restoration, dam removal, meander restoration of channelized segments, floodplain restoration and riparian buffer establishment. The 2004 tabulated ranking spreadsheet and the associated scoring metrics were used as the basis for the 2015 Sweetwater project, with the project partners reviewing the list and adding several projects not included. Municipalities and counties within the watershed were asked to provide any information for unlisted projects they deemed relevant, and these were also added to the spreadsheet. The project list encompassed all of the known potential projects that best suited the needs of the stakeholders and the overall watershed restoration goals as stated in the *Implementation Plan* and *Watershed Restoration Plan* for each watershed. Project Partners met to discuss the projects, and all of the projects were scored using a draft set of metrics. The prioritization metrics were revised in response to comments by the Project Partners to better achieve the Sweetwater goals (Table 1.)

The project partners reviewed the matrix and rankings. Although bank stabilization was initially viewed as the primary goal, it became clear that the need for projects that exclusively addressed bank erosion in the watersheds of interest was limited. A more common problem was the extensive floodplain encroachment and channelization of streams throughout the watersheds. The initial project goal was for 10 smaller projects, but the Project Partners modified the strategy to include 9

larger scale meander and floodplain restoration projects, each including elements of bank stabilization. The finalized list of projects advanced to concept design includes:

- *Rotary Park* (Menomonee Falls) - Meander restoration of a 4,500 feet reach of the Menomonee River at Pilgrim Road and Menomonee Parkway. The project would result in 7,000 feet of restored, meandering river channel, constructed riffle and pool features, restored streambanks, trails and park amenities.
- *Frontier Park* (Butler) - Channel restoration and riparian area restoration. This 500 foot segment of the Menomonee River was channelized historically, and a large amount of floodplain material was excavated to create the parking lot and adjacent Frontier Park surface. Reclamation here includes filling in the ponded area to restore the river channel, bank stabilization, and restoration of the floodplain to include parking lot relocation away from the channel, and relocation of the baseball field to minimize disturbance and expand the riparian buffer.
- *Lyons Park Creek* (Milwaukee) – This project involves creating a floodplain bench and restored riparian corridor over 450 feet of Lyons Park Creek downstream of South 55th Street to the park footbridge. For an additional 500 feet downstream of the footbridge, the project would include removal of concrete debris, riffle and pool construction, minor bank stabilization and storm sewer outfall integration.
- *Elm Grove Village Park* (Elm Grove) – The focus in this reach is meander restoration of a 2,500 foot section of a channelized Underwood Creek downstream of Marcella Avenue to Elmhurst Parkway. This project would include 4,000 feet of new channel construction, removal of invasive vegetation and restoration of a native vegetation riparian corridor.
- *Underwood Creek* (Brookfield) – This project involves meander restoration of Underwood Creek from Clearwater Drive to North Avenue. This would transform a 4,000 foot section of a channelized ditch into roughly 7,000 feet of new stream channel. The project would also include restoration of a native vegetation riparian corridor.
- *Butler Creek Reach 1* (Brookfield) – The focus in this reach is meander restoration of Butler Creek from Hampton Road to W Lisbon Road. This project involves meander restoration of a 1,700 foot section of the channelized ditch, resulting in roughly 2,500 feet of new stream channel. The project would also include restoration of a native vegetation riparian corridor.
- *Butler Creek Reach 2* (Brookfield) – This project involves meander restoration of a 5,700 foot section of a channelized Butler Creek from Shamrock Lane to Lilly Road (Lilly Heights Park). This project would include 8,000 feet of new channel construction and restoration of a native vegetation riparian corridor.
- *Kinnickinnic River – Jackson Park East and West* (Milwaukee) – This effort is separated into two projects. The West project encompasses 4,600 feet of the upper Kinnickinnic River from South 60th Street to the footbridge in line with South 51st Street. The West project involves bank stabilization and floodplain bench creation, incised channel restoration, and riparian zone restoration. The East project segment covers the river from the footbridge downstream to South 43rd Street and involves the same restoration elements. A major goal here will be to restore the channel while minimizing the impact to valuable monument trees.

Field reconnaissance was completed on the priority sites selected. GIS information such as aerial photos and roads were incorporated into the concept drawings, which depict both existing and proposed corridor elements. Concept plans are included here as Appendix A. The following paragraphs describe the general restoration approaches shown in the concept plans:

MEANDER RESTORATION

Historically, the Menomonee River was a more sinuous stream and was also much smaller, likely less than two thirds of its current width. Agricultural and urban impacts increased the rate and volume of runoff to the river, and the river responded by deepening and widening. Farming and urban development included the channelization or straightening of the river system, which resulted in a steepening of the river slope, further contributing to channel instability. Much of this channelization came with hard armoring of channel banks.

Ditching, also called straightening or channelization of streams and rivers, homogenizes the aquatic habitat, resulting in channels with no variability in bedform. The riffles, runs and pools normally present in meandering alluvial channels are important areas of habitat diversity. In a ditched system, these features are no longer present, and are replaced by flat bottom, wide and shallow channels with marginal habitat. Channelization also reduces the amount of available habitat due to the significant shortening of the river. This shortening also increases the slope of the stream, which can cause channel downcutting, subsequent bank instability and sediment pollution.

Meandering encourages undercutting, deposition of lateral bars and the creation of pools, riffles and runs, all important aspects of stream habitat. In every concept presented, with the exception of Frontier Park, the central design element is restoration of channel meanders. Design of natural meandering channels in urban areas requires not only a solid understanding of natural channel form, but also of the many constraints and disturbance pressures on the normal geomorphic processes of erosion and deposition. The Menomonee River system is subject to extremes such as low base flow discharge in winter or during drought, and large and increasingly frequent flood flows. The channel size is a function of this hydrologic regime. Returning the stream to a pre-settlement condition is not possible given the changes to the floodplain and the hydrologic regime, but we can restore the channel to an equilibrium natural condition given the modern constraints. In the concept plan, we have used the existing channel width as an analog for design, but during final design these dimensions may change slightly.

Table 1. Sweetwater Scoring Metrics

Infrastructure risk	No risk to infrastructure with no action, or no infrastructure present	Low to moderate infrastructure risk and minimal risk to public safety with no action, or inf. value <$100,000	Infrastructure at moderate but not immediate risk, moderate public safety risk, or infrastructure value <$200,000	Infrastructure at high or imminent risk of failure with no action. Public safety at risk or infr. value >$200,000
Erosion/channel stability	Minimal improvement to overall stream stability and function, <250 ft	Low to moderate improvement 250-1000 ft	Moderate improvement 1000-2500 ft	Significant improvement to overall stream stability and function or >2500 ft
Design complexity	Complex plans >20 sheets, specification and project manual, 2-D or other complex modeling	Plans under 20 sheets, moderate complexity, 1-D hydraulic modeling	Plans 10-20 sheets, simple modeling or analog based design	Plans <10 sheets or no plans, fit in field, analog design (eg. simple plantings)
Permitting complexity	Complex permitting, EAW/EIS, CLOMR and LOMR issues, wetlands, mitigation, contaminants	Moderately complex permitting, state and USACE Chap 30/31, no contamination, simple wetland and cultural resource submittals	Simple permitting, no wetland or cultural resources issues, limited submittal	No permits required
Other complexity factors	Major groundwater and surfacewater issues, potential site contamination, or other complexities.	Moderate groundwater and surfacewater issues, potential site contamination, or other complexities.	Minor groundwater and surfacewater issues, potential site contamination, or other complexities.	No groundwater and surfacewater issues, potential site contamination, or other complexities.
Hydrologic benefit (incl. flood storage benefit)	No hydrologic benefit	Low impact, minimal reduction in rate and volume of runoff, flows <2 yr or channel forming flow	Moderate impact , some reduction in rate and volume of runoff, flows <5 yr or channel forming flow	Significant reduction in rate and volume of runoff for flows <10 yr or channel forming flow
Sediment/nutrient loading	No load reduction resulting	Some minor reduction in sediment pollution, increased filtration of nutrients	Moderate reduction in bank erosion and surface runoff entering stream. Buffer or other BMP establishment > 30 ft	Significant BMP installation, stormwater detention, infiltration or buffer filter. Major bank stabilization or erosion control.
Project cost	> $1M	$501 - $999K	$100 - 500K	$0 - $99K
Aesthetic, Recreation and Access impact	No impact	Low impact	Moderate positive impact	High positive impact
Public Education	No public education value	Low value - Poor site access, difficult to see, small project	Moderate value - Good access, moderate demonstration value	High value - Easy access, cooperating landowner, good demonstration and visual impact
In-stream Ecological Benefit	No in-stream ecological benefit	Low benefit - Spot location, small size	Moderate benefit - subreach based, moderate sized project	High benefit - Reach based, >1000 ft of stream
Riparian Ecological Benefit	No riparian ecological benefit	Low benefit - Spot location, small size	Moderate benefit - subreach based, moderate sized project	High benefit - Reach based, large riparian areas, floodplain scale
Project proximity/synergy	Independent project	Borders one additional project, moderate impacts to adjacent project	Near two additional projects, positive impact to all projects	Ties in well, has positive impact on other planned or existing projects

FLOODPLAIN RESTORATION

In addition to, and often in conjunction with, ditching and channelization, floodplain encroachment has caused further degradation. Under natural conditions, flood energy is dissipated over wide areas of the Menomonee River floodplain. However, in many of the tributary channels and in main stem reaches through urban settings, humans have filled in these floodplains and built roads and structures on them. This filling causes flood flows to concentrate in a narrower area, increasing the erosive power of the river channel and speeding the conveyance of water to downstream reaches that then flood more often and more severely.

It is well known that floodplain hydraulic connectivity correlates well with biological diversity in streams, due to the fact that energy coming into and leaving the stream environment must traverse both the channel and the floodplain. Flood waters hydrate dried floodplain areas, maintain vernal pools, allow for spawning of wetland dependent fish and macroinvertebrates, and provide important water for floodplain vegetation. Floods also transport nutrients and organic matter (e.g. leaves, migrating fish) back and forth in the riparian corridor. Native floodplain vegetation provides critical migratory habitat for birds and other animals.

Restoration of floodplains involves excavating small floodplain benches or can also include large scale floodplain excavation. Alternatively, incised channels can be raised back up to reconnect floodplains. This involves excavation of unwanted material, removal off site, stabilization of floodplain soils and banks, and planting of native vegetation. Floodplain restoration in park areas such as Rotary Park or Jackson Park, can also involve extensive trail development, relocation of park amenities, and reconstruction of infrastructure (bridges, outfalls).

CONSTRUCTION LOGISTICS AND PHASING

For most floodplain and meander restoration projects, the existing channel is used as a dewatering channel or the stream is put into a pipe and pumped around the project area, so the new channel and floodplain are constructed in a dry state. Once all of the channel and bank features are constructed, the water is "turned on" and then the floodplain features can be finalized. Long meandering projects can be completed in phases, depending on the amount of funding that is available. Phasing projects can be a good way of generating additional funding. Once a seed project is completed, funders are more likely to build on the successful initial effort.

DESIGN DEVELOPMENT

Concept designs offer a look into the spatial possibilities, but do not generate the topography and detailed design material quantities needed for accurate construction planning and cost estimating. The next step in the design process is to generate a design progress submittal, generally expressed as a percentage of a complete, construction ready planset. For large urban projects with park amenities and infrastructure, it is beneficial to all parties to generate a 30% or even a 60% planset. Sometimes, both submittals are warranted. In order to generate the topographic detail necessary for such plans, and to develop a hydraulic model of flows, a survey of the existing channel needs to be completed. This information is combined with either ground survey and/or LiDAR data often available to municipalities.

Topographic survey data is input into AutoCAD or another drafting program, and existing and preliminary proposed surfaces are constructed. Channel and floodplain design analysis includes modeling flood flows, sediment movement and erosive energy for a variety of flood flows. Material types and quantities are determined. Once the preliminary submittals are reviewed, comments are incorporated into 90% and 100% complete plans and specifications.

At one of the submittal junctures, plans are submitted for state, federal and local permitting. Once permits are issued, then the plans can be let out for public bid and a construction contractor hired to complete the installation under the supervision of the project Owner and the project design engineer.

CONCEPT LEVEL COST ESTIMATES

The cost information provided in Appendix B comes with the understanding that these are preliminary estimates based on concept designs only. These estimates can be used for planning purposes, but 30%, 60% and 90% design submittals will need to be generated before more refined construction estimates can be given to improve accuracy in the bid process. Cost estimates for concept level projects are typically given with an accuracy of +/- 50 to 100%. We have included a 50% caveat, but it should be noted that true costs for projects are refined at each progressive submittal. It is likely that the plan will change significantly between concept and the next submittal, and estimated costs will need to be modified accordingly.

APPENDIX A - CONCEPT PLANS

inter·fluve

Sweet Water

Rotary Park

Sweetwater Concept Design (August 26, 2015)

0 150 300 600 ft.

N

SHEET 1

inter·fluve

Sweet Water

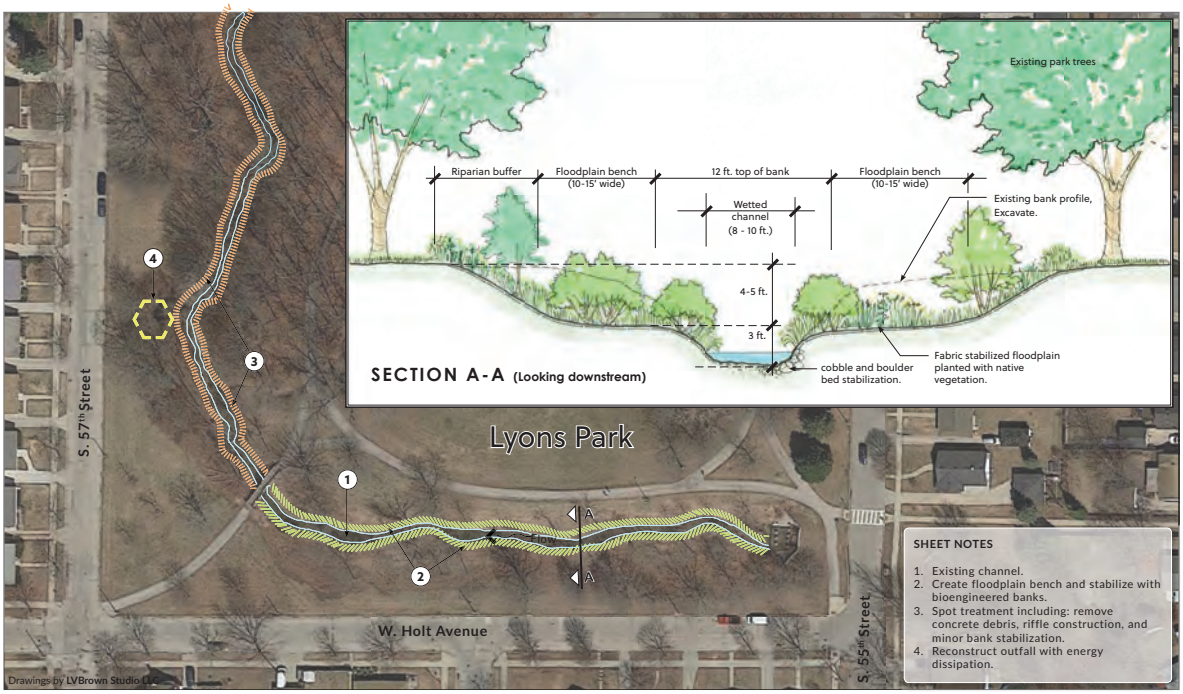
Frontier Park - Butler, WI

Sweetwater Concept Design (June 19, 2015)

0 100 200 400 ft.

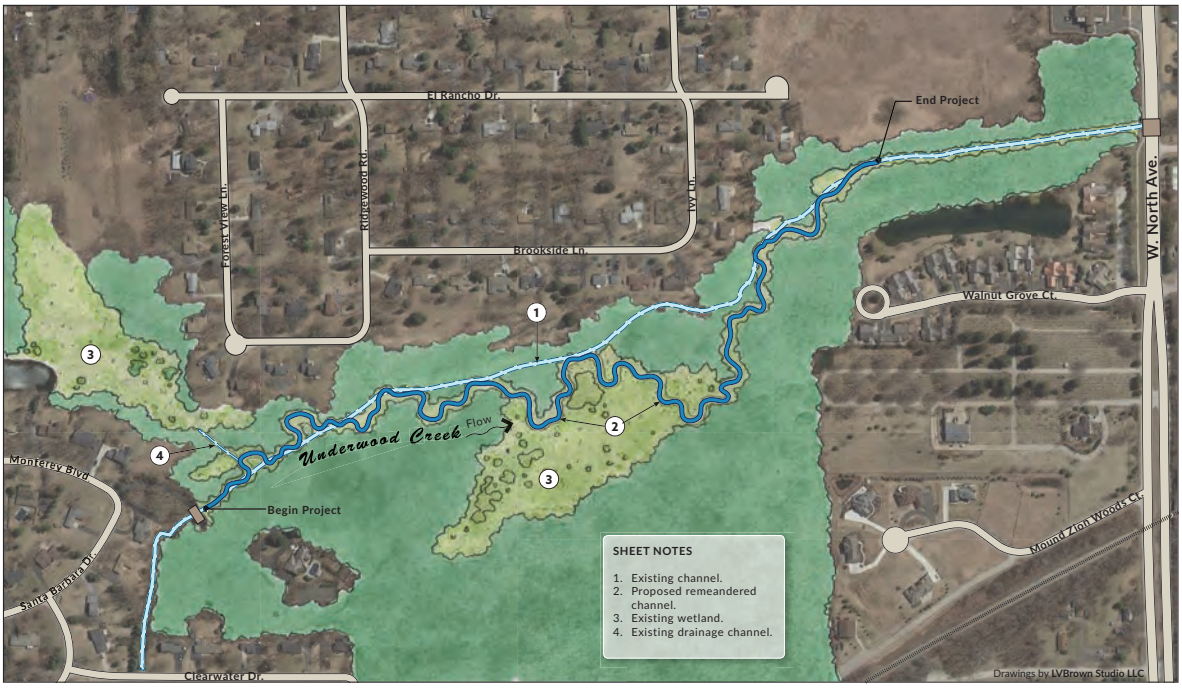
N

SHEET 2



Lyons Park Creek
Sweetwater Concept Design (June 19, 2015)
0 40 80 120 ft.
N
SHEET 3

Underwood Creek - Elm Grove
Sweetwater Concept Design (June 19, 2015)
0 150 300 450 ft.
N
SHEET 4

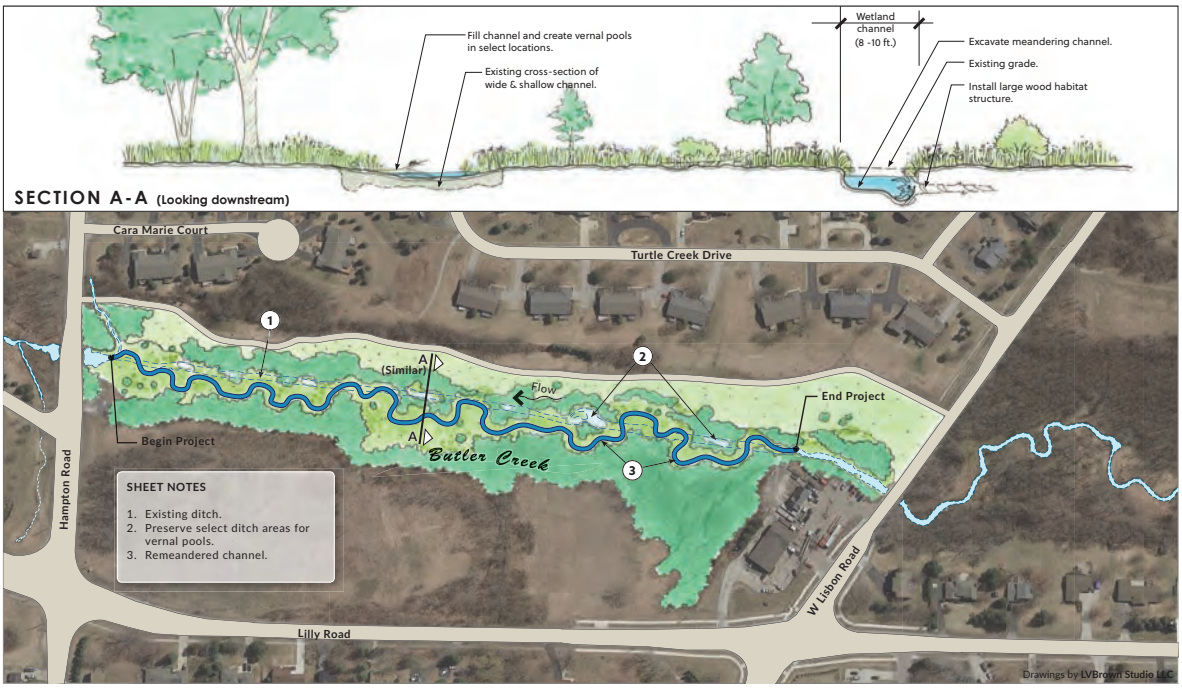


Underwood Creek - Juneau to Pomona

Sweetwater Concept Design (June 19, 2015)

0 150 300 450 ft. N

SHEET 5



Butler Creek - Reach 1

Sweetwater Concept Design (August 26, 2015)

0 100 200 300 ft. N

SHEET 6

Butler Creek - Reach 2

Sweetwater Concept Design (June 19, 2015)

0 200 400 600 ft.

N

SHEET 7

Kinnickinnic River - Jackson Park West

Sweetwater Concept Design (August 26, 2015)

0 100 200 400 ft.

N

SHEET 8

inter·fluve

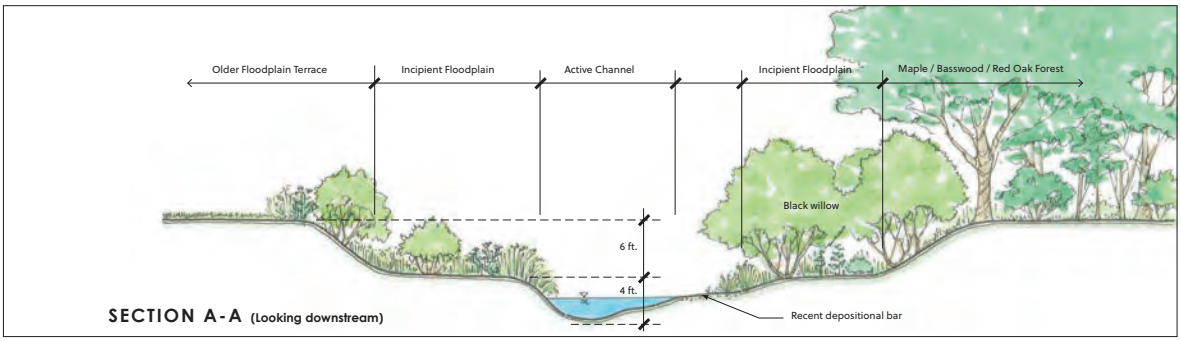
Kinnickinnic River - Jackson Park East

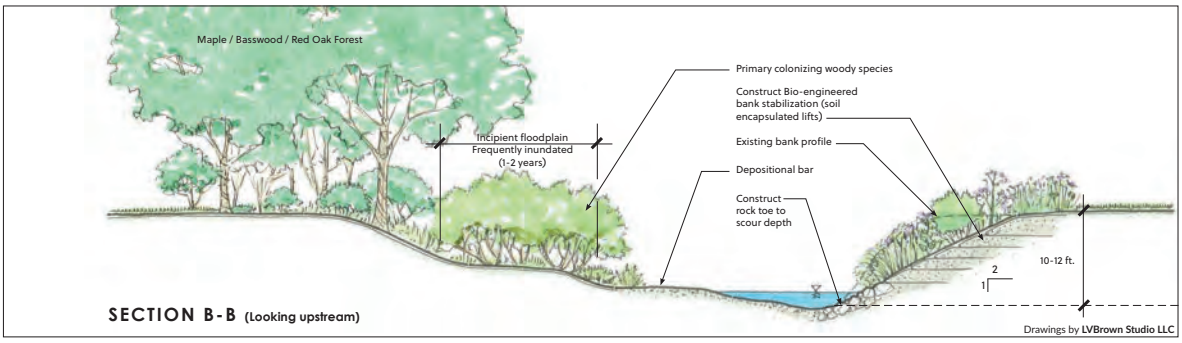
Sweetwater Concept Design (August 26, 2015)

0 100 200 400 ft.

N

SHEET 9





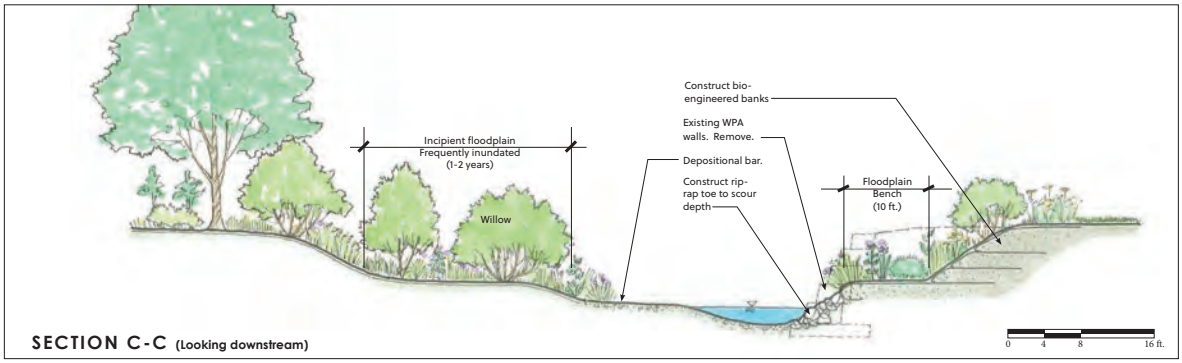
inter·fluve

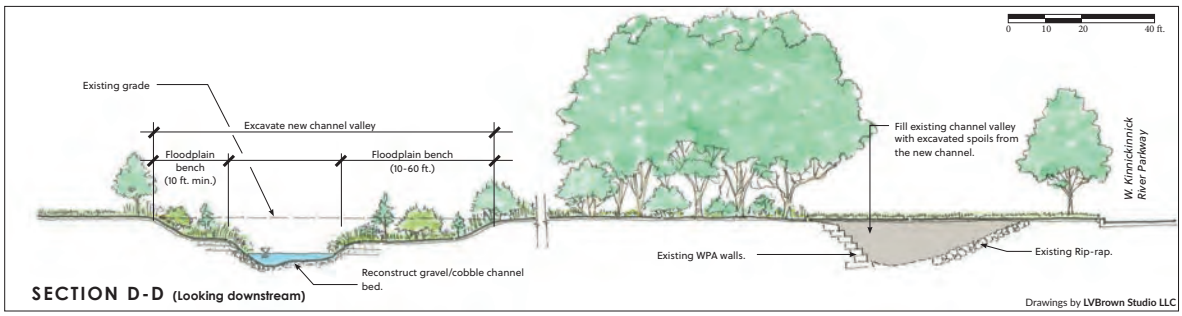
Kinnickinnic River - Jackson Park - Sections

Sweetwater Concept Design (June 19, 2015)

0 4 8 16 ft.

SHEET 10



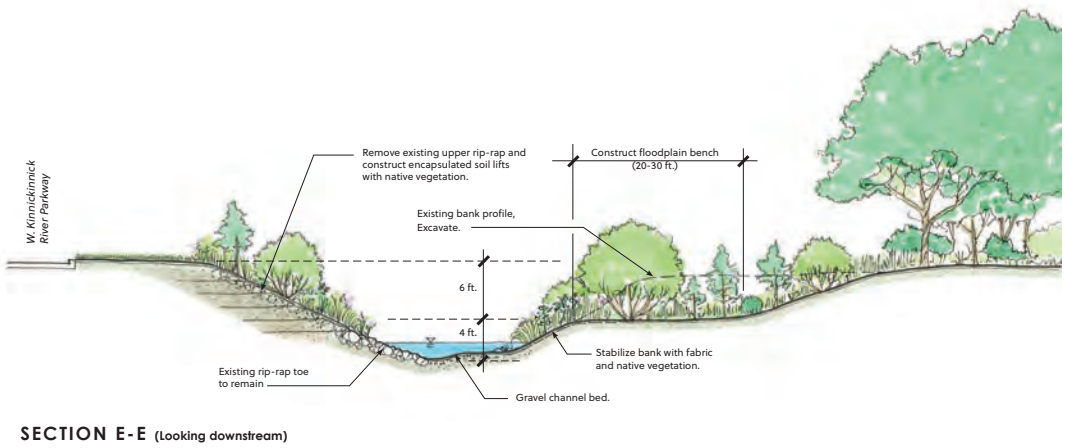


Kinnickinnic River - Jackson Park - Sections

Sweetwater Concept Design (June 19, 2015)

0 4 8 16 ft.

SHEET 11



Drawings by LVBrown Studio LLC

Kinnickinnic River - Jackson Park - Sections

Sweetwater Concept Design (June 19, 2015)

0 4 8 16 ft.

SHEET 12

APPENDIX B – CONCEPT COST ESTIMATES

COST ESTIMATE WORKSHEET

PROJECT NAME: **Rotary Park, Menomonee Falls - Menomonee River** Milwaukee, WI

* Costs are ballpark (+/- 50%) Comprehensive project 8/24/2015

Phase I - Engineering and Permitting

Item	Description	Cost per	Unit	Number	Cost
Engineering Design	Includes survey, analysis, modeling, 30, 60, 90 and 100% submittals, plans specs. Concepts are complete. Stream only, no LA	$180,000	LS	1	$180,000
Permitting	All permits and related work	$25,000	LS	1	$25,000
				Total Design and Engineering	**$205,000**

Phase 2 - Construction

Item	Description	Cost per	Unit	Number	Cost
Staging and mobilization	includes clearing, equipment mobilization, general erosion control, haul road, staging area setup (10%)	$135,673.84	lump	1.0	$135,674
Clear, grub and process wood/slash	Clear trees - Remove whole trees, save slash and rootwads, logs on site. Slash and wood to be stored in strategic piles.	$3,500.00	acre	2.0	$7,000
Dewatering	Assumes combination of work off-line and dam/pump and/or diversion, limited in-situ dewatering necessary	$25,000	lump	1	$25,000
Excavation	Channel excavation, fill of old channel - assumes $3.50 per yd to move each time, 3 times. Visual compaction.	$15.00	CY	36,296	$544,444
Grade control riffles	Assumes some riffle construction (imported fill), and also simple bank shaping and erosion control, dig and pitch for bar formation	$100.00	CY	622	$62,222
Fabric treatments	Encapsulated lifts at old channel crossings only	$42.00	face ft	2,700	$113,400
Bank construction	1 side, surface fabric (2 layer) treatment, includes fabric, stakes and staples	$4.00	SY	20,000	$80,000
Large wood/logs	Assumes rootwads and logs, at least 50% on site. (15-25 ft long), includes materials and installation. Used at channel connections	$350.00	each	30	$10,500
Seeding	Single pass corridor 40ft wide + disturbed areas , staging and access repair (avg 60ft width); 30 lb/ac	$100.00	lb	289	$28,926
Planting	Trees and shrubs, includes materials (plants, vispore mats, deer protection, mulch) and labor	$100.00	each	400	$40,000
Construction oversight	Construction manual, pre bid, pre con, staking, oversight, punch list, and final inspection	$60,000	LS	1	$60,000
				Estimated Construction Cost	**$1,107,166** +/-50%

Estimate does not include pedestrian bridges, ball fields or other park amenities
Additional considerations include long term invasive species management of riparian vegetation

COST ESTIMATE WORKSHEET

PROJECT NAME: **Rotary Park, Menomonee Falls - Menomonee River** Milwaukee, WI

* Costs are ballpark (+/- 50%) Upstream and Downstream Reaches Separated 8/24/2015

Phase I - Engineering and Permitting (Assumes design of upstream reach only)

Item	Description	Cost per	Unit	Number	Cost
Engineering Design	Includes survey, analysis, modeling, 30, 60, 90 and 100% submittals, plans specs. Concepts are complete. Stream only, no LA	$150,000	LS	1	$150,000
Permitting	All permits and related work	$20,000	LS	1	$20,000
				Total Design and Engineering (Upstream reach)	**$170,000**

Phase 2 - Construction(Upstream from Pilgrim Rd to first footbridge)

Item	Description	Cost per	Unit	Number	Cost
Staging and mobilization	includes clearing, equipment mobilization, general erosion control, haul road, staging area setup (10%)	$33,743.20	lump	1.0	$33,743
Clear, grub and process wood/slash	Clear trees - Remove whole trees, save slash and rootwads, logs on site. Slash and wood to be stored in strategic piles.	$3,500.00	acre	1.0	$3,500
Dewatering	Assumes combination of work off-line and dam/pump and/or diversion, limited in-situ dewatering necessary	$15,000	lump	1	$15,000
Excavation	Channel excavation, fill of old channel - assumes $3.00 per yd to move each time, 3 times. Visual compaction.	$9.00	CY	9,333	$84,000
Grade control riffles	Assumes some riffle construction (imported fill), and also simple bank shaping and erosion control, dig and pitch for bar formation	$100.00	CY	100	$10,000
Fabric treatments	Encapsulated lifts at old channel crossings only	$42.00	face ft	1,800	$75,600
Bank construction	1 side, surface fabric (2 layer) treatment, includes fabric, stakes and staples	$4.00	SY	5,667	$22,667
Large wood/logs	Assumes rootwads and logs, at least 50% on site. (15-25 ft long), includes materials and installation. Used at channel connections	$350.00	each	15	$5,250
Seeding	Single pass corridor 40ft wide + disturbed areas , staging and access repair (avg 60ft width); 30 lb/ac	$100.00	lb	74	$7,438
Planting	Trees and shrubs, includes materials (plants, vispore mats, deer protection, mulch) and labor	$100.00	each	50	$5,000
Construction oversight	Construction manual, pre bid, pre con, staking, oversight, punch list, and final inspection	$30,000	LS	1	$30,000
				Estimated Construction Cost (Upstream Reach)	**$292,198** +/-50%

Estimate does not include pedestrian bridges, ball fields or other park amenities
Additional considerations include long term invasive species management of riparian vegetation

Phase 3 - Engineering and Permitting (Assumes design of downstream reach)

Item	Description	Cost per	Unit	Number	Cost
Engineering Design	Includes survey, analysis, modeling, 30, 60, 90 and 100% submittals, plans specs. Concepts are complete. Stream only, no LA	$180,000	LS	1	$180,000
Permitting	All permits and related work	$20,000	LS	1	$20,000
				Total Design and Engineering (Downstream reach)	**$200,000**

Phase 4 - Construction(From first footbridge to downstream end of project)

Item	Description	Cost per	Unit	Number	Cost
Staging and mobilization	includes clearing, equipment mobilization, general erosion control, haul road, staging area setup (10%)	$76,688.66	lump	1.0	$76,689
Clear, grub and process wood/slash	Clear trees - Remove whole trees, save slash and rootwads, logs on site. Slash and wood to be stored in strategic piles.	$3,500.00	acre	1.0	$3,500
Dewatering	Assumes combination of work off-line and dam/pump and/or diversion, limited in-situ dewatering necessary	$15,000	lump	1	$15,000
Excavation	Channel excavation, fill of old channel - assumes $3.00 per yd to move each time, 3 times. Visual compaction.	$9.00	CY	26,444	$238,000
Grade control riffles	Assumes some riffle construction (imported fill), and also simple bank shaping and erosion control, dig and pitch for bar formation	$100.00	CY	533	$53,333
Fabric treatments	Encapsulated lifts at old channel crossings only	$42.00	face ft	1,800	$75,600
Bank construction	1 side, surface fabric (2 layer) treatment, includes fabric, stakes and staples	$4.00	SY	17,000	$68,000
Large wood/logs	Assumes rootwads and logs, at least 50% on site. (15-25 ft long), includes materials and installation. Used at channel connections	$350.00	each	15	$5,250
Seeding	Single pass corridor 40ft wide + disturbed areas , staging and access repair (avg 60ft width); 30 lb/ac	$100.00	lb	211	$21,074
Planting	Trees and shrubs, includes materials (plants, vispore mats, deer protection, mulch) and labor	$100.00	each	350	$35,000
Construction oversight	Construction manual, pre bid, pre con, staking, oversight, punch list, and final inspection	$40,000	LS	1	$40,000
				Estimated Construction Cost (Downstream reach)	**$631,446** +/-50%

Estimate does not include pedestrian bridges, ball fields or other park amenities
Additional considerations include long term invasive species management of riparian vegetation

COST ESTIMATE WORKSHEET

PROJECT NAME: **Frontier Park, Butler, WI - Menomonee River**

Milwaukee, WI
8/24/2015

* Costs are ballpark (+/- 50%)

Phase I - Engineering and Permitting

Item	Description	Cost per	Unit	Number	Cost
Engineering Design	Includes survey, analysis, modeling, 30, 60, 90 and 100% submittals, plans specs. Concepts are complete. Stream only, no LA	$75,000	LS	1	$75,000
Permitting	All permits and related work	$15,000	LS	1	$15,000
			Total Design and Engineering		**$90,000**

Phase 2 - Construction

Item	Description	Cost per	Unit	Number	Cost
Staging and mobilization	includes clearing, equipment mobilization, general erosion control, haul road, staging area setup (10%)	$31,702.11	lump	1.0	$31,702
Clear, grub and process wood/slash	Clear trees - Remove whole trees, save slash and rootwads, logs on site. Slash and wood to be stored in strategic piles.	$3,500.00	acre	1.0	$3,500
Dewatering	Assumes combination of work off-line and dam/pump and/or diversion, limited in-situ dewatering necessary	$15,000	lump	1	$15,000
Excavation	Channel excavation, fill of old channel - assumes $3.50 per yd to move each time, 3 times. Visual compaction.	$15.00	CY	7,407	$111,111
Grade control riffles	Assumes riffle construction (imported fill) at one location, and also simple bank shaping and erosion control, dig and pitch	$100.00	CY	148	$14,815
Fabric treatments	Encapsulated lifts at old channel crossings only	$42.00	face ft	500	$21,000
Bank construction	1 side, surface fabric (2 layer) treatment, includes fabric, stakes and staples	$4.00	SY	1,667	$6,667
Large wood/logs	Assumes rootwads and logs, at least 50% on site. (15-25 ft long), includes materials and installation. Used at channel connections	$350.00	each	100	$35,000
Seeding	Disturbed areas, staging and access repair	$100.00	lb	28	$2,755
Planting	Trees and shrubs, includes materials (plants, vispore mats, deer protection, mulch) and labor	$100.00	each	50	$5,000
Construction oversight	Construction manual, pre bid, pre con, staking, oversight, punch list, and final inspection	$20,000	LS	1	$20,000
		.	**d Construction Cost**		**$266,550** +/-50%

Estimate does not include pedestrian bridges and other park amenities
Additional considerations include long term invasive species management of riparian vegetation

Baseball Field

Landscape architecture design	Includes baseball field relocation design	$50,000	LS	1	$50,000
Ball field relocation	New infield, grade, seeding, backstop, fencing and demolition and site repair of old facility	$50,000	LS	1	$50,000

COST ESTIMATE WORKSHEET

PROJECT NAME: **Lyons Park, Lyons Park Creek, Milwaukee**

Milwaukee, WI

8/24/2015

* Costs are ballpark (+/- 50%)

Phase I - Engineering and Permitting

Item	Description	Cost per	Unit	Number	Cost
Engineering Design	Includes survey, analysis, modeling, 30, 60, 90 and 100% submittals, plans specs. Concepts are complete. Stream only, no LA	$55,000	LS	1	$55,000
Permitting	All permits and related work	$15,000	LS	1	$15,000
				Total Design and Engineering	**$70,000**

Phase 2 - Construction

Item	Description	Cost per	Unit	Number	Cost
Staging and mobilization	includes clearing, equipment mobilization, general erosion control, haul road, staging area setup (10%)	$24,374.57	lump	1.0	$24,375
Clear, grub and process wood/slash	Clear trees - Remove whole trees, save slash and rootwads, logs on site. Slash and wood to be stored in strategic piles.	$3,500.00	acre	0.5	$1,750
Dewatering	Assumes combination of work off-line and dam/pump and/or diversion, limited in-situ dewatering necessary	$15,000	lump	1	$15,000
Excavation	Channel excavation, fill of old channel - assumes $3.50 per yd to move each time, 3 times. Visual compaction.	$15.00	CY	1,600	$24,000
Grade control riffles	Assumes 3 constructed riffles (imported materials), rearrange existing in-channel material below ped crossing	$100.00	CY	33	$3,333
Fabric treatments	FES lifts in lower bank floodplain area	$42.00	face ft	900	$37,800
Bank construction	1 side, surface fabric (2 layer) treatment, includes fabric, stakes and staples	$4.00	SY	3,000	$12,000
Riprap/boulders	Assumes 5ft deep, 2ft thick, 450 x 2 sides, Cobble sized rock, installed	$100.00	CY	333	$33,333
Outfall energy dissipator	Concrete or riprap solution	$30,000.00	LS	1	$30,000
Seeding	Disturbed areas, staging and access repair	$100.00	lb	20.3	$2,030
Planting	Trees and shrubs, includes materials (plants, vispore mats, deer protection, mulch) and labor	$100.00	each	50	$5,000
Construction oversight	Construction manual, pre bid, pre con, staking, oversight, punch list, and final inspection	$20,000	LS	1	$20,000
				d Construction Cost	**$208,622** +/-50%

Estimate does not include pedestrian bridges and other park amenities
Additional considerations include long term invasive species management of riparian vegetation

COST ESTIMATE WORKSHEET

PROJECT NAME: **Underwood Creek - Elm Grove, WI (Marcella to Elmhurst Pkwy)** Milwaukee, WI

* Costs are ballpark (+/- 50%) Elm Grove Village Park 8/24/2015

Phase I - Engineering and Permitting

Item	Description	Cost per	Unit	Number	Cost
Engineering Design	Includes survey, analysis, modeling, 30, 60, 90 and 100% submittals, plans specs. Concepts are complete. Stream only, no LA	$98,000	LS	1	$98,000
Permitting	All permits and related work	$20,000	LS	1	$20,000
				Total Design and Engineering	**$118,000**

Phase 2 - Construction

Item	Description	Cost per	Unit	Number	Cost
Staging and mobilization	includes clearing, equipment mobilization, general erosion control, haul road, staging area setup (10%)	$36,916.25	lump	1.0	$36,916
Clear, grub and process wood/slash	Clear trees - Remove whole trees, save slash and rootwads, logs on site. Slash and wood to be stored in strategic piles.	$3,500.00	acre	6.2	$21,694
Dewatering	Assumes combination of work off-line and dam/pump and/or diversion, limited in-situ dewatering necessary	$10,000	lump	1	$10,000
Excavation	Channel excavation, fill of old channel - assumes $3.50 per yd to move each time, 3 times. Visual compaction. Assumes 4500 ft of new channel.	$15.00	CY	5,000	$75,000
Grade control riffles	Assumes riffle construction (imported fill)	$100.00	CY	133	$13,333
Fabric treatments	Encapsulated lifts at old channel crossings only	$42.00	face ft	1,000	$42,000
Bank construction	1 side, surface fabric (2 layer) treatment, includes fabric, stakes and staples	$4.00	SY	10,111	$40,444
Large wood/logs	Assumes rootwads and logs, at least 50% on site. (15-25 ft long), includes materials and installation. Used at channel connections	$350.00	each	100	$35,000
Seeding	Disturbed areas, staging and access repair	$100.00	lb	103	$10,331
Planting	Trees and shrubs, includes materials (plants, vispore mats, deer protection, mulch) and labor	$100.00	each	200	$20,000
Construction oversight	Construction manual, pre bid, pre con, staking, oversight, punch list, and final inspection	$30,000	LS	1	$30,000
				d Construction Cost	**$334,719** +/-50%

Estimate does not include pedestrian bridges and other park amenities
Additional considerations include long term invasive species management of riparian vegetation

COST ESTIMATE WORKSHEET

PROJECT NAME: **Underwood Creek - Brookfield, WI (Clearwater to North Ave.)**

Milwaukee, WI

* Costs are ballpark (+/- 50%)

8/24/2015

Phase I - Engineering and Permitting

Item	Description	Cost per	Unit	Number	Cost
Engineering Design	Includes survey, analysis, modeling, 30, 60, 90 and 100% submittals, plans specs. Concepts are complete. Stream only, no LA	$98,000	LS	1	$98,000
Permitting	All permits and related work	$20,000	LS	1	$20,000
				Total Design and Engineering	**$118,000**

Phase 2 - Construction

Item	Description	Cost per	Unit	Number	Cost
Staging and mobilization	includes clearing, equipment mobilization, general erosion control, haul road, staging area setup (10%)	$36,616.25	lump	1.0	$36,616
Clear, grub and process wood/slash	Clear trees - Remove whole trees, save slash and rootwads, logs on site. Slash and wood to be stored in strategic piles.	$3,500.00	acre	5.5	$19,284
Dewatering	Assumes combination of work off-line and dam/pump and/or diversion, limited in-situ dewatering necessary	$10,000	lump	1	$10,000
Excavation	Channel excavation, fill of old channel - assumes $3.50 per yd to move each time, 3 times. Visual compaction. Assumes 4500 ft of new channel.	$15.00	CY	5,000	$75,000
Grade control riffles	Assumes riffle construction (imported fill)	$100.00	CY	133	$13,333
Fabric treatments	Encapsulated lifts at old channel crossings only	$42.00	face ft	1,000	$42,000
Bank construction	1 side, surface fabric (2 layer) treatment, includes fabric, stakes and staples	$4.00	SY	10,111	$40,444
Large wood/logs	Assumes rootwads and logs, at least 50% on site. (15-25 ft long), includes materials and installation. Used at channel connections	$350.00	each	100	$35,000
Seeding	Disturbed areas, staging and access repair	$100.00	lb	103	$10,331
Planting	Trees and shrubs, includes materials (plants, vispore mats, deer protection, mulch) and labor	$100.00	each	180	$18,000
Construction oversight	Construction manual, pre bid, pre con, staking, oversight, punch list, and final inspection	$30,000	LS	1	$30,000
				d Construction Cost	**$330,008** +/-50%

Estimate does not include pedestrian bridges and other park amenities
Additional considerations include long term invasive species management of riparian vegetation

COST ESTIMATE WORKSHEET

PROJECT NAME: **Butler Creek, Brookfield WI**

Milwaukee, WI
8/24/2015

* Costs are ballpark (+/- 50%)

Phase I - Engineering and Permitting

Item	Description	Cost per	Unit	Number	Cost
Engineering Design	Includes survey, analysis, modeling, 30, 60, 90 and 100% submittals, plans specs. Concepts are complete. Stream only, no LA	$98,000	LS	1	$98,000
Permitting	All permits and related work	$20,000	LS	1	$20,000
				Total Design and Engineering	**$118,000**

Phase 2 - Construction

Item	Description	Cost per	Unit	Number	Cost
Staging and mobilization	includes clearing, equipment mobilization, general erosion control, haul road, staging area setup (10%)	$17,879.75	lump	1.0	$17,880
Clear, grub and process wood/slash	Clear trees - Remove whole trees, save slash and rootwads, logs on site. Slash and wood to be stored in strategic piles.	$3,500.00	acre	1.7	$6,026
Dewatering	Assumes combination of work off-line and dam/pump and/or diversion, limited in-situ dewatering necessary	$10,000	lump	1	$10,000
Excavation	Channel excavation, fill of old channel - assumes $3.50 per yd to move each time, 3 times. Visual compaction. Assumes 1500 ft of new channel.	$15.00	CY	1,667	$25,000
Grade control riffles	Assumes riffle construction (imported fill)	$100.00	CY	44	$4,444
Fabric treatments	Encapsulated lifts at old channel crossings only	$42.00	face ft	500	$21,000
Bank construction	1 side, surface fabric (2 layer) treatment, includes fabric, stakes and staples	$4.00	SY	2,889	$11,556
Large wood/logs	Assumes rootwads and logs, at least 50% on site. (15-25 ft long), includes materials and installation. Used at channel connections	$350.00	each	60	$21,000
Seeding	Disturbed areas, staging and access repair	$100.00	lb	62	$6,198
Planting	Trees and shrubs, includes materials (plants, vispore mats, deer protection, mulch) and labor	$100.00	each	200	$20,000
Construction oversight	Construction manual, pre bid, pre con, staking, oversight, punch list, and final inspection	$40,000	LS	1	$40,000
				d Construction Cost	**$183,104** +/-50%

Estimate does not include pedestrian bridges and other park amenities
Additional considerations include long term invasive species management of riparian vegetation

COST ESTIMATE WORKSHEET

PROJECT NAME: **Butler Creek, Brookfield, WI**

Milwaukee, WI
8/24/2015

* Costs are ballpark (+/- 50%)

Phase I - Engineering and Permitting

Item	Description	Cost per	Unit	Number	Cost
Engineering Design	Includes survey, analysis, modeling, 30, 60, 90 and 100% submittals, plans specs. Concepts are complete. Stream only, no LA	$108,000	LS	1	$108,000
Permitting	All permits and related work	$20,000	LS	1	$20,000
				Total Design and Engineering	**$128,000**

Phase 2 - Construction

Item	Description	Cost per	Unit	Number	Cost
Staging and mobilization	includes clearing, equipment mobilization, general erosion control, haul road, staging area setup (10%)	$40,892.42	lump	1.0	$40,892
Clear, grub and process wood/slash	Clear trees - Remove whole trees, save slash and rootwads, logs on site. Slash and wood to be stored in strategic piles.	$3,500.00	acre	1.1	$4,017
Dewatering	Assumes combination of work off-line and dam/pump and/or diversion, limited in-situ dewatering necessary	$15,000	lump	1	$15,000
Excavation	Channel excavation, fill of old channel - assumes $3.50 per yd to move each time, 3 times. Visual compaction. Assumes 4500 ft of new channel.	$15.00	CY	6,444	$96,667
Grade control riffles	Assumes riffle construction (imported fill)	$100.00	CY	44	$4,444
Fabric treatments	Encapsulated lifts at old channel crossings only	$42.00	face ft	500	$21,000
Bank construction	1 side, surface fabric (2 layer) treatment, includes fabric, stakes and staples	$4.00	SY	14,444	$57,778
Large wood/logs	Assumes rootwads and logs, at least 50% on site. (15-25 ft long), includes materials and installation. Used at channel connections	$350.00	each	100	$35,000
Seeding	Disturbed areas, staging and access repair	$100.00	lb	227	$22,727
Planting	Trees and shrubs, includes materials (plants, vispore mats, deer protection, mulch) and labor	$100.00	each	200	$20,000
Construction oversight	Construction manual, pre bid, pre con, staking, oversight, punch list, and final inspection	$40,000	LS	1	$40,000
				d Construction Cost	**$357,526** +/-50%

Estimate does not include pedestrian bridges and other park amenities
Additional considerations include long term invasive species management of riparian vegetation

COST ESTIMATE WORKSHEET

PROJECT NAME: **Kinnickinnic River, Milwaukee, WI**

Milwaukee, WI
8/18/2015

* Costs are ballpark (+/- 50%)

Phase I - Engineering and Permitting

Item	Description	Cost per	Unit	Number	Cost
Engineering Design	Includes survey, analysis, modeling, 30, 60, 90 and 100% submittals, plans specs. Concepts are complete. Stream only, no LA	$300,000	LS	1	$300,000
Permitting	All permits and related work	$40,000	LS	1	$40,000
				Total Design and Engineering	**$340,000**

Phase 2 - Construction

Item	Description	Cost per	Unit	Number	Cost
Staging and mobilization	includes clearing, equipment mobilization, general erosion control, haul road, staging area setup (10%)	$164,444.40	lump	1.0	$164,444
Clear, grub and process wood/slash	Clear trees - Remove whole trees, save slash and rootwads, logs on site. Slash and wood to be stored in strategic piles.	$3,500.00	acre	4.0	$14,000
Dewatering	Assumes combination of work off-line and dam/pump and/or diversion, limited in-situ dewatering necessary	$35,000	lump	1	$35,000
Excavation	Channel excavation, fill of old channel - assumes $3.50 per yd to move each time, 3 times. Visual compaction. 1,100 feet of new channel and 4,000 ft of bench widening.	$15.00	CY	37,037	$555,556
Grade control riffles	Assumes riffle construction (imported fill)	$100.00	CY	593	$59,259
Fabric treatments	Encapsulated lifts	$42.00	face ft	6,000	$252,000
Bank construction	1 side, surface fabric (2 layer) treatment, includes fabric, stakes and staples	$4.00	SY	28,889	$115,556
Seeding	Disturbed areas, staging and access repair	$100.00	lb	289	$28,926
Planting	Trees and shrubs, includes materials (plants, vispore mats, deer protection, mulch) and labor	$100.00	each	500	$50,000
Construction oversight	Construction manual, pre bid, pre con, staking, oversight, punch list, and final inspection	$100,000	LS	1	$100,000
				d Construction Cost	**$1,374,740** +/-50%

Estimate does not include pedestrian bridges and other park amenities
Additional considerations include long term invasive species management of riparian vegetation

APPENDIX F. MENOMONEE RIVER MUNICIPAL GROUP STORMWATER PERMIT 2020

WISCONSIN
DEPT. OF NATURAL RESOURCES

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 _____ 3/31/2020
Jacob Zimmerman, PE — Date Permit Signed
Water Resources Engineer

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

Table of Contents

Section Page
I. APPLICABILITY 4
A. PERMITTED AREA 4
B. AUTHORIZED DISCHARGES 4
C. INDIVIDUAL RESPONSIBILITY 4
D. SHARED RESPONSIBILITY 4
E. WATER QUALITY STANDARDS 5
F. WETLANDS 5
G. ENDANGERED AND THREATENED SPECIES 5
H. HISTORIC PROPERTY 5
I. IMPAIRED WATERBODIES 6
J. GENERAL STORM WATER DISCHARGE LIMITATIONS 6
K. EXCLUSIONS 7
II. STORM WATER MANAGEMENT PROGRAM 8
A. GROUP PUBLIC EDUCATION AND OUTREACH CONDITIONS 8
B. INDIVIDUAL EDUCATION AND OUTREACH CONDITIONS 9
C. PUBLIC INVOLVEMENT AND PARTICIPATION 10
D. ILLICIT DISCHARGE DETECTION AND ELIMINATION 10
E. CONSTRUCTION SITE POLLUTION CONTROL 13
F. POST-CONSTRUCTION STORM WATER MANAGEMENT 15
G. POLLUTION PREVENTION 16
1. Winter Road Management: 17
2. Nutrient Management: 17
3. Street Sweeping and Catch Basin Cleaning: 17
4. Management of Leaves and Grass Clippings: 18
5. Storm Water Pollution Prevention Planning: 18
6. Internal Training and Education: 18
H. STORM WATER QUALITY MANAGEMENT 18
I. STORM SEWER SYSTEM MAP 19
J. AMENDMENTS 19
K. ANNUAL REPORT 20
L. REAPPLICATION FOR PERMIT COVERAGE 21
III. SPECIAL CONDITIONS 23

A. TOTAL MAXIMUM DAILY LOADS (TMDLs): 23
B. INDIVIDUAL BENCHMARKS 25
IV. IMPLEMENTATION SCHEDULE 29
A. ALL PERMITTEES: 29
B. INDIVIDUAL CONDITIONS: 30
V. STANDARD CONDITIONS 32
VI. DEFINITIONS 36
VII. TSS AND TP WASTELOAD ALLOCATIONS 40

I. APPLICABILITY

A. PERMITTED AREA

This Wisconsin Pollution Discharge Elimination System (WPDES) permit regulates municipal separate storm sewer system (MS4) discharges from the following municipalities located fully or partially within the Menomonee River Watershed:

- 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

In this permit these municipalities are referred to as the Menomonee River Watershed Permittees. This permit covers all areas within the jurisdiction of the Menomonee River Watershed Permittees, including areas of the communities which do not drain into the Menomonee River watershed. This permit is issued in accordance with chapter 283, Wis. Stats. and chs. NR 151 and NR 216, Wis. Adm. Code.

B. AUTHORIZED DISCHARGES

This permit authorizes storm water point source discharges from the MS4 to waters of the state in the permitted area. This permit also authorizes the discharge of storm water co-mingled with flows contributed by process wastewater, non-process wastewater, and storm water associated with industrial activity, provided the discharges are regulated by other WPDES permits or are discharges which are not considered illicit discharges pursuant to Section II. D. 1 of this permit.

C. INDIVIDUAL RESPONSIBILITY

Each Menomonee River Watershed Permittee is responsible for:

1. Effectively prohibiting non-storm water discharges into the MS4 unless otherwise permitted by Section I. B.

2. Reducing pollutants to the maximum extent practicable (MEP). Compliance with this permit, completion of individual benchmarks, and implementation of the storm water management program establishes this MEP requirement.

3. Completing the Total Maximum Daily Load (TMDL) requirements in Section III. A. and the applicable municipality specific special requirements in Section III. B.

D. SHARED RESPONSIBILITY

1. The Menomonee River Watershed Permittees may work together to comply with the provisions of Section II. A. of this permit.

2. The Menomonee River Watershed Permittees' implementation of one or more of the conditions of this permit may incorporate cooperative efforts with other MS4 regulated

permittees or efforts by other groups or organizations if the shared responsibility is approved by the Department. The permittee may rely on another municipality or contract with another entity to satisfy a condition of this permit if all of the following are met:

a) The other municipality or entity implements the required control measure or permit requirements.
b) A particular control measure, or component thereof, is at least as stringent as the corresponding permit requirements.
c) The other municipality or entity agrees to implement a control measure or permit requirement on the permittee's behalf. This shall be shown by formal written agreement, signed by both parties' authorized representatives. The agreement shall be explicit as to which specific permit conditions are being covered by which municipality or other entity. Copies of current agreements shall be submitted with the annual report or to the Department upon request.

E. WATER QUALITY STANDARDS

1. This permit specifies the conditions under which storm water may be discharged to waters of the state for the purpose of achieving water quality standards contained in chs. NR 102 through 105, NR 140, and NR 207, Wis. Adm. Code. During the permit term, compliance with water quality standards will be addressed by adherence to the requirements of this permit, implementation of storm water management programs and practices, and modifications to practices when practices are determined not effective to achieve the aforementioned goals and standards.

2. This permit does not authorize water discharges that the Department, prior to authorization of coverage under this permit, determines will cause or have reasonable potential to cause or contribute to an excursion above any applicable water quality standards. Where such determinations have been made prior to authorization, the Department may authorize coverage under this permit where the storm water management programs required under this permit will include appropriate controls and implementation procedures designed to bring the storm water discharge into compliance with water quality standards.

F. WETLANDS

The permittee's MS4 discharge shall comply with the applicable wetland water quality standards provisions in ch. NR 103, Wis. Adm. Code.

G. ENDANGERED AND THREATENED SPECIES

The permittee's MS4 discharge shall comply with the endangered and threatened resource protection requirements of s. 29.604, Wis. Stats., and ch. NR 27, Wis. Adm. Code.

H. HISTORIC PROPERTY

The permittee's MS4 discharge may not affect any historic property that is listed property, or on the inventory or on the list of locally designated historic places under s. 44.45, Wis. Stats., unless the Department determines that the MS4 discharge will not have an adverse effect on any historic property pursuant to s. 44.40(3), Wis. Stats.

I. IMPAIRED WATERBODIES

The requirements of this section apply to receiving waters listed as impaired on the 303(d) list without established TMDL wasteload allocations to which the permittee discharges. The permittee shall:

1. Review the applicable pollutants of concern on the 2018 303(d) list, or the most recent United States Environmental Protection Agency (EPA) approved list that are relevant to the permittee's MS4 discharge and determine whether any part of its MS4 discharges to a listed impaired waterbody. Review shall occur within 12 months each time the 303(d) list is revised.

2. Include a written section in their storm water management program that discusses the management practices and control measures it will implement as part of its program to reduce, with the goal of eliminating, the discharge of each pollutant of concern that contributes to the impairment of the waterbody. This section of the permittee's program shall specifically identify control measures and practices that will collectively be used to eliminate the MS4's discharge of pollutant(s) of concern that contribute to the impairment of the waterbody and explain why these control measures and practices were chosen as opposed to other alternatives. Pollutant(s) of concern means a pollutant that is causing impairment of a waterbody.

   Note: The Department maintains a searchable database of impaired waterways. This publicly accessible database is available at http://dnr.wi.gov/water/impairedSearch.aspx.

3. After a permittee's start date of coverage under this permit, the permittee may not establish a new MS4 discharge of a pollutant of concern to an impaired waterbody or increase the discharge of a pollutant of concern to an impaired waterbody unless the new or increased discharge causes the receiving water to meet applicable water quality standards, or the new discharge is consistent with an EPA approved TMDL.

J. GENERAL STORM WATER DISCHARGE LIMITATIONS

In accordance with s. NR 102.04, Wis. Adm. Code, the Menomonee River Watershed Permittees shall control storm water discharges so that all surface waters including the mixing zone meet the following conditions at all times and under all flow and water level conditions:

1. Substances that will cause objectionable deposits on the shore or in the bed of a body of water, shall not be present in such amounts as to interfere with public rights in waters of the state.

2. Floating or submerged debris, oil, scum or other material shall not be present in such amounts as to interfere with public rights in waters of the state.

3. Materials producing color, odor, taste or unsightliness shall not be present in such amounts as to interfere with public rights in waters of the state.

4. Substances in concentrations or combinations which are toxic or harmful to humans shall not be present in amounts found to be of public health significance, nor shall substances be present in amounts which are acutely harmful to animal, plant or aquatic life.

K. EXCLUSIONS

The following are excluded from coverage under this permit:

1. Combined Sewer and Sanitary Sewer Systems:
   Discharges of water from a wastewater treatment facility, sanitary sewer or a combined sewer system conveying both sanitary and storm water. These discharges are regulated under s. 283.31, Wis. Stats, and require a separate individual permit.

2. Agricultural Facilities and Practices:
   Discharges from “agricultural facilities” and “agricultural practices”. “Agricultural facility" means a structure associated with an agricultural practice. “Agricultural practice" means beekeeping; commercial feedlots; dairying; egg production; floriculture; fish or fur farming; grazing; livestock raising; orchards; poultry raising; raising of grain, grass, mint and seed crops; raising of fruits, nuts and berries; sod farming; placing land in federal programs in return for payments in kind; owning land, at least 35 acres of which is enrolled in the conservation reserve program under 16 USC 3831 to 3836; and vegetable raising.

3. Other Excluded Discharges:
   Storm water discharges from industrial operations or land disturbing construction activities that require separate coverage under a WPDES permit pursuant to subchs. II or III of ch. NR 216, Wis. Adm. Code. For example, while storm water from industrial or construction activity may discharge from an MS4, this permit does not satisfy the need to obtain any other permits for those discharges. This exclusion does not apply to each permittee’s responsibility to regulate construction sites within its jurisdiction in accordance with Sections II. E. and F. of this permit.

4. Indian Country:
   Storm water discharges within Indian Country. The federal Clean Water Act requires that owners and operators of storm water discharges within Indian Country to obtain permit coverage directly from the EPA.

II. STORM WATER MANAGEMENT PROGRAM

The permittee shall have a written storm water management program (SWMP) that describes in detail how the permittee intends to comply with the permit requirements for each minimum control measure. Unless otherwise specified, the permittee shall submit written program documents no later than March 31, 2022 and shall begin implementing any updates to its storm water management programs no later than March 31, 2022.

A. GROUP PUBLIC EDUCATION AND OUTREACH CONDITIONS

The Menomonee River Watershed Permittees shall implement a written public education and outreach program to increase the awareness of how the combined actions of human behavior influence storm water pollution and its effects on the environment. The public education and outreach program may incorporate cooperative efforts with other entities not regulated by this permit provided a mechanism is developed and implemented to track the results of these cooperative efforts and reported annually.

The Menomonee River Watershed Permittees intend to collaborate and satisfy these conditions collectively. This does not prohibit the Menomonee River Watershed Permittees from continuing to develop and implement unique programs within their respective jurisdictional municipal boundaries.

The program shall:

1. For each topic in Table 1, identify targeted pollutants of concern, the targeted audience, delivery mechanism and the entity responsible for implementation.

2. Address all topics at least once during the permit term with a minimum of 3 topics being addressed, either collectively or individually, each year. Topics may be repeated as necessary.

3. Address the topics in Table 1 below:

Table 1: Public Education and Outreach Topics

#	Topic Area	Description
1	Illicit Discharge Detection and Elimination	Promote detection and elimination of illicit discharges and water quality impacts associated with such discharges from municipal separate storm sewer systems.
2	Household Hazardous Waste Disposal/Pet Waste Management/Vehicle Washing	Inform and educate the public about the proper management of materials that may cause storm water pollution from sources including automobiles, pet waste, household hazardous waste and household practices.
3	Yard Waste Management/Pesticide and Fertilizer Application	Promote beneficial onsite reuse of leaves and grass clippings and proper use of lawn and garden fertilizers and pesticides.
4	Stream and Shoreline Management	Promote the management of streambanks and shorelines by riparian landowners to minimize erosion and restore and enhance the ecological value of waterways.

5	Residential Infiltration	Promote infiltration of residential storm water runoff from rooftop downspouts, driveways and sidewalks through implementation of green infrastructure best management practices (BMPs) such as rain barrels, rain gardens, and permeable pavements.
6	Construction Sites and Post-Construction Storm Water Management	Inform and educate those responsible for the design, installation, and maintenance of construction site erosion control practices and storm water management facilities on how to design, install and maintain the practices.
7	Pollution Prevention	Storm water runoff from commercial properties and, where appropriate, educate specific businesses such as lawn care companies, golf courses, carwashes, and restaurants on storm water pollution prevention planning to reduce pollutant sources.
8	Green Infrastructure/Low Impact Development	Promote environmentally sensitive land development designs by developers and designers, including green infrastructure and low impact development.
9	Snow and Ice Control	Promote BMPs for snow and ice removal and inform specific audiences such as snow removal/deicing companies, private residences, industrial and commercial facilities, and residents about resources that provide further information on methods of reducing application of chemical deicers while maintaining public safety.

B. INDIVIDUAL EDUCATION AND OUTREACH CONDITIONS

Each MS4, excluding Milwaukee County, must implement an education and outreach program designed to achieve measurable goals based upon target audiences, specific storm water quality issues in the community, or identified pollutants of concern. The permittee must:

1. Evaluate the Storm Water Education Needs of their individual community by September 30, 2021. The permittee shall:

   a) Conduct a survey or use other appropriate methods to identify their education needs.

   b) Submit a list of prioritized storm water education needs for their community including the methods and rationale used for prioritization.

2. Complete Targeted Education. The permittee shall:

   a) By September 30, 2023, provide education and outreach within the MS4 boundary for at least one prioritized education topic identified in Section II. B. 1.

   b) Develop metrics that will be used for measuring progress after the education event has been held.

c) Submit as part of the permit application (due September 30, 2024), a summary of the results of the education efforts and planned targeted education for the next permit term.

C. PUBLIC INVOLVEMENT AND PARTICIPATION

The permittee shall implement a public involvement and participation program that provides opportunities for the public to effectively participate in the development, implementation, and modification of the permittee's storm water management program. The approach must include provisions for receiving and considering public comments on the following permit activities: annual reports, SWMP revisions, adoption of storm water related ordinances, and TMDL pollutant load reduction benchmark development. The permittee shall also identify delivery mechanism and target participants associated with each permit activity. Delivery mechanisms may include public workshop, presentation of storm water information, government event (public hearing, council meeting, etc.), citizen committee meeting, or website.

D. ILLICIT DISCHARGE DETECTION AND ELIMINATION

Each municipality shall continue to implement a program to detect, remove, and eliminate illicit connections and discharges to the municipal separate storm sewer system. The program must include:

1. **Ordinance:** An ordinance or other regulatory mechanism, at a minimum, to:
   a) Prohibit illicit discharge, spilling or dumping of non-storm water substances or material into the permittee's MS4 or waters of the state.

   b) Identify non-storm water discharges or flows that are not considered illicit discharges. Non- storm water discharges that are not considered illicit discharges including water line flushing, landscape irrigation, diverted stream flows, uncontaminated groundwater infiltration, uncontaminated pumped groundwater, discharges from potable water sources, foundation drains, air conditioning condensation, irrigation water, lawn watering, individual residential car washing, flows from riparian habitats and wetlands, firefighting, and discharges authorized under a WPDES permit unless identified by the permittee as significant source of pollutants to waters of the state.

   c) Establish inspection and enforcement authority.

Note: Chapter NR 815, Wis. Adm. Code, regulates injection wells including storm water injection wells. Construction or use of a well to dispose of storm water directly into groundwater is prohibited under s. NR 815.11(5), Wis. Adm. Code.

2. **Dry Weather Outfall Screening:** A written IDDE field screening procedure. At a minimum, the procedure must include:
   a) The name, title, and phone number of the individual(s) responsible for field screening activities.

   b) Field screening during dry weather periods (72 hours after measurable rainfall) at the MS4 outfalls.

(1) Location. Screening locations shall be selected by the following criteria:

(a) All major outfalls which showed no indication of illicit discharges during the previous permit term. Annually, at least 20 percent of such major outfalls shall be screened, on a rolling basis, such that at the end of the permit term all major outfalls which showed no indication of illicit discharges during the previous permit term have been screened.

(b) All major outfalls which showed evidence of illicit discharges or exceeded a parameter action level during the last two samplings under the preceding permit term shall be evaluated at a minimum one time per year.

(c) All other outfalls regardless of size, which have been identified as a priority screening location based upon the Human Illicit Discharge Potential methodology. At least 20 percent of such priority outfalls shall be screened annually, on a rolling basis such that at the end of the permit term all major outfalls which showed no indication of illicit discharges during the previous permit term have been screened.

Note: The Human Illicit Discharge Potential methodology was developed during the previous permit term. The prioritization of non-major outfalls should be periodically updated based upon the results of field screening.

(2) Visual Observation. A narrative description of visual observations including color, odor, turbidity, oil sheen or surface scum, trash, flow rate, condition of conveyance system or outfall, and any other relevant observations regarding the potential presence of non-storm water discharges or illicit dumping shall be completed for each outfall visited.

(3) Field Analysis. If flow is observed, a field analysis must be conducted to determine the cause of the dry weather flow. The field analysis shall include sampling for pH, total chlorine, total copper, total phenol, and detergents unless the permittee elects to use alternative indicator parameters such as ammonia, potassium, and fluoride. Other alternative indicator parameters may be authorized by the Department in writing. Where appropriate, pollutant parameter action levels identified by the permittee must be considered. Field analysis procedures shall describe when other investigation methods such as dye testing or televising will be used.

(4) Pollutant parameter action levels that will be used as part of the field screening and analysis under Section II. D. 2. b) (3). The action levels will identify concentrations for identified pollutants that, if exceeded, will require further investigation, which may include laboratory analysis, to identify the source the illicit discharge.

(5) Laboratory Analysis. If general observations and field screening indicate the presence of a suspected illicit discharge and the source or cause of the illicit discharge cannot be determined through other investigatory methods, the permittee

shall collect a water quality sample for laboratory analysis for ongoing discharges. The water quality sample must be analyzed for pollutant parameters or identifiers which will aide in the determination of the sources of the illicit discharge.

c) Documentation. Visual observation and field screening results shall be recorded for each outfall and kept for 5 years. A summary of results shall be included with the annual report.

3. **Investigation and Elimination Procedures.** The permittee shall have written procedures for investigating and responding to known or suspected illicit discharges. Procedures must be developed for all of the following:

a) The name, title, and phone number of the individual(s) responsible for responding to reports of illicit discharges and spills.

b) Immediately investigating portions of the municipal separate storm sewer system that, based on the results of visual observation, field screening, laboratory analysis, or other relevant information, such as a complaint or referral, indicates a reasonable potential for containing illicit discharges.

c) Responding to spills that discharge into and/or from the MS4 including tracking the source of the spill if unknown.

d) Preventing and containing spills that may discharge into or are already within the MS4.

e) Immediately notifying the Department in accordance with ch. NR 706, Wis. Adm. Code, if the permittee identifies a spill or release of a hazardous substance, which results in the discharge of pollutants into waters of the state. The Department shall be notified via the 24-hour toll free spill hotline at 1-800-943-0003. The permittee shall cooperate with Department in efforts to investigate and prevent such discharges from polluting waters of the state.

f) Elimination of the illicit discharge as soon as practicable.

(1) Once the source of an illicit discharge is determined, the permittee must take appropriate action to seek to eliminate the illicit discharges within 30 days. This includes an initial evaluation of the feasibility to eliminate the discharge within 30 days. The permittee shall contact the Department if the illicit discharge cannot be eliminated in the 30-day time period.

(2) If the permittee determines that the elimination of the illicit discharge will take more than 30 days due to technical, logistical or other reasonable issues, the permittee must develop and implement an illicit discharge elimination plan to remove the illicit discharge in an expeditious manner. The elimination plan must be submitted to the Department within 45 days of determining the source of an illicit discharge. In lieu of developing and implementing an individual elimination plan for common types of illicit discharges, the permittee may document and

implement response procedures, a response plan, or similar document. The action plan, response procedures, response plan or similar document must include a timeframe for elimination of the illicit discharge as soon as practicable.

g) Elimination of any leakage or discharge from sanitary conveyance systems into the MS4 as required in s. NR 216.07 (3) (h), Wis. Adm. Code.

h) Providing the Department with advance notice of the time and location of dye testing within a MS4.

i) Notification of adjacent municipality. In the case of an illicit discharge that originates from the municipality's permitted area and that discharges directly to a storm sewer system or property under the jurisdiction the adjacent municipality, the first municipality shall notify the affected municipality within one working day.

j) Documentation. The permittee shall maintain a system for documenting complaints, referrals, and any actions taken to investigate or eliminate an illicit discharge. A summary of illicit discharge activities for each year shall be included in the annual report.

4. **Enforcement Response.** Include documentation in an enforcement response plan or similar document, by March 31, 2022 a description of the enforcement response procedures the permittee implements when an illicit discharge investigation identifies a responsible party.

5. **Training:** All staff responsible for implementation of the IDDE program shall receive training at least once per permit term. This includes office staff, field staff, and emergency response staff (police and fire departments).

E. CONSTRUCTION SITE POLLUTION CONTROL

The permittee shall continue to implement and enforce a written program that establishes measurable goals and reduces the discharge of sediment and construction materials from construction sites. The permittee through implementation of this program shall:

1. Maintain and enforce the municipal ordinance regarding construction site storm water discharges on all sites, including municipal projects. The municipal ordinance must include the following items:

   a) Performance standards equivalent to, or more restrictive than, those under ss. NR 151.11 and 151.23, Wis. Adm Code.

   b) Sanctions to ensure compliance to the extent authorized by law.

   c) Requirements for construction site operators to manage waste such as discarded building materials, concrete truck washout, chemicals, litter, and sanitary waste at the construction site so to reduce adverse impacts to waters of the state.

Note: The County has identified in their permit application that in lieu of a County ordinance, the County defers to the applicable municipal construction erosion control ordinance for all county projects. Construction activities undertaken by Milwaukee County, as well as all other construction activities occurring on Milwaukee County owned lands, are required to follow the construction erosion control ordinance of the applicable municipality that the project is within.

2. Implement procedures for conducting plan reviews to ensure site planning considers potential water quality impacts. Erosion and sediment control best management practices must comply with design, installation, and maintenance standards that meet or exceed the Department's technical standards or permittee's ordinance.

3. Conduct erosion control inspections at sites one acre or more in size within the permittee's jurisdiction. Beginning April 1, 2021, conduct erosion control inspections following the frequency and actions outlined in Table 2.

Table 2: Construction Site Inspection Frequency

Site	Inspection Frequency
(1) All sites one acre or more in size	• New projects shall be inspected within the first two weeks of commencement of land disturbing activity • All active sites shall be inspected at least once every 45 days • All inactive sites shall be inspected at least once every 60 days
(2) Follow up inspection	• Follow up inspections are required within 7 days of any sediment discharge or inadequate control measure, unless corrections were made and observed by the inspector during initial inspection or corrections were verified via photographs submitted to the inspector
(3) Final inspection	• Confirm that all graded areas have reached final stabilization and that all temporary control measures are removed, and permanent storm water management BMPs are installed as designed

4. Maintain records of site inspections, including any follow up necessary on sites out of compliance with their site-specific erosion control plans, as identified in the permittee's program.

5. Enforce erosion and sediment control plan requirements for landowners of construction sites equivalent to those contained in s. NR 216.46, Wis. Adm. Code, including municipal projects applicable under the permittee's ordinance.

6. Enforce permit coverage termination requirements for landowners of construction sites equivalent to those contained in s. NR 216.55, Wis. Adm. Code, including removal of all temporary erosion and sediment control best management practices and complete site restoration with perennial vegetative cover.

7. Maintain an enforcement response plan or similar document describing the enforcement procedures the permittee will follow when addressing issues at construction sites. The enforcement procedures must ensure construction activities are in compliance with the ordinances.

8. Implement procedures for responding to information submitted by the public, including complaints.

F. POST-CONSTRUCTION STORM WATER MANAGEMENT

Each municipality shall continue to implement and enforce a written program that establishes measurable goals and to control the quantity and quality of discharges from areas of new development and redevelopment, after construction is completed. The program shall include:

1. An ordinance or other regulatory mechanism to regulate post-construction storm water discharges from new development and redevelopment. At a minimum, the ordinance or other regulatory mechanism shall establish or include:

   Note: Milwaukee County has identified in their permit application that in lieu of a County ordinance, the County defers to the applicable municipal post-construction storm water discharge ordinance for all county projects. Construction activities undertaken by Milwaukee County, as well as all other construction activities occurring on Milwaukee County owned lands, are required to follow the post-construction storm water discharge ordinance of the applicable municipality that the project is within. To fulfill this permit requirement, the County can submit to the Department a declaration or other written policy that identifies this procedure.

   a) Applicability and jurisdiction that shall apply to new development and redevelopment projects with one acre or more of land disturbance, and sites of less than one acre if they are part of a larger common plan of development or sale within the jurisdiction of the permittee. The jurisdiction shall include any adjacent developing areas that are planned to have a minimum density of 500 people per square mile, the urbanized area, and developing areas whose runoff will connect to the MS4.

   b) Design criteria, standards and specifications equivalent to the technical standards approved by the Department. The Department approved technical standards are available at http://dnr.wi.gov/topic/stormwater/standards/index.html.

   c) Post-construction performance standards equivalent to, or more restrictive than, those in ss. NR 151.121 through 151.125, Wis. Adm. Code.

   d) Storm water management plan requirements for landowners of construction sites equivalent to those contained in s. NR 216.47, Wis. Adm. Code.

   e) Permitting requirements, procedures and fees.

f) Long-term maintenance requirements for landowners and other persons responsible for long- term maintenance of post-construction storm water control measures, including requirement for routine inspection and maintenance of privately-owned post-construction storm water control measures that discharge into the MS4 to maintain their pollutant removal operating efficiency.

g) Inspection and enforcement authority.

2. Written procedures for post-construction site plan review which incorporate consideration of potential water quality impacts, including source water protection areas where applicable. Post-construction reviews must be conducted for all construction sites with one or more acres of land disturbance.

3. A system for tracking and completing long-term maintenance, inspections, and enforcement of all post-construction BMPs, public and private. This system shall include:

a) An inventory of all municipally owned or operated BMPs which includes:

(1) BMP, name, location, BMP type, and year constructed.
(2) Record drawing.
(3) An operation and maintenance plan with inspection procedures and schedule.
(4) Written documentation of the municipalities' ability to use a privately-owned BMP to meet a water quality requirement of this permit.

b) Written procedures that will be used by the permittee through its ordinance jurisdiction, approval process, and authority, to track and enforce the long-term maintenance of storm water management facilities implemented to meet the post-construction performance standards in Section II F. 1. c).

c) Long-term maintenance inspections at least once per permit term

d) Inspection documentation

e) A description of the inspection and enforcement response procedures the permittee will follow when addressing project compliance issues with the enforceable post-construction storm water management performance standards.

4. Green Infrastructure Barrier Removal. Each permittee shall review design, construction, landscaping and other related ordinances to identify and remove barriers to implementation of green infrastructure projects within the MS4. Barriers shall be removed through adopted ordinance revisions by March 31, 2022. If barriers are identified after March 31, 2022, the barriers shall be removed within 18 months of barrier identification.

G. POLLUTION PREVENTION

Each municipality shall develop and implement a written pollution prevention program that establishes measurable goals for pollution prevention. The program shall include:

1. Winter Road Management:
   a) Road salt or other deicer shall not be applied in quantities larger than required to maintain public safety. The permittee shall develop and implement a written salt application or salt reduction strategy to minimize over application of deicers. The strategy shall include a description of the temperature, precipitation event, and road conditions, and other factors which warrant different management techniques. The plan will also include a description of the equipment and products used for road management.

   b) All salt application equipment shall be calibrated annually beginning November 2020. Calibration methods shall be documented in the salt application strategy or similar document and calibration records kept for 5 years.

   c) Training on the Permittee's salt strategy shall be provided at a frequency no less than every other year.

   d) The quantity of salt and other deicing products shall be tracked on a monthly basis and reported on the annual report.

2. Nutrient Management:
   The application of turf and garden fertilizers on five acres or more of municipally controlled properties shall be done in accordance with a site-specific nutrient application schedule based on appropriate soil tests. The nutrient application schedule shall be designed to maintain the optimal health of the turf or garden vegetation. All properties subject to this section shall be identified on the MS4 map.

3. Street Sweeping and Catch Basin Cleaning:
   a) If street sweeping or catch basin cleaning is utilized to meet a water quality requirement under this permit, sweeping and catch basin shall continue at the frequency specified in the SWMP. The number of lane miles swept, number of catch basins cleaned, and the weight in tons of the material collected shall be tracked and included in the Annual Report.

   b) Material collected through street sweeping and catch basin cleaning shall be handled and stored in a manner that prevents contamination of storm water runoff and shall be disposed of or beneficially reused in accordance with applicable solid and hazardous waste statutes and administrative codes. Non-storm water discharges to waters of the state associated with dewatering and drying material collected under section a) of this section are not authorized by this permit.

      Note: Information on managing waste and materials is available on the Department's Internet site at: https://dnr.wi.gov/topic/Waste/. Information on WPDES permits for non-storm water discharges is available on the Department's Internet site at: https://dnr.wi.gov/topic/wastewater/

4. Management of Leaves and Grass Clippings:
   If the permittee provides leaf and grass clipping collection, the program shall include the following:

   a) A description of the leaf collection program, including pick-up methodology and equipment used, timing of associated street cleaning, standard operating procedures, schedule and frequency, and instructions for residents and property owners.

   b) Identification of leaf disposal locations.

   c) An estimate of the weight in tons of material collected annually and a description of how the weight is estimated.

   d) By March 31, 2023, A description of the BMPs which the permittee employs or will employ to its leaf collection program that reduce nutrient loading to the receiving waters. The permittee shall consider source, transport and discharge location when considering BMPs for the leaf collection program.

5. Storm Water Pollution Prevention Planning:
   All municipal garages, municipal storage areas, and other public works related municipal facilities shall have a Storm Water Pollution Prevention Plan (SWPPP). The SWPPPs shall:

   a) Be developed and implemented by December 31, 2020 for sites without a SWPPP.

   b) Include the information under s. NR 216.27 (3), Wis. Adm. Code, minus the monitoring requirements under s. NR 216.27 (3) (l), Wis. Adm. Code.
      Note: The SWPPP requirements can be located here: https://docs.legis.wisconsin.gov/code/admin_code/nr/200/216/II/27.

   c) Conduct and document quarterly visual inspections of the property and annual facility compliance inspections.

   d) Discuss spill prevention and response for each facility.

   e) Contain procedures for annual training of municipal staff on implementation of the SWPPP.

6. Internal Training and Education:
   The permittee shall provide education for appropriate municipal and other personnel involved in implementing the pollution prevention programs. Documentation shall be maintained of the date, the names of each person attending, and the content of the training.

H. STORM WATER QUALITY MANAGEMENT

Each municipality shall develop and implement a municipal storm water management program that controls the discharge of total suspended solids from the MS4 system to waters of the state.

1. The storm water management program shall achieve compliance with the developed urban area performance standards of s. NR 151.13(2), Wis. Adm. Code, for those areas of the municipality that were not subject to the post-construction performance standards of s. NR 151.12 or 151.24, Wis. Adm. Code. (Note: projects prior to Oct. 1, 2004).

2. The permittee shall ensure continued operation and maintenance of all best management practices implemented on or before July 1, 2011 to achieve a total suspended solids reduction of more than 20 percent as compared to no controls.

I. STORM SEWER SYSTEM MAP

Each municipality shall maintain a municipal separate storm sewer system map. The municipal storm sewer system map shall include:

1. Identification of waters of the state, watershed boundaries, name and classification of receiving waters, and identification of whether the receiving water is listed as an impaired water under s. 303 (d) of the Clean Water Act.

2. Identification of all known municipal storm sewer system outfalls discharging to waters of the state or other municipal separate storm sewer systems, stormwater drainage basin boundaries for each MS4 outfall, and municipal separate storm sewer conveyance systems with flow direction. Major outfalls shall be categorized and priority outfalls for illicit discharge detection and elimination shall be identified. Other major municipal, government, or privately-owned storm water conveyance systems lying within, but not owned by the permittee, shall also be identified.

3. A boundary defining the municipal border and the storm water planning area.

4. The location of any known discharge to the municipal separate storm sewer system that has been issued a WPDES permit by the Department.

5. Location of municipally owned or operated structural storm water controls including detention basins, infiltration basins, and manufactured treatment devices. If the permittee will be taking credit for pollutant removal from privately-owned facilities, they must be identified.

6. Identification of publicly owned parks, recreational areas and other open lands.

7. Location of municipal garages and other public works facilities.

8. Identification of streets.

9. Identification of other potential sources of pollution.

J. AMENDMENTS

The permittee shall amend a program required under this permit as soon as possible if the permittee becomes aware that it does not meet a requirement of this permit. The permittee shall

amend its program if notified by the Department that a program or procedure is insufficient or ineffective in meeting a requirement of this permit. The Department notice to the permittee may include a deadline for amending and implementing the amendment.

K. ANNUAL REPORT

The Permittee shall submit an annual report by **March 31st of the following year** for each calendar year unless the Department authorizes biannual reporting to be submitted the 2nd and 4th year of the permit term pursuant to s. NR 216.07(8) Wis. Adm. Code. The municipal governing body, interest groups and the general public shall be provided opportunity to review and comment on the annual report. The annual report shall include:

1. An evaluation of program compliance, the appropriateness of identified BMPs, and progress towards achieving identified measurable goals. Any program changes made as a result of this evaluation shall be identified and described in the annual report. For any identified deficiencies towards achieving the requirements under Section II of this permit or lack of progress towards meeting a measurable goal, the permittee shall initiate program changes to improve their effectiveness.

2. Updated storm sewer system maps, where necessary, to identify any new outfalls, structural controls, or other noteworthy changes.

3. An IDDE report that includes:

   a) A summary of screening results from outfalls evaluated under Section II D.2.

   b) Identified Illicit Discharges: A summary of each identified illicit discharge and follow up actions.

   c) Spills: A summary of all spills including location, material, quantity, and follow up actions.

4. A summary describing:

   a) The number and nature of construction and post-construction inspections and enforcement actions conducted to ensure compliance with the required ordinances.

   b) Street sweeping frequency and the amount collected.

   c) Catch basin cleaning frequency and the amount collected.

   d) All SWPPP inspections.

   e) Pollutant loading removal rates and status of meeting performance standards.

2. A fiscal analysis which includes the annual expenditures and budget for the reporting year, and the proposed budget for the next year.

3. Identification of any known water quality improvements or degradation in the receiving water to which the permittee's MS4 discharges as required in Section I I. 2. Where degradation is identified, identify why and what actions are being taken to improve the water quality of the receiving water.

4. A duly authorized representative of the permittee shall sign and certify the annual report and include a statement or resolution that the permittee's governing body or delegated representatives have reviewed or been apprised of the content of the annual report.

5. The annual report and other required reports, and permit compliance documents shall be submitted electronically through the Department's electronic reporting system.

   Note: The Department's electronic reporting system is Internet-based and available at: https://dnr.wi.gov/permits/water/. Municipal storm water permit eReporting information and user support tools can be found at: https://dnr.wi.gov/topic/stormwater/municipal/eReporting.html

L. REAPPLICATION FOR PERMIT COVERAGE

To remain covered after the expiration date of this permit, pursuant to s. NR 216.09, Wis. Adm. Code, the permittee shall submit an application package to the Department by September 30, 2024 for continued coverage under a reissued version of this permit. The application package shall include:

1. For each storm water management program, the proposed program modifications and measurable goals for the next permit term. This includes specific actions and activities or structural BMPs and expected dates of implementation.

2. An assessment of the proposed storm water management program's adequacy to reduce pollutants to the MEP. The assessment must include:

   a) Explanation and rationale on how implementation of the programs provides the highest level of performance that is achievable during the next permit term considering other environmental problems, technical capability, current technology, and available resources.

   b) Estimate the additional pollution reduction and water quality benefits from the proposed action. This includes proposed BMPs for pollutants causing impairments not included in a TMDL.

3. A fiscal evaluation summarizing program expenditures for the current permit cycle and projected program allocations for the next permit cycle.

4. An updated estimate of annual storm water pollutant loads for TSS and TP. A description of how the pollutant loads were calculated shall be provided.

5. The established TMDL pollutant load reduction benchmarks, as required by Section III. A. 3.

6. The proposed fecal coliform reduction benchmarks for the next permit term, as discussed in Section III. A. 4.

7. Updated MS4 maps showing service boundary of the MS4, projected changes in land use and future growth, and industrial WPDES permittees which discharge to the MS4.

8. A summary of the results from the individual education efforts in Permit Section II. B. 2 and the planned education efforts for the next permit term.

III. SPECIAL CONDITIONS

A. TOTAL MAXIMUM DAILY LOADS (TMDLs):

The Requirements of this section apply to discharges covered under the "Total Maximum Daily Loads for Total Phosphorus, Total Suspended Solids, and Fecal Coliform Milwaukee River Basin, Wisconsin" as approved by USEPA on March 9, 2018. The Permittee shall complete the following:

1. **TMDL POLLUTANT LOAD REDUCTION EVALUATION FOR TSS AND TP:**
The progress towards reducing TMDL pollutant loads shall be evaluated by the Permittee through modeling analysis, or through substantially similar or equivalent methods as approved by the Department. The results of the pollutant reduction evaluation shall be described in a report and submitted to the Department by March 31, 2023. The report must contain the following items:

a) A map that identifies:

(1) The TMDL reachshed boundaries within the municipal boundary
(2) The MS4 drainage boundaries associated with each TMDL reachshed
(3) Identification of areas within the municipal boundary the permittee believes should be excluded from its analysis to show progress towards reducing TMDL pollutant loads
(4) Structural BMPs and associated drainage area for each BMP used for pollutant reduction.

b) The associated area, in acres, for the lands identified in Section III. A.1.a (1) through (4).

c) An explanation for why the the area identified in Section III. A.1.a (3) are to be excluded from analysis

d) The methodology and rationale used to evaluate progress towards reducing TMDL pollutant loads

e) For each reachshed, an estimate of the current pollutant loading without considering implementation of BMPs and an estimate of the current pollutant loadings considering BMP implementation. The difference between these two estimates is the existing load reduction. For privately owned BMPs, the permittee must have a maintenance agreement to count the load reduction.

f) A comparison of the applicable TMDL WLA for each reachshed to the estimated pollutant loading with and without BMPs. The applicable TMDL reachshed reductions from the no controls condition are identified in Section VII.

g) For each structural BMP, a tabular summary which identifies the type of BMP, area treated in acres, pollutant loading reduction efficiency, and documentation of the maintenance agreement for any private BMP.

h) A description of the effectiveness of non-structural BMPs, if applicable, and the rationale for the selected approach.

i) A narrative summarizing progress towards the applicable TMDL WLAs, and if applicable, existing TMDL benchmarks.

j) If the permittee estimates that the TMDL WLAs are achieved with existing BMP implementation, the permittee must provide a statement supporting this conclusion.

2. WLA ATTAINMENT ANALYSIS:

The permittee shall complete an assessment of TSS and TP WLA attainment, including identifying information related to the type and extent of BMPs necessary to achieve the pollutant load reductions in the Milwaukee River Basin TMDL and the financial costs and other resources that may be associated with the implementation, operation and maintenance of BMPs. The results of the assessment must be submitted to the Department by September 30, 2023. The attainment analysis shall also include:

a) A review of local development and redevelopment standards. This review shall evaluate historical development and redevelopment rates and the potential pollutant load reduction achieved in future years if more stringent pollutant reductions standards are adopted.

3. ESTABLISHMENT OF WLA BENCHMARKS FOR TSS AND TP

A TMDL pollutant reduction benchmark must be developed for TSS and TP where existing BMP implementation is not achieving the WLA. Updated pollutant benchmarks must be submitted by September 30, 2024. The submittal must include:

a) The pollutant load reduction benchmark proposed to achieve additional progress towards the TMDL WLA during the next permit term.

b) An explanation of the relationship between the TMDL WLA and the TMDL benchmark for each TMDL pollutant.

c) A description of how SWMP implementation contributes to the overall reduction of the TMDL pollutants during the next permit term.

d) Identification of additional BMPs or modified BMPs that will result in further reductions in the discharge of the applicable TMDL pollutants, including the rationale for proposing the BMPs.

e) An estimate of current pollutant loading that reflect implementation of the current BMPs and the BMPs proposed to be implemented during the next permit term.

4. FECAL COLIFORM REDUCTION EFFORTS:

a) Each permittee shall develop an action benchmark for bacteria for their Illicit Discharge Screening program as described in Section II. D. 6. By June 30, 2021.

b) Fecal Coliform Inventory: By March 31, 2023, the permittee shall develop and submit to the Department an inventory of fecal coliform sources and a map indicating the locations of the potential sources of fecal coliform entering the MS4. The inventory shall be in tabular format and include a label code, location, description, and ownership of the source. The map shall identify the location of the sources by label code. The

inventory shall consider flow variation in its identification of sources. The inventory and map shall include the following sources:

(1) Known or suspected leaking or failing septic systems
(2) Sanitary sewer overflow locations
(3) Livestock and domesticated animals housed or raised within the MS4 permitted area and discharging into the MS4, but not including household pets.
(4) Zoos, kennels, animal breeders, pet stores, and dog training facilities
(5) Waste hauling, storage, and transfer facilities
(6) Areas that attract congregations of nuisance urban birds and wildlife
(7) Known or suspected properties with inadequate food or organic waste handling or storage
(8) Composting sites or facilities
(9) Known or suspected areas with improper human sanitation use
(10) Any other source that the permittee identifies as discharging to the MS4.

c) By September 30, 2023, the permittee shall develop and submit to the Department a fecal coliform source elimination plan. The plan shall include:

(1) Prioritization of source removal with and explanation of the prioritization criteria. Prioritization criteria shall include, at a minimum, fecal coliform source, exposure risk, ease of removal, and cost.
(2) A description of the type and extent BMPs to be employed to address each source
(3) A cost estimate of BMP implementation, operation, and maintenance
(4) A schedule for implementation of the bacteria elimination plan that reflects expeditious reduction with specific actions or benchmarks identified to be implemented during the next permit term.
(5) BMPs identified may be structural, non-structural, targeted outreach, new or revised ordinances, new design criteria, or new plan review considerations, but the plan shall include rationale for using each BMP, the reasons selection of each BMP, and the expected result of BMP implementation.

B. INDIVIDUAL BENCHMARKS

The following requirements represent specific actions each permittee must complete. The requirements build upon the existing pollutant reductions and move the permittees towards achieving future load reduction goals. The requirements are individual in nature because each MS4 has its own pollutant reduction goals and associated plans for achieving the reductions. Where appropriate, completion of a benchmark may incorporate cooperative efforts with other entities regulated or not by this permit on the condition that requirements defined in section I.D.2. of this permit are upheld.

The permittee shall achieve the following benchmarks applicable to their MS4. All benchmarks shall be completed by the end of the permit term unless specified sooner.

1. The **City of Brookfield** shall:

a) Implement control measures identified in its January 8, 2018 SWMP as development and redevelopment occurs.

b) Develop and execute a study to determine the impacts of sediment removal in four storm water ponds. The findings shall be incorporated into the Post-Construction program through the adaptive management process.

2. The **Village of Butler** shall:

a) Complete at least two water quantity or quality projects. At least one project must be within the Village limits.

3. The **Village of Elm Grove** shall:

a) Complete the Tonawanda Wetland Restoration project

b) Complete one project which replaces curb and gutter drainage with grassed swale drainage.

4. The **Village of Germantown** shall:

a) By, September 30, 2021, develop an enhanced pond maintenance program. The program shall:

(1) Develop and implement a system for evaluating and maintaining storm water ponds within the Village. The system shall include evaluation criteria to be used during inspections, criteria which inspection results will be compared to for determining maintenance needs, and prioritization criteria for determining which ponds receive maintenance beyond routine maintenance.

(2) Provide maintenance when inspections identify deficiencies with the structure. The prioritization criteria may be used if multiple structures need maintenance to target the highest need structures.

(3) Evaluate all ponds by permit expiration.

(4) Evaluate ponds for retrofit potential. If a pond is identified as a retrofit site, it shall be included in the WLA Attainment Assessment under Section A.2.

b) Utilize the 10-year Road Capital Improvement Project program to reduce impervious pavement.

(1) By September 30, 2021, develop Criteria for roadway evaluation which will be used to identify planned road projects which can reduce impervious area.

(2) Roadways which can reduce impervious area after reconstruction shall be included in the WLA Attainment Assessment under Section A.2

c) Complete one green infrastructure project within the Village.

5. The **City of Greenfield** shall:

a) Update the City's storm water website to provide additional educational material and promote usage of rain barrels.

b) Develop a partnership between the local schools and parks to provide education on storm water management to students.

c) Coordinate education and outreach with planned illicit discharge screening to supply educational material to residents and businesses tributary to the screening locations. The coordinated education shall begin March 31, 2022**.**

d) Develop or update storm water pollution prevention plans for public works yards by December 31, 2020.

e) Complete two storm water quality projects within the City's MS4 boundary.

6. The **Village of Menomonee Falls** shall:

a) Complete three storm water quantity or quality projects. One project must be water quality related and be completed within the Village's MS4 boundary.

b) Revise the municipal street sweeping program by March 31, 2022. The Program shall:

(1) Update and implement the street sweeping program to more effectively remove pollutants.

(2) Develop a coordinated leaf collection and street sweeping program.

c) Clean all catch basins at least once per year beginning January 1, 2021.

d) Develop a Storm Water Pollution Prevention Plan for the new public works facility by December 31, 2020.

e) Inspect stormwater outfalls in accordance with Section II. D.

7. The **City of Milwaukee** shall:

a) Update the storm water management website and provide additional educational material.

b) Install BMPs to provide treatment for an additional 275,000 gallons annually. The quantity can be achieved on an average basis over the permit term. The City shall provide a summary of progress with each annual report.

c) Update storm water pollution prevention plan inspection procedures. Procedures shall be updated by March 31, 2021.

8. **Milwaukee County** shall:

a) Install BMPs to provide treatment for an additional 5,000,000 gallons of storm water over the course of the permit term.

b) Coordinate one storm water workshop as part of the education and outreach program. The workshop shall focus on one of the pollution prevention activities under Section II.G.

c) Develop and Execute one pilot project which evaluates an innovative BMP design or innovative contracting mechanism for storm water related services.

9. The **City of West Allis** shall:

a) Continue to promote and subsidize the sale of rain barrels within the City's MS4 boundary.

b) Develop and implement a green infrastructure plan for City parking lots. The City shall implement green infrastructure on three lots during the permit term.

c) Review existing development ordinances and study feasibility of creating requirements above the existing minimum requirements. This can include new design standards or TMDL performance standards.

10. The **Village of West Milwaukee** shall:

a) Install two storm water quality improvement projects during the permit term.

11. The **City of Wauwatosa** shall:

a) Install BMPs which will provide treatment for an additional 400,000 gallons of storm water during the permit term.

IV. IMPLEMENTATION SCHEDULE

A. ALL PERMITTEES:

The permittees shall comply with the specific permit conditions contained in Permit Sections II and III according to the schedules in Table 3. All permittees shall begin implementing any updates to their storm water management programs no later than March 31, 2022. Required reports and permit compliance documents shall be submitted electronically through the Department's electronic reporting system.

Note: The Department's electronic reporting system is Internet-based and available at: https://dnr.wi.gov/permits/water/. Municipal storm water permit eReporting information and user support tools can be found at: https://dnr.wi.gov/topic/stormwater/municipal/eReporting.html

Table 3: Implementation Schedule for Permit Requirements

PERMIT SECTION	ACTIVITY	COMPLIANCE DATE	COMMENTS
Section I.H.1	Identify discharges to an impaired waterbody.	12 months after 303(d) list is updated.	All permittees
Section II	Submit written Storm Water Management Program document updates and begin implementation.	March 31, 2022	All permittees
Section II.B.1. (b)	Individual Education and Outreach – Submit prioritized education needs based upon survey results.	September 30, 2021	All permittees (excluding Milwaukee County)
Section II.B.2. (a)	Individual Education and Outreach – Complete targeted education and outreach for one high priority education need.	September 30, 2023	All permittees (excluding Milwaukee County)
Section II.B.2. (c)	Individual Education and Outreach – Submit results of education effort and planned future efforts with permit application.	September 30, 2024	All permittees (excluding Milwaukee County)
Section II.D.4	Illicit Discharge Detection and Elimination- Submit Enforcement response plan.	March 31, 2022	All permittees (excluding Milwaukee County)
Section II.E.3	Construction Site Pollutant Control – Conduct inspections according to the specified frequency.	April 1, 2021	All permittees
Section II.F.4	Post-Construction Storm Water Management – Remove barriers to green infrastructure.	March 31, 2022, and 18 months after barrier identification	All permittees
Section II.G.1.b	Pollution Prevention – Calibrate salt application machinery.	Annually beginning November 2020.	All permittees
Section II.G.1.c	Pollution Prevention – Provide salt application training.	Every other year	All permittees

Section II.G.4.d	Leaf Management – Submit the BMPs the permittee will employ to reduce nutrient loading from leaves.	March 31, 2023	All permittees
Section II.G.5.a	Pollution Prevention – Submit storm water pollution prevention plans (SWPPP) for all sites without a current SWPPP.	December 31, 2020	All permittees
Section II.K	Submit Annual Report	March 31 of each year reporting on previous calendar year	All permittees
Section II.L	Submit Permit Application	September 30, 2024	All permittees
Section III.A.1	Total Maximum Daily Load—Submit pollutant reduction analysis report.	March 31, 2023	All Permittees
Section III.A.2	Total Maximum Daily Load—Submit wasteload allocation attainment analysis.	September 30, 2023	All Permittees
Section III.A.3	Total Maximum Daily Load—Submit TSS and TP benchmarks for the next permit term.	September 30, 2024	All Permittees
Section III.A.4 (a)	Total Maximum Daily Load—Develop bacteria action level for illicit discharge screening.	June 30, 2021	All Permittees
Section III.A.4 (b)	Total Maximum Daily Load—Submit fecal coliform source inventory.	March 31, 2023	All Permittees
Section III.A.4 (c)	Total Maximum Daily Load—Submit fecal coliform source elimination plan.	September 30, 2023	All Permittees

B. INDIVIDUAL CONDITIONS:

Each Permittee shall complete their individual benchmarks identified in Section III. B. by the end of the permit, March 31, 2025, unless otherwise specified in Table 3.

Table 3: Individual Benchmark Schedule

PERMITTEE	ACTIVITY	COMPLIANCE DATE	PERMIT SECTION
All Permittees	Complete all individual benchmarks.	March 31, 2025	Section III.B
Village of Germantown	Develop storm water pond maintenance program.	September 30, 2022	Section III.B.4.(a)
Village of Germantown	Develop roadway evaluation criteria for future stormwater projects.	September 30, 2021	Section III.B.4.(b)

City of Greenfield	Coordinate Public Education and Outreach with Illicit Discharge Screening.	March 31, 2022	Section II.B.5. (c)
City of Greenfield	Develop or update all SWPPPs.	December 31, 2020	Section II.B.5. (d)
Village of Menomonee Falls	Update municipal street sweeping program.	March 31, 2022	Section II.B.6. (b)
Village of Menomonee Falls	Clean all catch basins annually.	Beginning 2021, annually thereafter	Section II.B.6. (c)
Village of Menomonee Falls	Develop SWPPP for new public works facility.	December 31, 2020	Section II.B.6. (d)
City of Milwaukee	Update SWPPP inspection procedures.	March 31, 2021	Section II.B.7. (c)

V. STANDARD CONDITIONS

The conditions in s. NR 205.07(1) and (3), Wis. Adm. Code, are incorporated by reference in this permit. The Menomonee River Watershed Permittees shall meet these requirements. Some of these requirements are outlined below in paragraph A. through R. Requirements not specifically outlined below can be found in s. NR 205.07(1) and (3), Wis. Adm. Code.

A. DUTY TO COMPLY:

The municipalities shall comply with all conditions of the permit. Any permit noncompliance is a violation of the permit and is grounds for enforcement action, permit revocation or modification, or denial of a permit reissuance application.

B. COMPLIANCE SCHEDULES:

Reports of compliance or noncompliance with interim and final requirements contained in any compliance schedule of the permit shall be submitted in writing within 14 days after the schedule date, except that progress reports shall be submitted in writing on or before each schedule date for each report. Any report of noncompliance shall include the cause of noncompliance, a description of remedial actions taken, and an estimate of the effect of the noncompliance on the municipality's ability to meet the remaining schedule dates.

C. NONCOMPLIANCE NOTIFICATION:

1. Upon becoming aware of any permit noncompliance that may endanger public health or the environment, each municipality shall report this information by a telephone call to the Department within 24 hours. A written report describing the noncompliance shall be submitted to the Department within 5 days after the municipality became aware of the noncompliance. The Department may waive the written report on a case-by-case basis based on the oral report received within 24 hours. The written report shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times; the steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance; and if the noncompliance has not been corrected, the length of time it is expected to continue.

2. Reports of any other noncompliance not covered under General Condition's B, C.1, or E shall be submitted with the annual report. The reports shall contain all the information listed in General Condition C.1.

D. DUTY TO MITIGATE

Each municipality shall take all reasonable steps to minimize or prevent any adverse impact on the waters of the state resulting from noncompliance with the permit.

E. SPILL REPORTING

The permittee shall immediately notify the Department, in accordance with s. 292.11(2)(a), Wis. Stats., which requires any person who possesses or controls a hazardous substance or who causes the discharge of a hazardous substance to notify the DNR immediately of any discharge not authorized by the permit. The discharge of a hazardous substance that is not authorized by

this permit or that violates this permit may be a hazardous substance spill. To report a hazardous substance spill, call the DNR's 24-hour HOTLINE at 1-800-943-0003.

Note: For details on state and federal reportable quantities, visit:
https://dnr.wi.gov/topic/Spills/define.html

F. PROPER OPERATION AND MAINTENANCE:
The Permittee shall at all times properly operate and maintain all facilities and systems of treatment and control which are installed or used by the municipality to achieve compliance with the conditions of the permit and the storm water management program. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems only when necessary to achieve compliance with conditions of this permit.

G. BYPASS:
The Permittee may temporarily bypass storm water treatment facilities if necessary for maintenance, or due to runoff from a storm event which exceeds the design capacity of the treatment facility, or during an emergency.

H. DUTY TO HALT OR REDUCE ACTIVITY:
Upon failure or impairment of best management practices identified in the storm water management program, each municipality shall, to the extent practicable and necessary to maintain permit compliance, modify or curtail operations until the best management practices are restored, or an alternative method of storm water pollution control is provided.

I. REMOVED SUBSTANCES:
Solids, sludges, filter backwash or other pollutants removed from or resulting from treatment or control of storm water shall be stored and disposed of in a manner to prevent any pollutant from the materials from entering the waters of the state, and to comply with all applicable Federal, State, and Local regulations.

J. ADDITIONAL MONITORING:
If a municipality monitors any pollutant more frequently than required by the permit, the results of that monitoring shall be recorded and reported in accordance with this chapter. Results of this additional monitoring shall be included in the calculation and reporting of the data submitted in the annual report.

K. INSPECTION AND ENTRY:
Each municipality shall allow an authorized representative of the Department, upon the presentation of credentials, to:

1. Enter upon the municipal premises where a regulated facility or activity is located or conducted, or where records are required under the conditions of the permit.
2. Have access to and copy, at reasonable times, any records that are required under the conditions of the permit.

3. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices or operations regulated or required under the permit.
4. Sample or monitor at reasonable times, for the purposes of assuring permit compliance, any substances or parameters at any location.

L. DUTY TO PROVIDE INFORMATION:

Each municipality shall furnish the Department, within a reasonable time, any information which the Department may request to determine whether cause exists for modifying, revoking or reissuing the permit or to determine compliance with the permit. Each municipality shall also furnish the Department, upon request, copies of records required to be kept by the municipality.

M. PROPERTY RIGHTS:

The permit does not convey any property rights of any sort, or any exclusive privilege. The permit does not authorize any injury or damage to private property or an invasion of personal rights, or any infringement of federal, state or local laws or regulations.

N. DUTY TO REAPPLY:

If any of the Menomonee River Watershed Permittees wish to continue an activity regulated by the permit after the expiration date of the permit, the municipality shall apply for a new permit at least 180 days prior to the expiration date of the permit. If a timely and complete application for a new permit is filed and the permit is not reissued by the time the existing permit expires, the existing permit remains in effect until the application is acted upon.

O. OTHER INFORMATION:

Where a municipality becomes aware that it failed to submit any relevant facts in a permit application or submitted incorrect information in a permit application or in any report to the department, it shall promptly submit such facts or correct information to the department.

P. RECORDS RETENTION:

Each municipality shall retain records of all monitoring information, copies of all reports required by the permit, and records of all data used to complete the application for the permit for a period of at least 5 years from the date of the sample, measurement, report or application. The Department may request that this period be extended by issuing a public notice to modify the permit to extend this period.

Q. PERMIT ACTIONS:

As provided in s. 283.53, Wis. Stats., after notice and opportunity for a hearing the permit may be modified or revoked and reissued for cause. If a municipality files a request for a permit modification, revocation or reissuance, or a notification of planned changes or anticipated noncompliance, this action by itself does not relieve the municipalities of any permit condition.

R. SIGNATORY REQUIREMENT:

All applications, reports or information submitted to the Department shall be signed for by a ranking elected official, or other person authorized by them who has responsibility for the overall operation of the municipal separate storm sewer system and storm water management program activities regulated by the permit. The representative shall certify that the information

was gathered and prepared under their supervision and based on inquiry of the people directly under their supervision that, to the best of their knowledge, the information is true, accurate, and complete.

S. ENFORCEMENT ACTION:
The Department is authorized under s. 283.89 and 283.91, Wis. Stats., to use citations or referrals to the Department of Justice to enforce the conditions of this permit. Violation of a condition of this permit is subject to a fine of up to $10,000 per day of violation.

T. ATTAINMENT OF WATER QUALITY STANDARDS AFTER AUTHORIZATION:
Except for situations where a TMDL has been approved by US EPA during the permit term, at any time after authorization, the Department may determine that the discharge of storm water from a permittee's MS4 may cause, have the reasonable potential to cause, or contribute to an excursion of any applicable water quality standard. If such determination is made, the Department may require the permittee to do one of the following:

1. Develop and implement an action plan to address the identified water quality concern to the satisfaction of the Department.

2. Submit valid and verifiable data and information that are representative of ambient conditions to demonstrate to the Department that the receiving water or groundwater is attaining the water quality standard.

VI. DEFINITIONS

Definitions for some of the terms found in this permit are as follows:

A. Department means the Wisconsin Department of Natural Resources.

B. Development means residential, commercial, industrial and institutional land uses and associated roads.

C. Erosion means the process by which the land's surface is worn away by the action of wind, water, ice or gravity.

D. Hazardous substance means any substance or combination of substances including any waste of a solid, semisolid, liquid or gaseous form which may cause or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness or which may pose a substantial present or potential hazard to human health or the environment because of its quantity, concentration or physical, chemical or infectious characteristics. This term includes, but is not limited to, substances which are toxic, corrosive, flammable, irritants, strong sensitizers or explosives as determined by the Department.

E. Illicit connection means any man-made conveyance connecting an illicit discharge to a municipal separate storm sewer system.

F. Illicit discharge means any discharge to a municipal separate storm sewer system that is not composed entirely of storm water except discharges authorized by a WPDES permit or other discharge not requiring a WPDES permit such as landscape irrigation, individual residential car washing, firefighting, diverted stream flows, uncontaminated groundwater infiltration, uncontaminated pumped groundwater, discharges from potable water sources, foundation drains, air conditioning condensation, irrigation water, lawn watering, flows from riparian habitats and wetlands, and similar discharges. However, the occurrence of a discharge listed above may be considered an illicit discharge on a case-by-case basis if the permittee or the Department identifies it as a significant source of a pollutant to waters of the state.

G. Impaired water means a waterbody impaired in whole or in part and listed by the Department pursuant to 33 USC § 1313(d)(1)(A) and 40 CFR 130.7, for not meeting a water quality standard, including a water quality standard for a specific substance or the waterbody's designated use.

H. Infiltration means the entry and movement of precipitation or runoff into or through soil.

I. Jurisdiction means the area where the permittee has authority to enforce its ordinances or otherwise has authority to exercise control over a particular activity of concern.

J. Land disturbing construction activity means any man-made alteration of the land surface resulting in a change in the topography or existing vegetative or non-vegetative soil cover that may result in storm water runoff and lead to increased soil erosion and movement of sediment

into waters of the state. Land disturbing construction activity includes clearing and grubbing, demolition, excavating, pit trench dewatering, filling and grading activities.

K. Maximum Extent Practicable has the meaning given it in s. NR 151.002(25), Wis. Adm. Code.

L. Major outfall means a municipal separate storm sewer outfall that meets one of the following criteria:

1. A single pipe with an inside diameter of 36 inches or more, or from an equivalent conveyance (cross sectional area of 1,018 square inches) which is associated with a drainage area of more than 50 acres.

2. A municipal separate storm sewer system that receives storm water runoff from lands zoned for industrial activity that is associated with a drainage area of more than 2 acres or from other lands with 2 or more acres of industrial activity, but not land zoned for industrial activity that does not have any industrial activity present.

M. Municipality means any city, town, village, county, county utility district, town sanitary district, town utility district, school district or metropolitan sewage district or any other public entity created pursuant to law and having authority to collect, treat or dispose of sewage, industrial wastes, storm water or other wastes.

N. Municipality Operated BMP means a structural storm water management practice or BMP which is not owned by the Municipality which the municipality has a maintenance agreement with the owner and takes credit for pollutants removed from the BMP.

O. Municipal Separate Storm Sewer System or **MS4** means a conveyance or system of conveyances including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, constructed channels or storm drains, which meets all of the following criteria:

1. Owned or operated by a municipality.

2. Designed or used for collecting or conveying storm water.

3. Which is not a combined sewer conveying both sanitary and storm water.

4. Which is not part of a publicly owned wastewater treatment works that provides secondary or more stringent treatment

P. New MS4 discharge of a pollutant means an MS4 discharge that would first occur after the permittee's original date of initial coverage under an MS4 permit to a surface water to which the MS4 did not previously discharge storm water, and does not include an increase in an MS4's discharge to a surface water to which the MS4 discharged on or before coverage under this permit.

Q. Outfall means the point at which storm water is discharged to waters of the state or to a storm sewer (e.g., leaves one municipality and enters another).

R. Permittee means a person who has applied for and received WPDES permit coverage for storm water discharge. For the purposes of this permit, permittee is the owner or operator of a municipal separate storm sewer system authorized to discharge storm water into waters of the state.

S. Permitted area means the areas of land under the jurisdiction of the permittee that drains into a municipal separate storm sewer system, which is regulated under a permit issued pursuant to Subch. I of NR 216, Wis. Adm. Code

T. Pollutants of concern means a pollutant that is causing impairment of a waterbody.

U. Reach means a specific stream segment, lake or reservoir as identified in a TMDL.

V. Reachshed means the drainage area contributing runoff to a given reach.

W. Redevelopment means areas where development is replacing older development.

X. Riparian landowners are the owners of lands bordering lakes and rivers.

Y. Sediment means settleable solid material that is transported by runoff, suspended within runoff or deposited by runoff away from its original location.

Z. Start Date is the date of permit coverage under this permit, which is specified in the Department letter authorizing coverage.

AA. Storm water management practice or Best Management Practice (BMP) means structural or non-structural measures, practices, techniques or devices employed to avoid or minimize soil, sediment or pollutants carried in stormwater runoff to waters of the state.

BB. Storm Water Pollution Prevention Plan or SWPPP refers to the development of a site-specific plan that describes the measures and controls that will be used to prevent and/or minimize pollution of storm water.

CC. Total maximum daily load or **TMDL** means the amount of pollutants specified as a function of one or more water quality parameters, that can be discharged per day into a water quality limited segment and still ensure attainment of the applicable water quality standard.

DD. Urbanized area means a place and the adjacent densely settled surrounding territory that together have a minimum population of 50,000 people, as determined by the U.S. bureau of the census based on the latest decennial federal census.

EE. Wasteload Allocation or **WLA** means the allocation resulting from the process of distributing or apportioning the total maximum daily load to each individual point source discharge.

FF. Waters of the State has the meaning given it in s. 283.01(20), Wis. Stats.

GG. WPDES permit means a Wisconsin Pollutant Discharge Elimination System permit issued pursuant to ch. 283, Wis. Stats.

VII. TSS AND TP WASTELOAD ALLOCATIONS

The following tables identifies the total suspended solids (TSS) and total phosphorus (TP) reduction goals for each reachshed identified in the "Total Maximum Daily Loads for Total Phosphorus, Total Suspended Solids, and Fecal Coliform Milwaukee River Basin, Wisconsin" Report. The values represent the load reductions required from a no-controls scenario.

Table 1: Kinnickinnic River Basin

Reachshed (TMDL Subbasin)	Waterbody Name	Waterbody Extents	TSS % Reduction from No-controls	TP % Reduction from No-controls
KK-1	Lyons Park Creek	Entire Length	78.4%	68.1%
KK-2	Kinnickinnic River	From Wilson Park Creek to Lyons Park Creek	77.6%	68.1%
KK-3	South 43rd St. Ditch	Entire Length	76.8%	78.7%
KK-4	Edgerton Channel, Wilson Park Creek, Villa Mann Creek	Entire Length	84.0%	89.4%
KK-5	Holmes Avenue Creek	Entire Length	80.0%	78.7%
KK-6	Cherokee Park Creek	Entire Length	77.6%	69.0%
KK-7	Kinnickinnic River	Estuary to Wilson Park Creek	75.2%	45.0%

Table 2: Menomonee River Basin

Reachshed (TMDL Subbasin)	Waterbody Name	Waterbody Extents	TSS % Reduction from No-controls	TP % Reduction from No-controls
MN-1	Menomonee River	From Nor-X-Way Channel to Headwaters	66.4%	63.6%
MN-2	Goldendale Creek	Entire Length	63.2%	47.7%
MN-3	West Branch Menomonee River	Entire Length	65.6%	60.1%
MN-4	Willow Creek	Entire Length	64.0%	51.2%
MN-5	Nor-X-Way Channel	Entire Length	70.4%	72.5%
MN-6	Menomonee River and Dretzka Park Creek	From Little Menomonee River to Nor-X-Way Channel	73.6%	69.0%

Reachshed (TMDL Subbasin)	Waterbody Name	Waterbody Extents	TSS % Reduction from No-controls	TP % Reduction from No-controls
MN-7	Lilly Creek	Entire Length	70.4%	64.5%
MN-8	Butler Ditch	Entire Length	69.6%	58.3%
MN-9	Little Menomonee River	Entire Length	70.4%	64.5%
MN-10	Menomonee River	From Underwood Creek to Little Menomonee River	67.2%	31.7%
MN-11	Underwood Creek and Dousman Ditch	From South Branch Underwood Creek to Headwaters	72.0%	62.7%
MN-12	Underwood Creek	From Menomonee River to South Branch Underwood Creek	80.0%	76.1%
MN-13	South Branch Underwood Creek	Entire Length	76.8%	69.8%
MN-14	Menomonee River	From Honey Creek to Underwood Creek	64.8%	49.4%
MN-15	Honey Creek	Entire Length	73.6%	67.2%
MN-16	Menomonee River	From Estuary to Honey Creek	72.0%	49.4%

Table 3: Milwaukee River Basin

Reachshed (TMDL Subbasin)	Waterbody Name	Waterbody Extents	TSS % Reduction from No-controls	TP % Reduction from No-controls
MI-1	Upper Milwaukee River	From Campbellsport to Headwaters	**	**
MI-2	Upper Milwaukee River	From Kewaskum To Campbellsport and Auburn	73.6%	71.6%
MI-3	West Branch Milwaukee River	Entire Length	77.6%	48.6%
MI-4	Kewaskum Creek	Entire Length	76.8%	55.7%
MI-5	Watercress Creek and East Branch Milwaukee River	Entire Length	73.6%	51.2%
MI-6	Quass Creek and Milwaukee River	Near West Bend	73.6%	86.7%

Reachshed (TMDL Subbasin)	Waterbody Name	Waterbody Extents	TSS % Reduction from No-controls	TP % Reduction from No-controls
MI-7	Myra Creek and Milwaukee River	From North Branch Milwaukee River to West Bend	79.2%	67.2%
MI-8	North Branch Milwaukee River	from Adell Tributary to Headwaters	**	**
MI-9	Adell Tributary	Entire Length	**	**
MI-10	Chambers Creek, Batavia Creek, and North Branch Milwaukee River	Near Sherman	**	**
MI-11	Melius Creek	Entire Length	**	**
MI-12	Mink Creek	Entire Length	**	**
MI-13	Stony Creek, Wallace Creek, and North Branch Milwaukee River	Near Farmington	74.4%	46.8%
MI-14	Silver Creek	Entire Length	**	**
MI-15	Milwaukee River	Near Fredonia	**	**
MI-16	Milwaukee River	Near Saukville	75.2%	77.8%
MI-17	Milwaukee River	From Cedar Creek to Saukville	76.0%	83.1%
MI-18	Cedar Creek	From Jackson Creek to Headwaters	76.8%	71.6%
MI-19	Lehner Creek	Entire Length	77.6%	61.0%
MI-20	Jackson Creek	Entire Length	80.8%	77.8%
MI-21	Little Cedar Creek	Entire Length	80.8%	77.8%
MI-22	Cedar Creek	Near Jackson	76.8%	54.8%
MI-23	Evergreen Creek	Near Jackson	79.2%	53.0%
MI-24	North Branch Cedar Creek and Cedar Creek	From Milwaukee River to Myra Creek	73.6%	79.6%
MI-25	Milwaukee River	From Pigeon Creek to Cedar Creek	81.6%	43.2%
MI-26	Pigeon Creek	Entire Length	90.4%	88.5%
MI-27	Milwaukee River	From Lincoln Creek to Pigeon Creek	72.8%	53.9%
MI-28	Beaver Creek	Entire Length	72.8%	88.5%

Reachshed (TMDL Subbasin)	Waterbody Name	Waterbody Extents	TSS % Reduction from No-controls	TP % Reduction from No-controls
MI-29	South Branch Creek	Entire Length	71.2%	87.6%
MI-30	Indian Creek	Entire Length	65.6%	76.1%
MI-31	Lincoln Creek	Entire Length	71.2%	85.8%
MI-32	Milwaukee River	From Estuary to Lincoln Creek	58.4%	23.7%

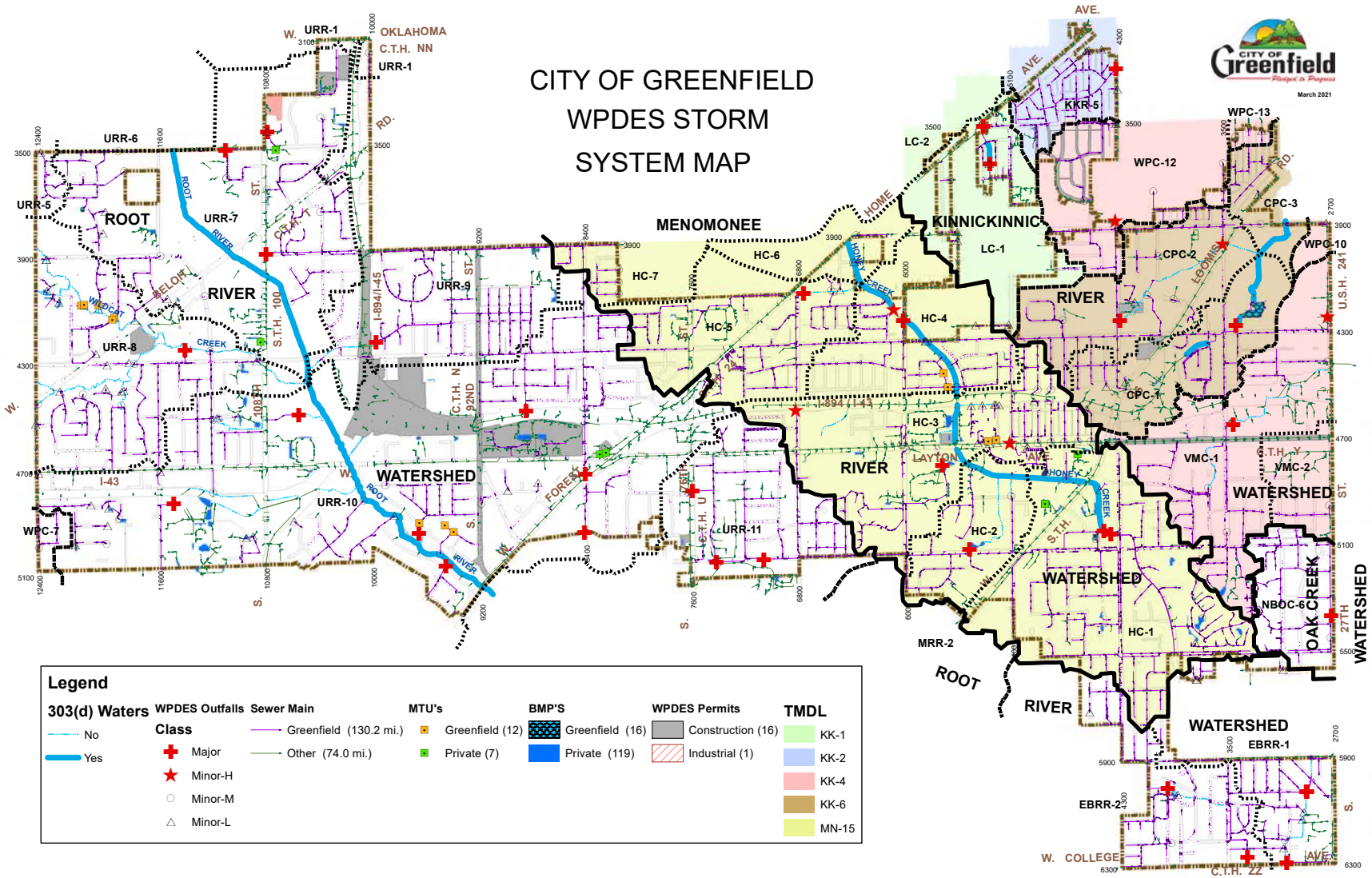
Note: **The TMDL did not assign a percent reduction for these reachsheds because modeling indicated that there is no direct MS4 discharge to this subbasin. If more detailed analysis conducted by the permittee indicates the presence of an MS4 discharge, contact your DNR storm water engineer or specialist for more information on how best to proceed.

APPENDIX G. MUNICIPAL SEPARATE STORM SEWER SYSTEM MAPS

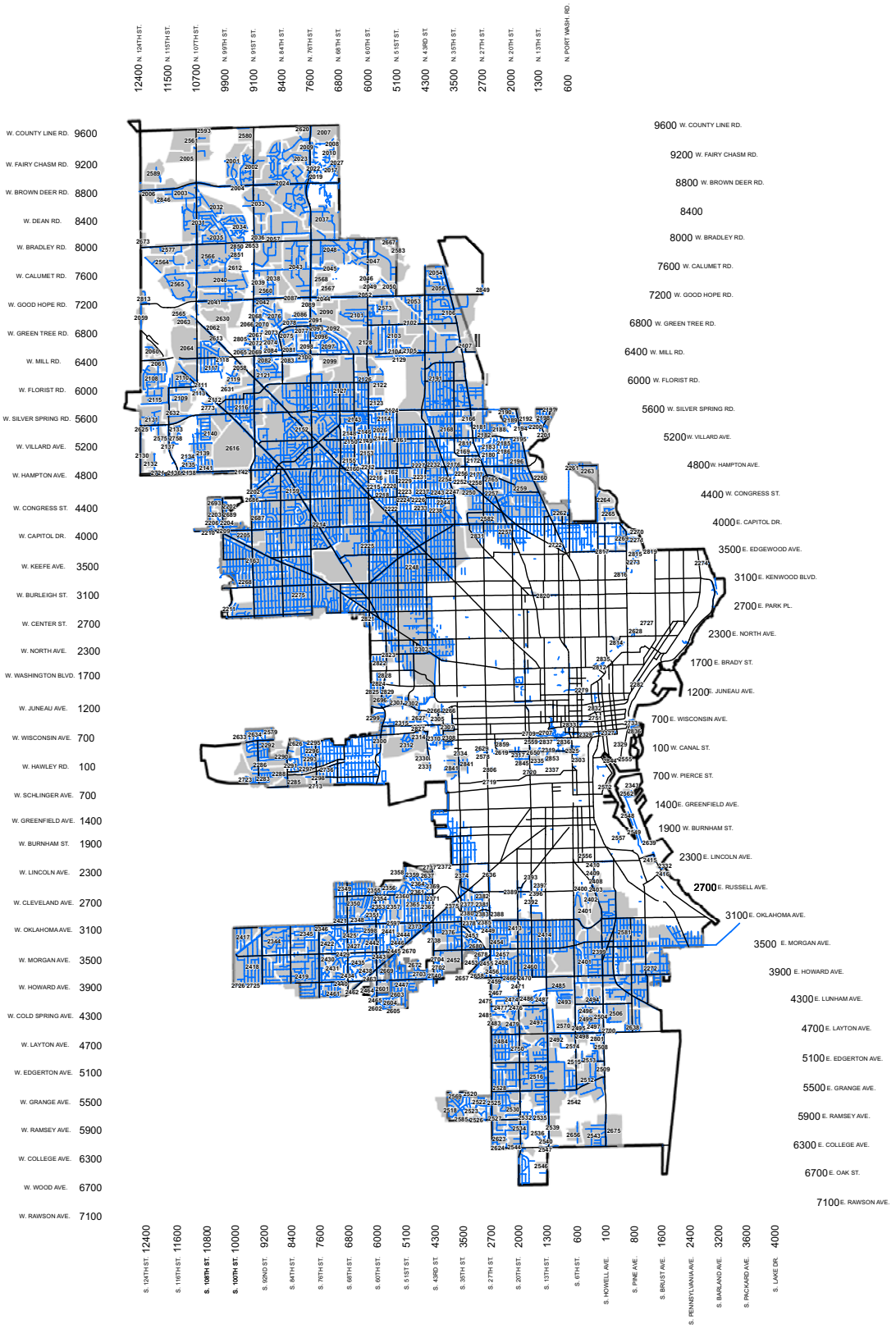
Civil Division	**Map Source**
Milwaukee County	TBD
City of Greenfield	2020 MS4 Annual Report
City of Milwaukee*	2020 MS4 Annual Report
City of Wauwatosa	2020 MS4 Annual Report
City of West Allis	2020 MS4 Annual Report
Village of Greendale	TBD
Village of West Milwaukee	TBD
Ozaukee County	2020 MS4 Annual Report
City of Mequon	2019 MS4 Annual Report
Washington County	2020 MS4 Annual Report
Town of Germantown	TBD
Village of Germantown	2020 MS4 Annual Report
Village of Richfield	2020 MS4 Annual Report
Waukesha County	2020 MS4 Annual Report
City of Brookfield	2019 MS4 Annual Report
City of New Berlin	2020 MS4 Annual Report
Town of Brookfield	2020 MS4 Annual Report
Town of Lisbon	TBD
Village of Butler	TBD
Village of Elm Grove	2020 MS4 Annual Report
Village of Menomonee Falls	2020 MS4 Annual Report

*Also partially in Washington and Waukesha County

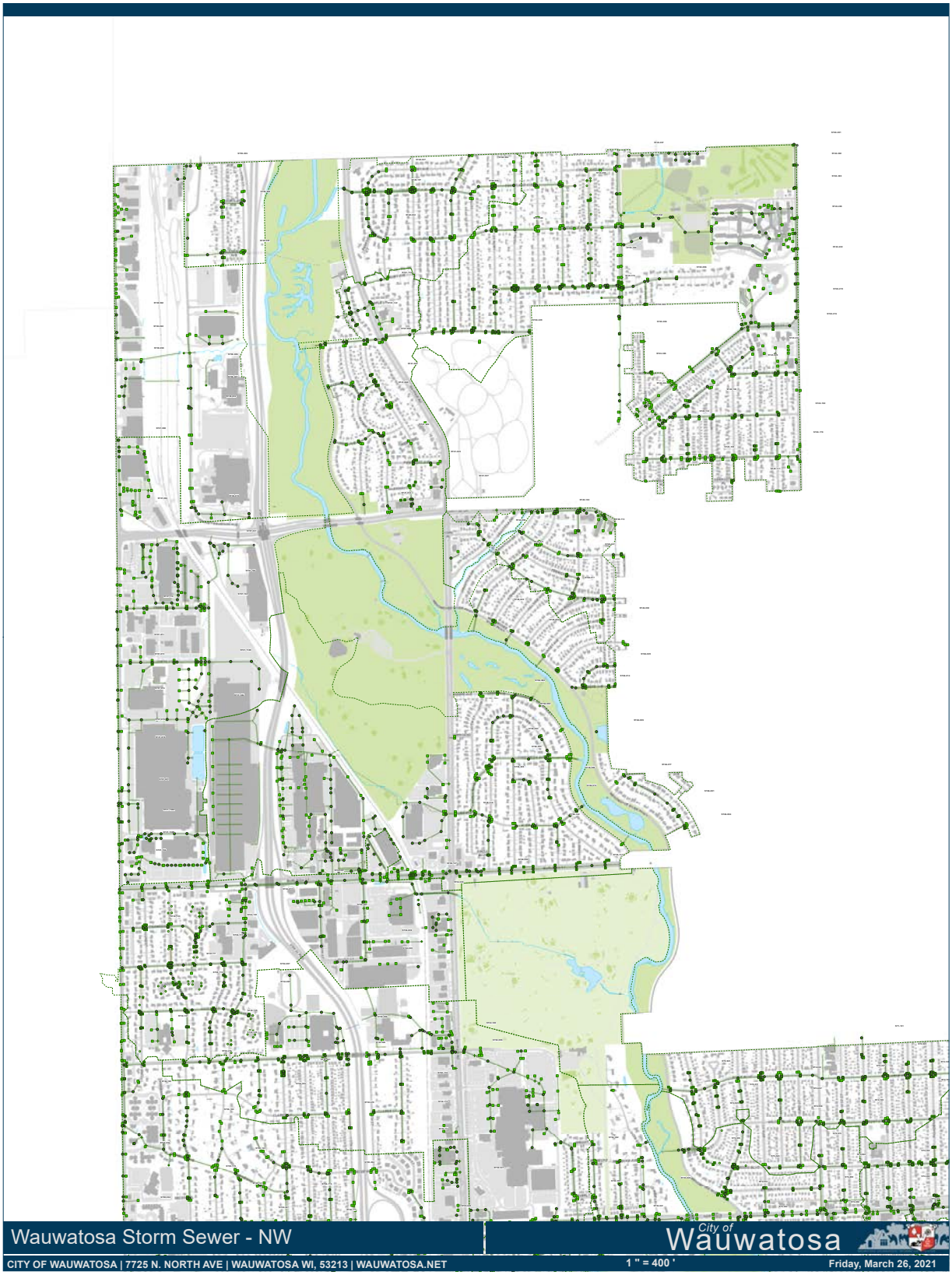
City of Greenfield MS4 Map



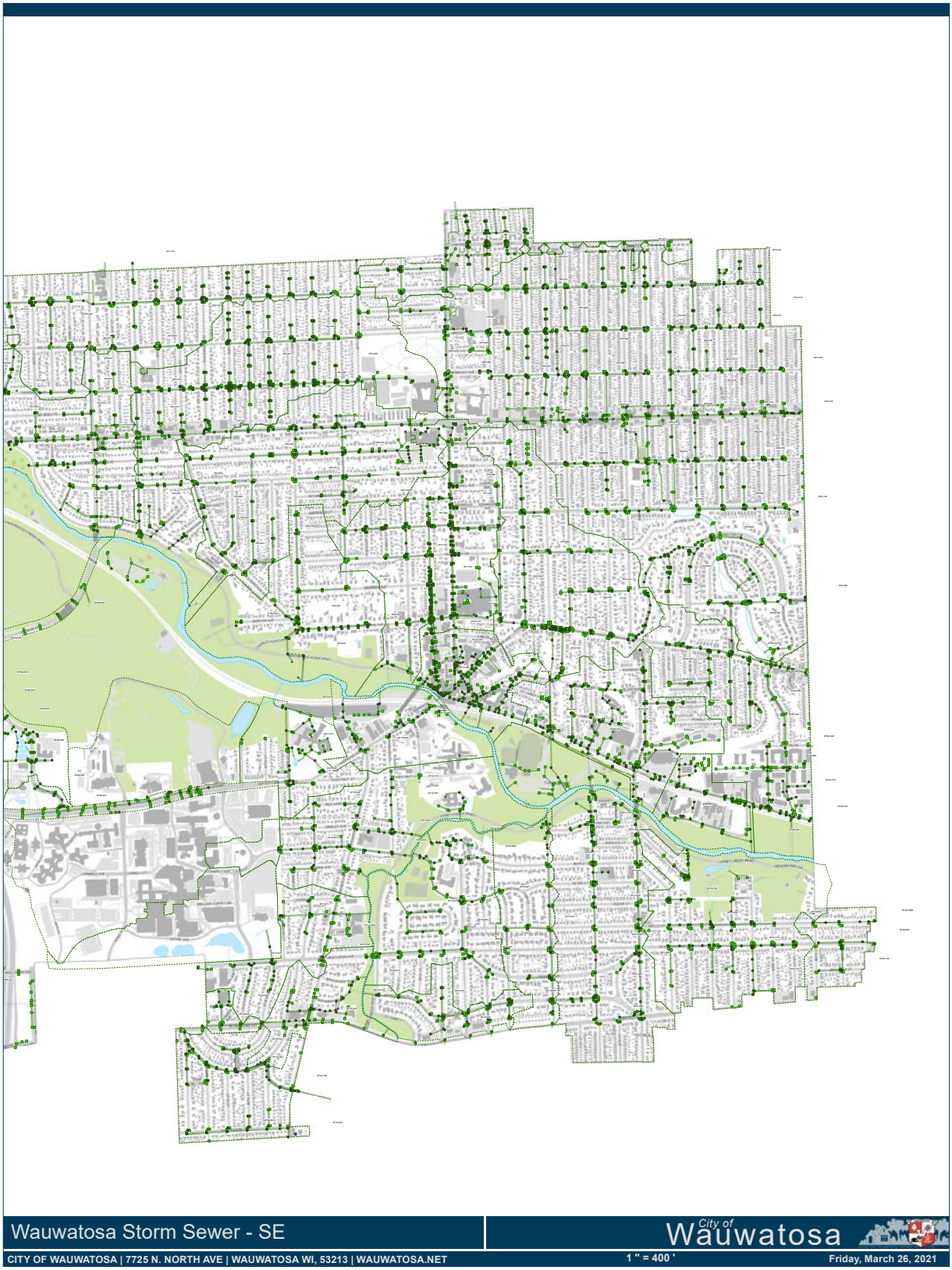
City of Milwaukee MS4 Map



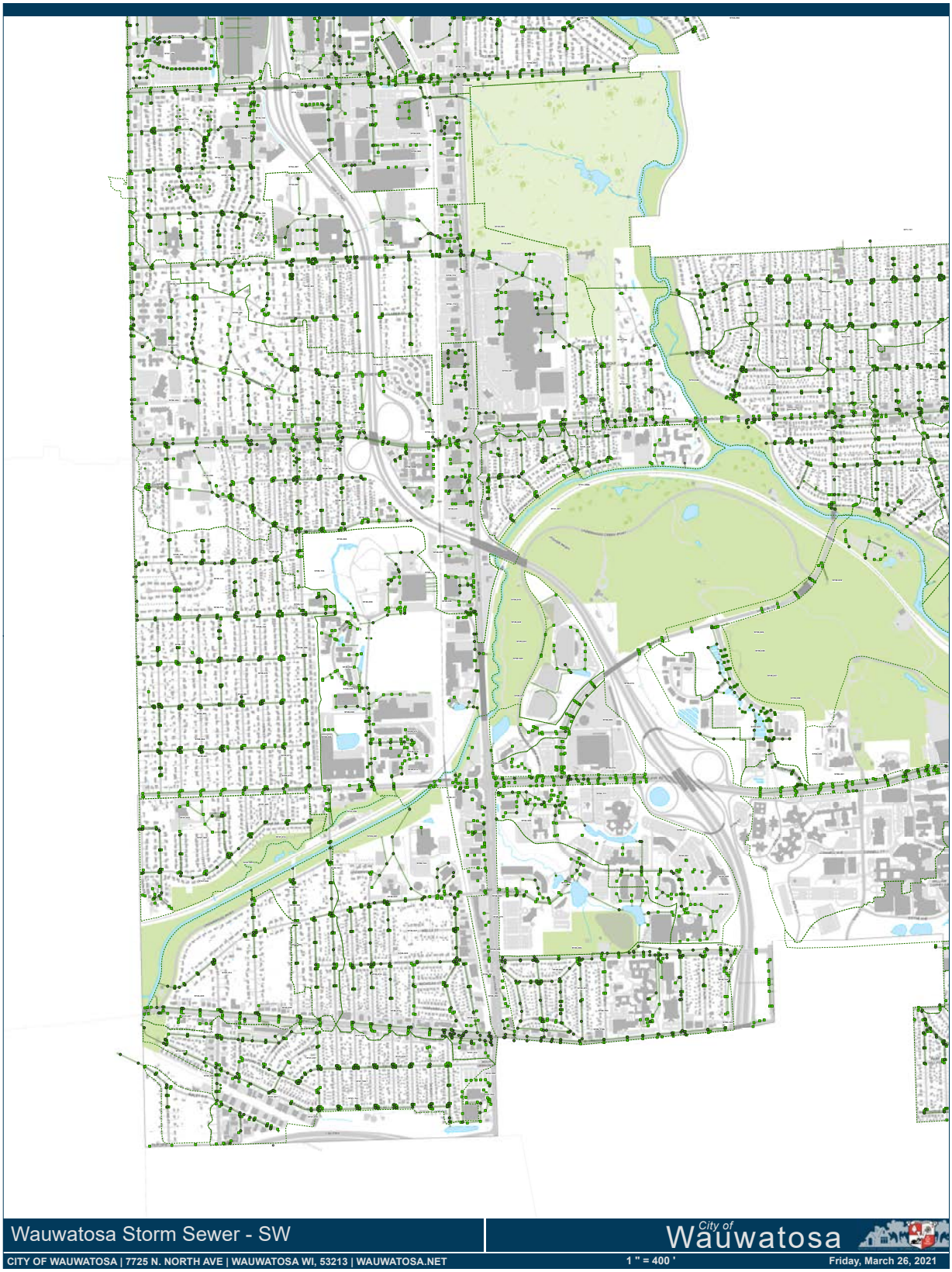
City of Wauwatosa MS4 Map (1 of 3: NW)



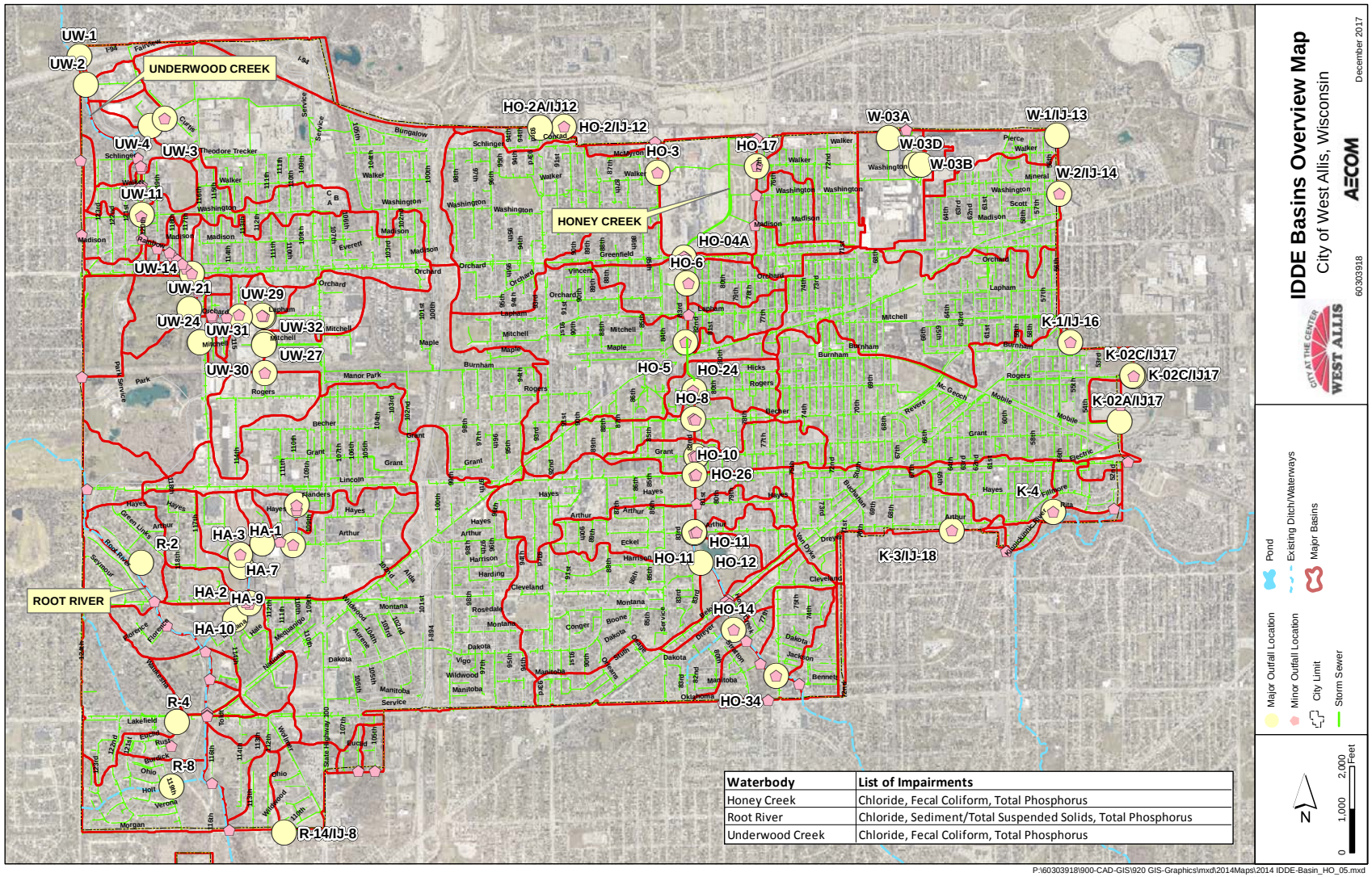
City of Wauwatosa MS4 Map (2 of 3: SE)



City of Wauwatosa MS4 Map (3 of 3: SW)

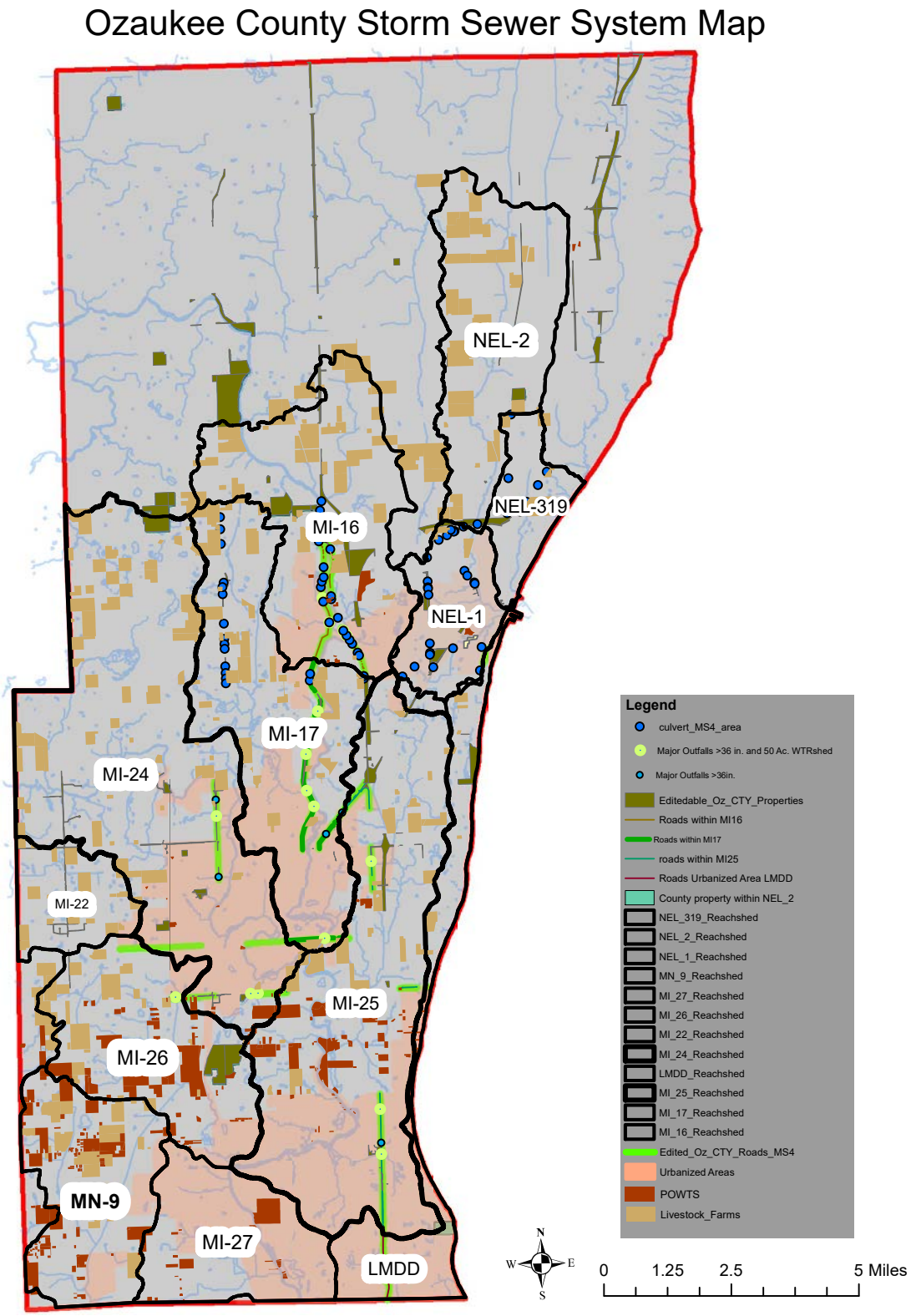


City of West Allis MS4 Map

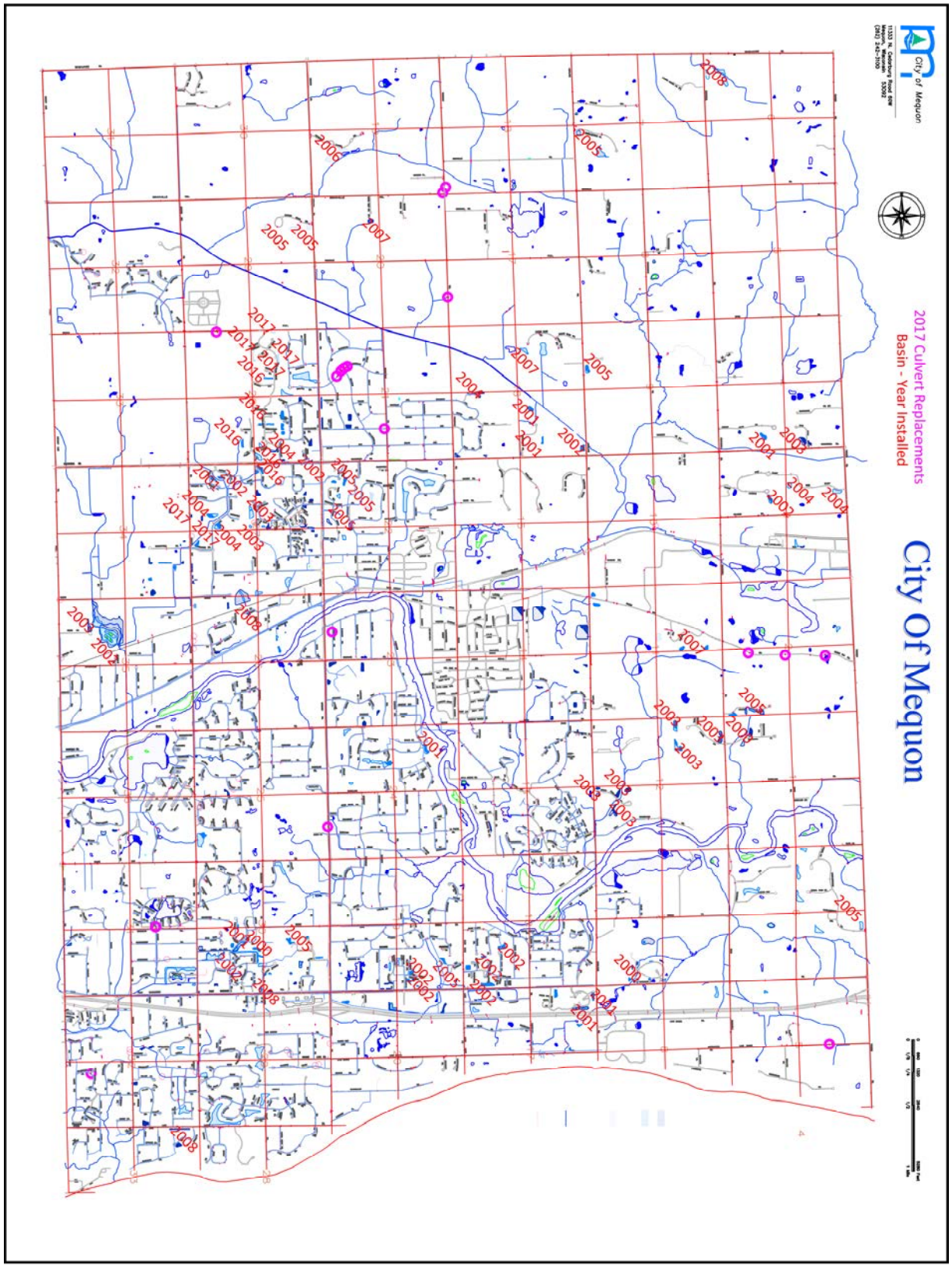


Waterbody	List of Impairments
Honey Creek	Chloride, Fecal Coliform, Total Phosphorus
Root River	Chloride, Sediment/Total Suspended Solids, Total Phosphorus
Underwood Creek	Chloride, Fecal Coliform, Total Phosphorus

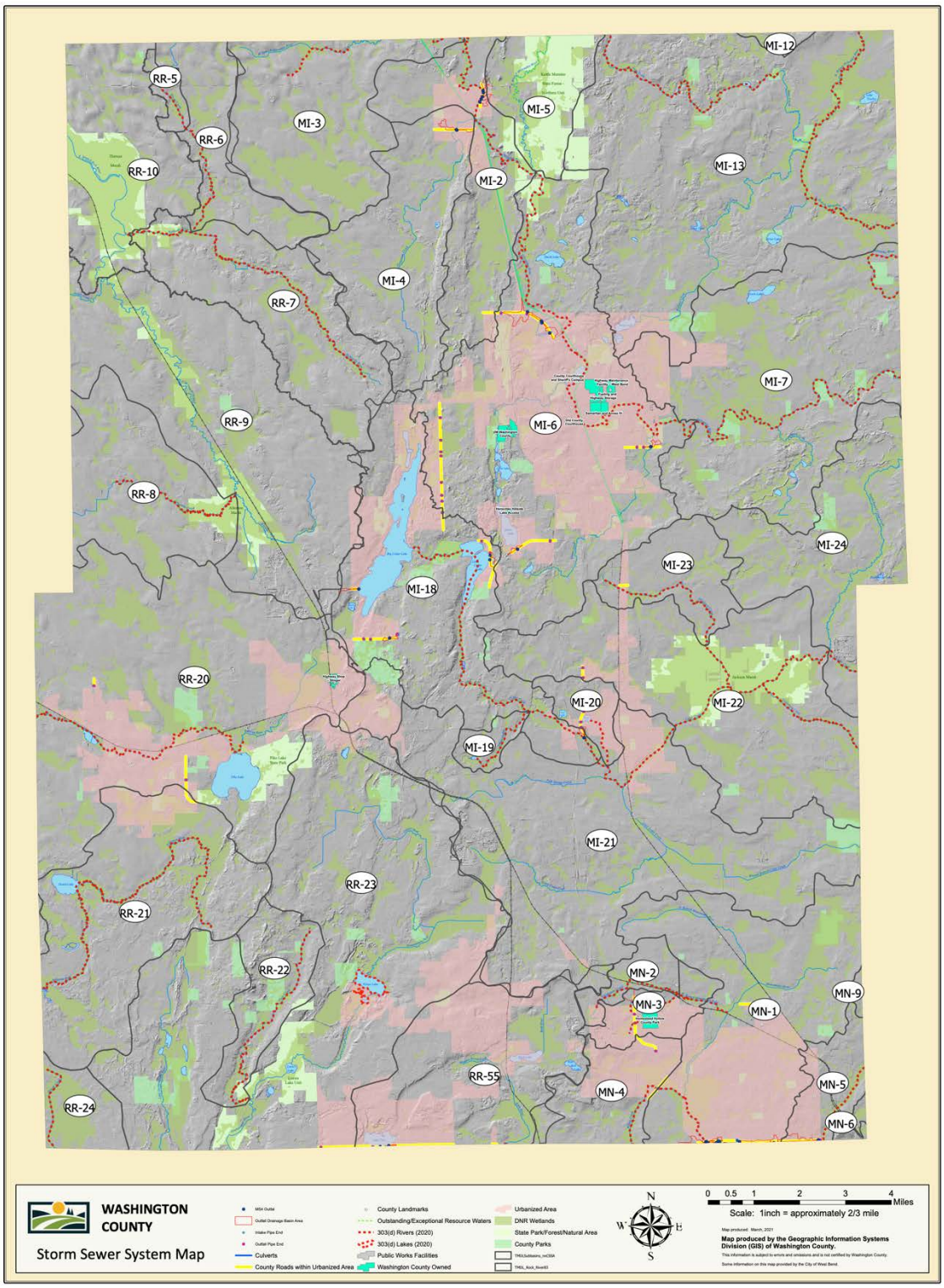
Ozaukee County MS4 Map



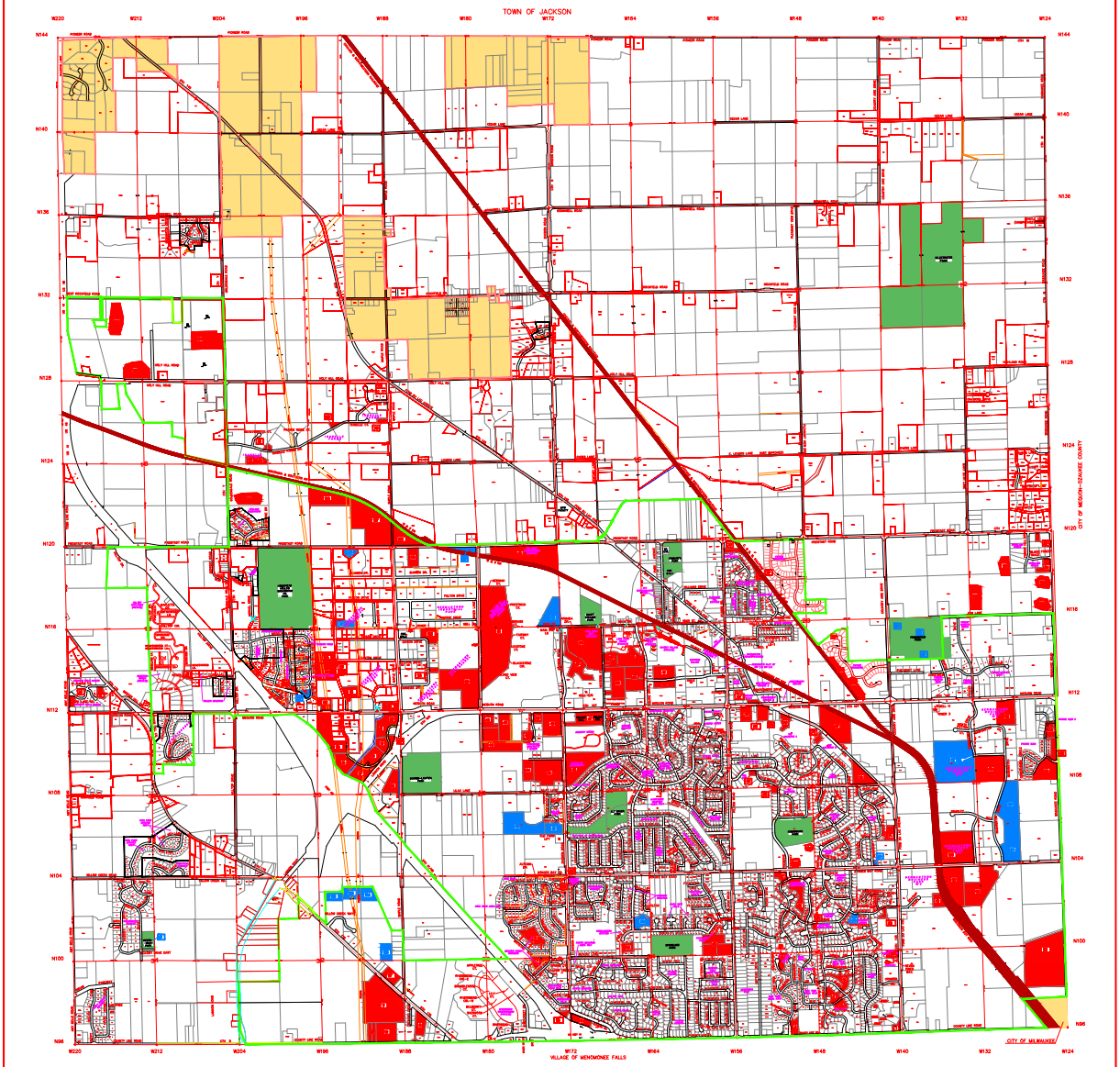
City of Mequon MS4 Map



Washington County MS4 Map



Village of Germantown MS4 Map



Private and Public Detention Pond Owners List

Pond Number	Owners Name
1	Autumn Ridge Condominium HOA
2	TreeTops Development LLC
3	TreeTops Development LLC
4	TreeTops Development LLC
5	TreeTops Development LLC
6	C&J Investment Properties LLC (by County Line Dental)
7	Meadow Creek Crossing
8	Meadow Creek Crossing
9	Continental I Fund Limited Partnership (by Sears)
10	Germantown Plaza II (by World Market)
11	Meridian Germantown LLC (by WalMart)
12	Germantown Ventures LLC (Bavarian Woods Subdivision)
13	Country Belle Manor LLC
14	Country Belle Manor LLC
15	Village of Germantown (Weidenbach Park)
16	MD Development LLC (by Moore Designs)
17	Kleinmann Properties LLC
18	AGRG Holdings (by LaFleur's Gymnastics)
19	BA Goff LLC (by Goff's Collision Repair Center)
20	SCS LLC (by Northwest Mutual)
21	Kleinmann Properties LLC (by GSC)
22	Does Not Exist?
23	Anderson Brothers Construction (by Best Western)
24	Village of Germantown (Maintenance by Goldenwood HOA)
25	Village of Germantown (Shadow Wood Subdivision)
26	LCM Funds 17 McCormick LLC (by Reindl Bindery)
27	Village of Germantown (by Wonik Materials)
28	Village of Germantown (by Wago Corporation)
29	Village of Germantown (by Nelson Container Corporation)
30	Germantown High School
31	The Glen at Blackstone Creek
32	The Cove Condominiums
33	Village of Germantown (by Recycling Center)
34	Lake Park Forest Condominiums
35	Lakewood Condominiums
36	Lake Park West Condominiums
37	Stonehedge Properties
38	Prairie Meadows Senior Housing LLC
39	Life Church Inc
40	Sylvan Circle LLC
41	Squire Court Condominiums
42	Glen Oaks Office Park LLC (by Falcons Rock Investment Counsel)
43	Sentinel Germantown LLC (by Aurora Healthcare)
44	Sentinel Germantown LLC (by Aurora Healthcare)
45	Berean Family Worship Center Inc (Dry Pond)
46	Faith Lutheran Church
47	Village of Germantown (by Village Hall & Police Department)
48	Gables Himmel Property LLC (The Gables of Germantown
49	Smv Germantown LLC (by Virginia Highlands Center)
50	Village of Germantown (Division Road Ponds)
51	Village of Germantown (Division Road Ponds)
52	Edward & Michelle Hagopian (Country Meadows Subdivision)
53	Terrence & Christine Conway (Country Meadows Subdivision)
54	Village of Germantown (Country Meadows Subdivision)
55	Pebblebrook Homes LLC (Pebblebrook Estates)
56	First Alliance Church (now Crossway Church)
57	Windsong At Germantown HOA
58	Windsong At Germantown HOA
59	Windsong At Germantown HOA
60	Village of Germantown (Sunberry Downs Subdivision)
61	Skyline Development Corporation (by Public Storage)
62	Bizco LLP (by International Concrete Product)
63	Superior of WI (by Veolia Environmental Services)
64	Village of Germantown (by Enviro-Safe Consulting)
65	Village of Germantown (by Packaging Specialties)
66	Heather Lake LLC (by Ellsworth Adhesives)
67	Village of Germantown (by Kitpackers)
68	Woodfield LLC (by Weimer Bearing & Transmission Inc)
69	Prairie Glen HOA
70	Prairie Glen HOA
71	Wexford Heights LP (Hillstone Apartments)
72	The Preserve HOA
73	Bethlehem Evangelical Lutheran Church
74	The Preserve HOA
75	Red Badger LLC (by Germantown Express Care)
76	Naumann-Greene Properties LLC (by WI School of Massage Therapy)
77	The Woodlands Partners LLC (The Woodlands Subdivision)
78	The Woodlands Partners LLC (The Woodlands Subdivision)
79	Isabelle Farms HOA
80	Isabelle Farms HOA
81	Isabelle Farms HOA
82	Isabelle Farms HOA
83	Isabelle Farms HOA
84	Woodland Ventures LLC (Woodland Ponds Subdivision)
85	Woodland Ventures LLC (Woodland Ponds SUbdivision)
86	Seven Pines Condominiums
87	Village of Germantown (Freidenfeld Park)
88	Village of Germantown (Freidenfeld Park)
89	Village of Germantown (Freidenfeld Park)
90	Village of Germantown (Wooded Hills Subdivision)
91	The Preserve HOA
92	Preserve JBJ LTD Partnership (by Ellen's Home South)
93	Freistadt All Temp LLC (by D & G)
94	Life Investors Germantown Memory Care LLC (by Tender Reflections)
95	Varnum LLC (by Dollar Tree)
96	H-T Properties (By Construction Supply & Erection)
97	Neal & Brian Karthauser (by Karthauser & Sons)
98	M & J Miller Investments LLC (by Anytime Fitness)
99	Tree Tops Development LLC
100	Bielinski Homes Inc (Prairie Glen II Subdivision)
101	Truffles LLC
102	Village of Germantown (TID #6)
103	Village of Germantown (TID #6)
104	Village of Germantown (TID #6)
105	Village of Germantown (TID #6)
106	Phylmack LLC (by JW Speaker Corporation)
107	AGNL Dairy LLC (by Gehl Foods)
108	Germantown Realty Investment LLC (by Machining Concept)
109	DSM Food Specialties USA
110	Pinnacle Investment Properties LLC (by Pinnacle Woodwork)
111	Sunlite Plastics Inc
112	P & M Properties (by First Choice Ingredients)
113	Trouble Free Reality LLC (by Xtreme Stainless)
114	GLPC Acquisition (by American Paper & Packaging)
115	Leonard & Marlene In (by Maple Metal Products)
116	5G Investments LLC (by La Chimenea)
117	Robert Weiland (by Walmart)
118	JDG Holdings (by Jacob Daub DDS)
119	Sunberry Woods HOA
120	Waste Management
121	Hyponex Corporation (by Scotts Co)
122	TN Real Estate LLC (by Complete Office of Wisconsin)
123	TID #8
124	Dickman
125	Diedeotric
126	Speaker
127	Wnenwood PhR1
128	Wnenwood PhR1
129	Wnenwood PhR1
130	Harvest Hills
131	Harvest Hills
132	Woodland Ponds Estates
133	Outlot #4 & Woodland Ponds Estates
134	Kinderberg
135	Kinderberg

LEGEND
- PUBLIC DETENTION POND
- PRIVATE DETENTION POND
- OTHER MUNICIPALITY (TOWN OF GERMANTOWN, CITY OF MILWAUKEE)
- PUBLIC ROAD
- PRIVATE ROAD

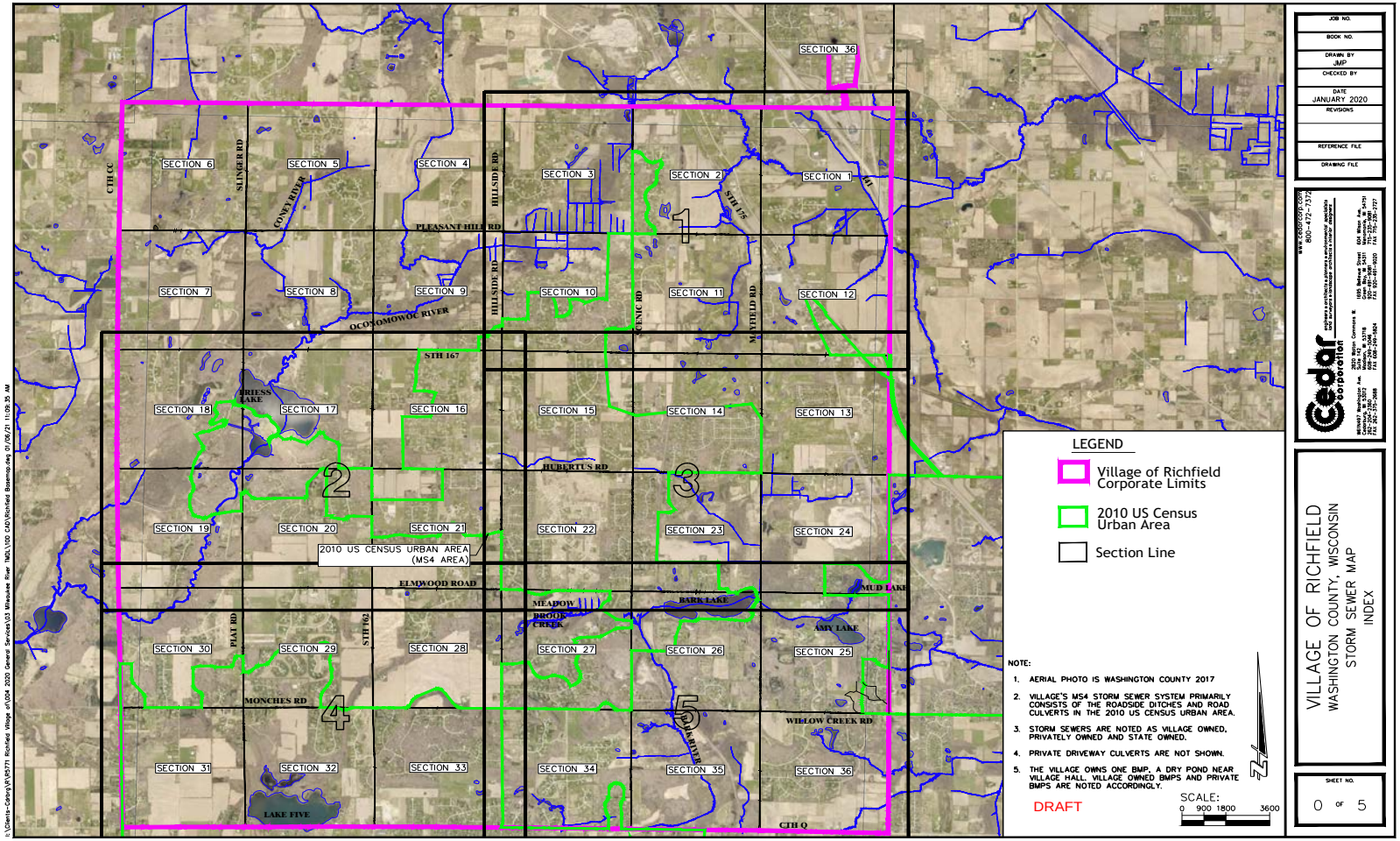
SCALE IN FEET
1000' 0 1000'

ENGINEERING DEPARTMENT
Village of Germantown
Germantown ...Welcomes

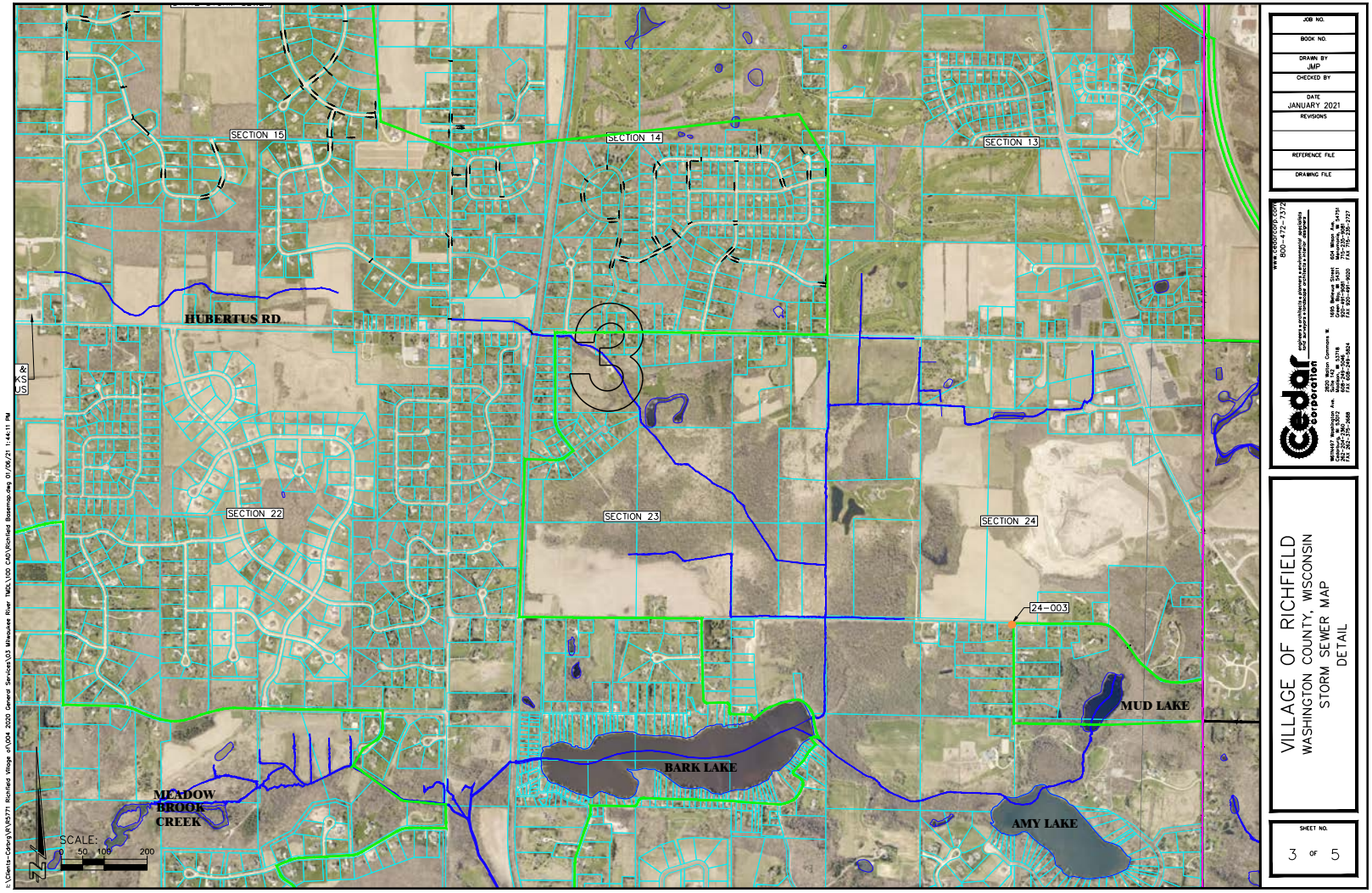
STORMWATER POND FACILITY MAP
VILLAGE OF GERMANTOWN
VILLAGE OF GERMANTOWN ENGINEERING DEPARTMENT
GERMANTOWN, WISCONSIN

DESIGNED BY RCB	DATE 1/29/2010		
DRAWN BY RCB	DATE		
APPROVED BY BRB	DATE	2 2021 UPDATE	3/11 DDR
CADFILE f:\eng\gis\stormwater\pond map 2010		1 2018 UPDATE	8/15 B.G.
		REVISION DESCRIPTION	DATE BY

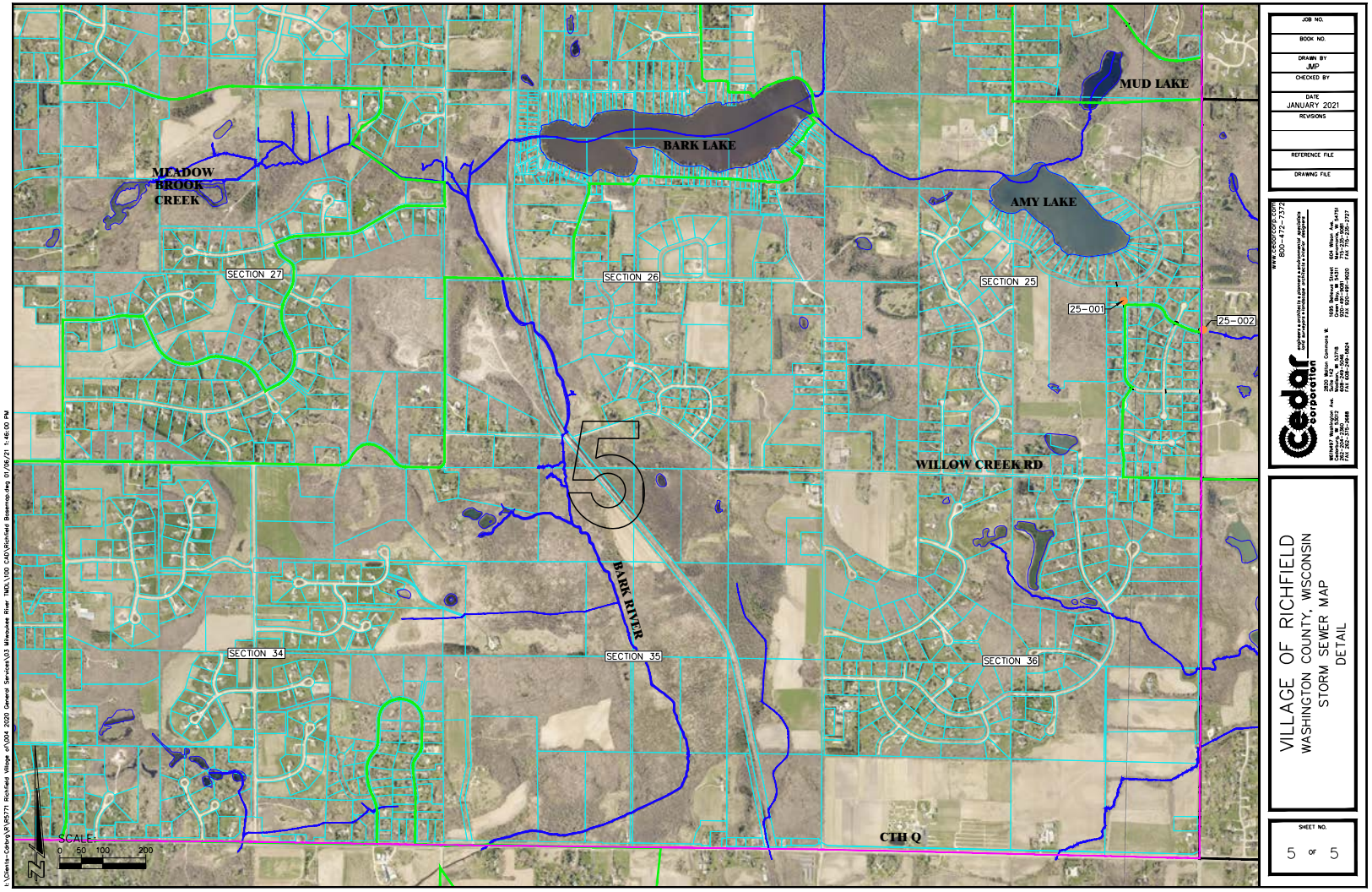
Village of Richfield MS4 Map (1 of 3: Reference Map)



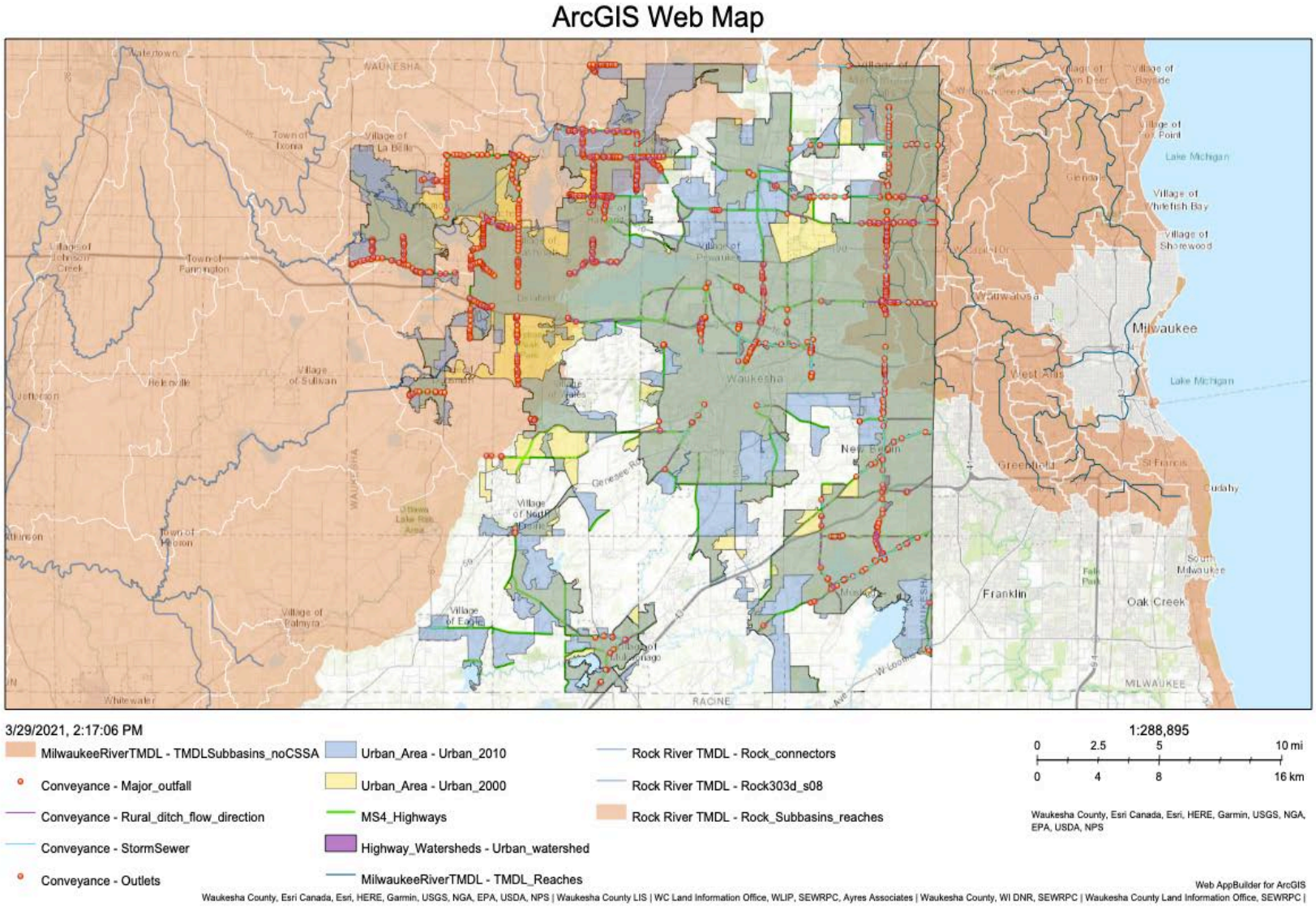
Village of Richfield MS4 Map (2 of 3: Central East)



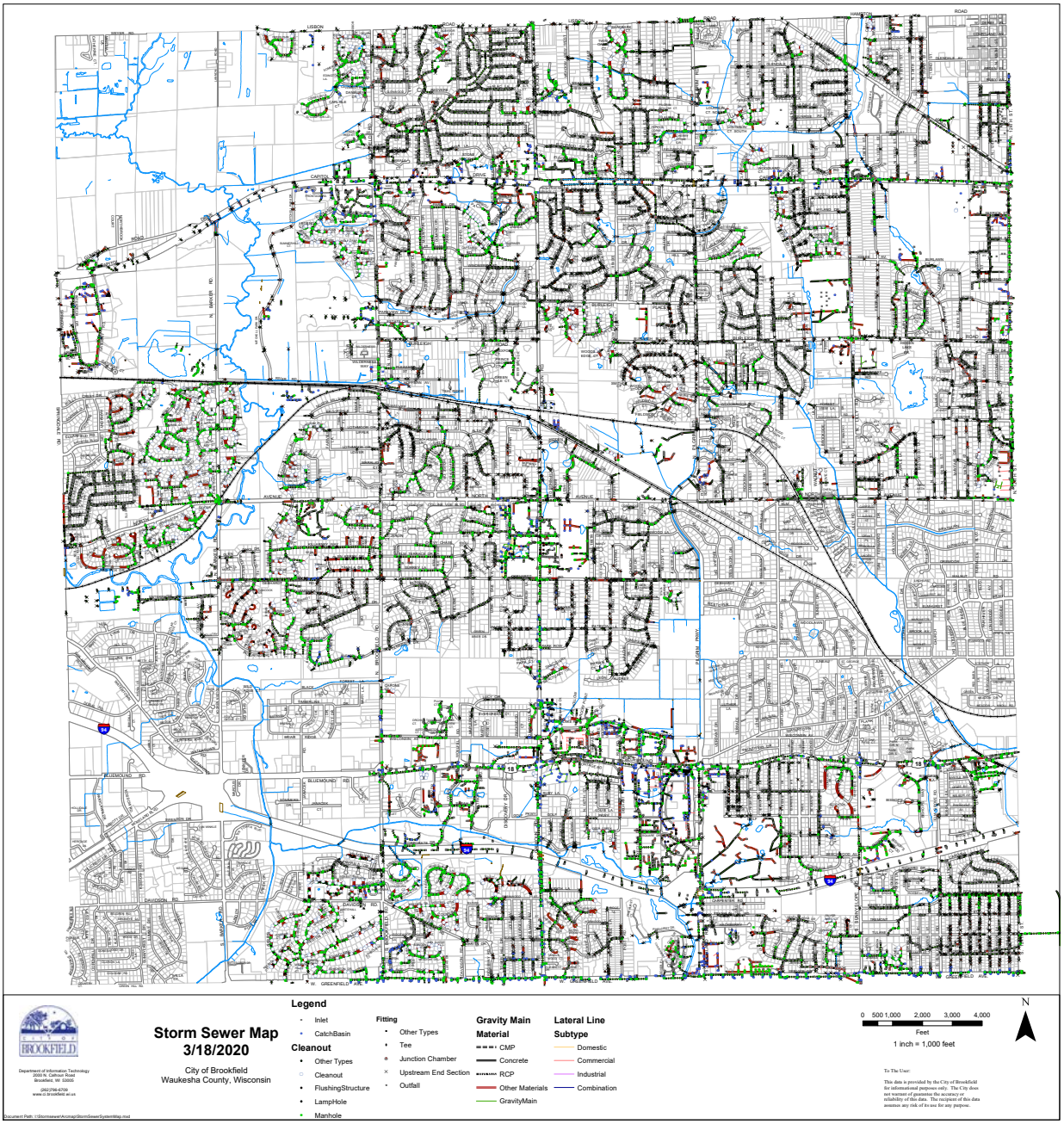
Village of Richfield MS4 Map (3 of 3: SE)



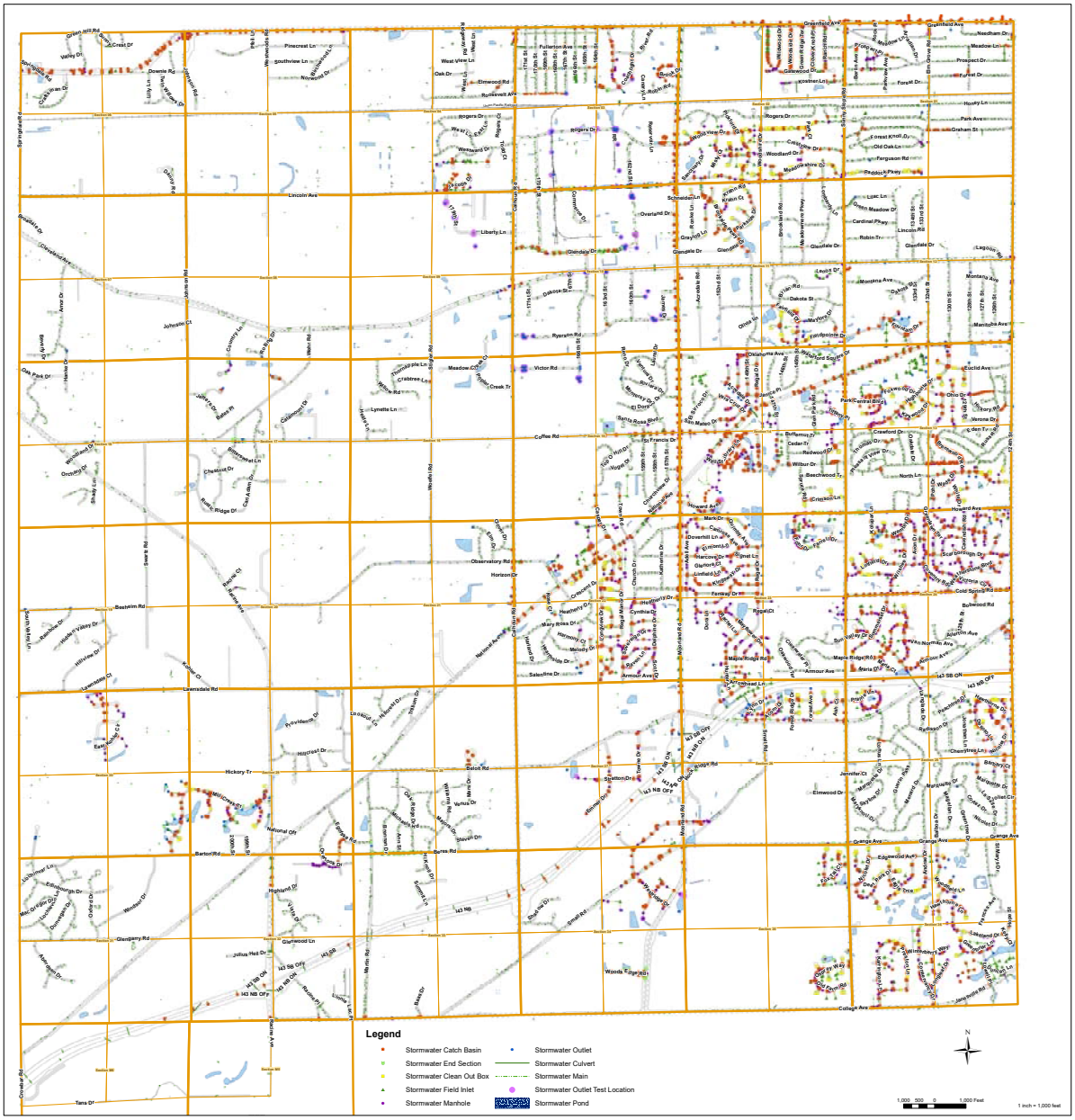
Waukesha County MS4 Map



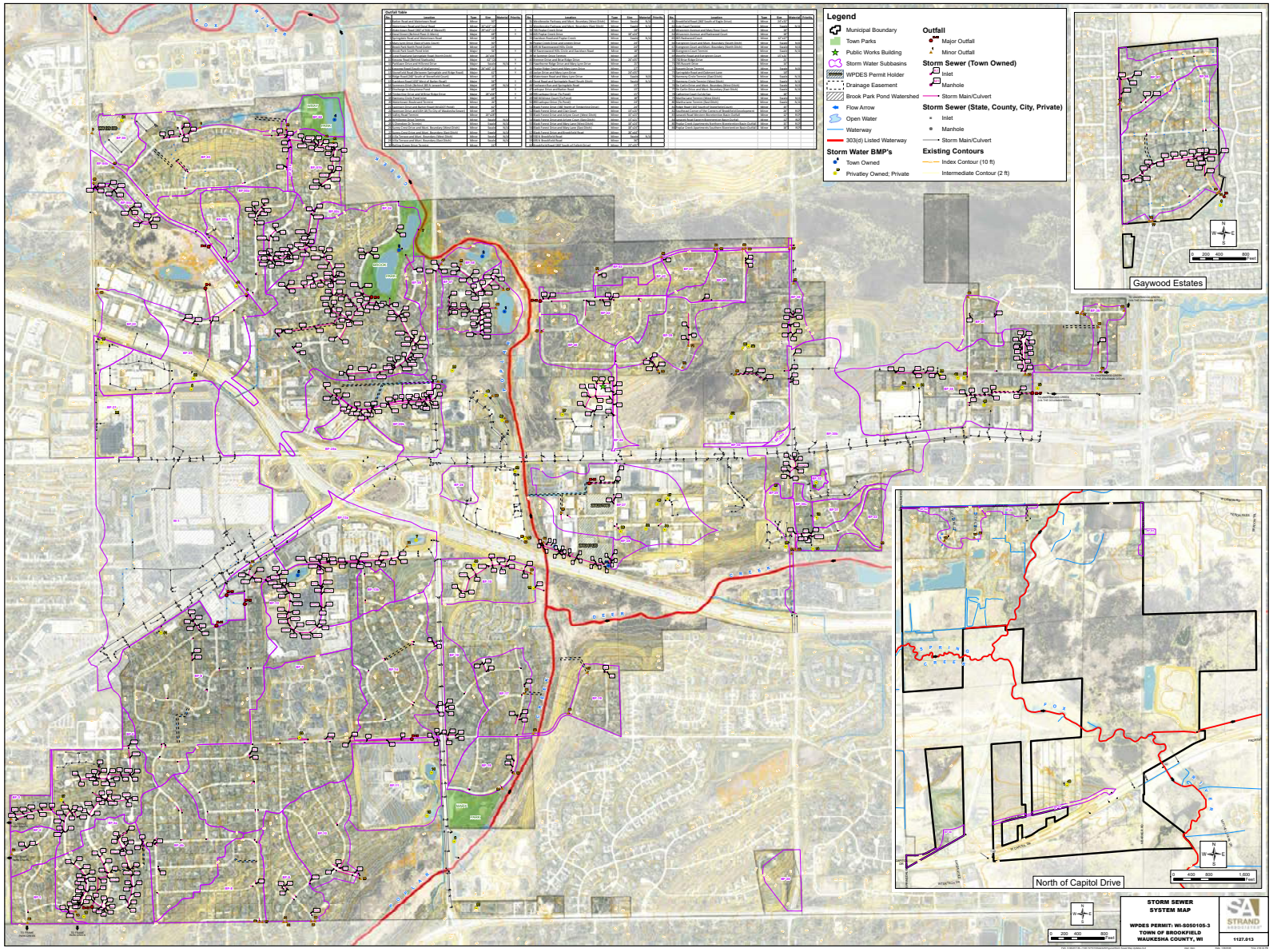
City of Brookfield MS4 Map



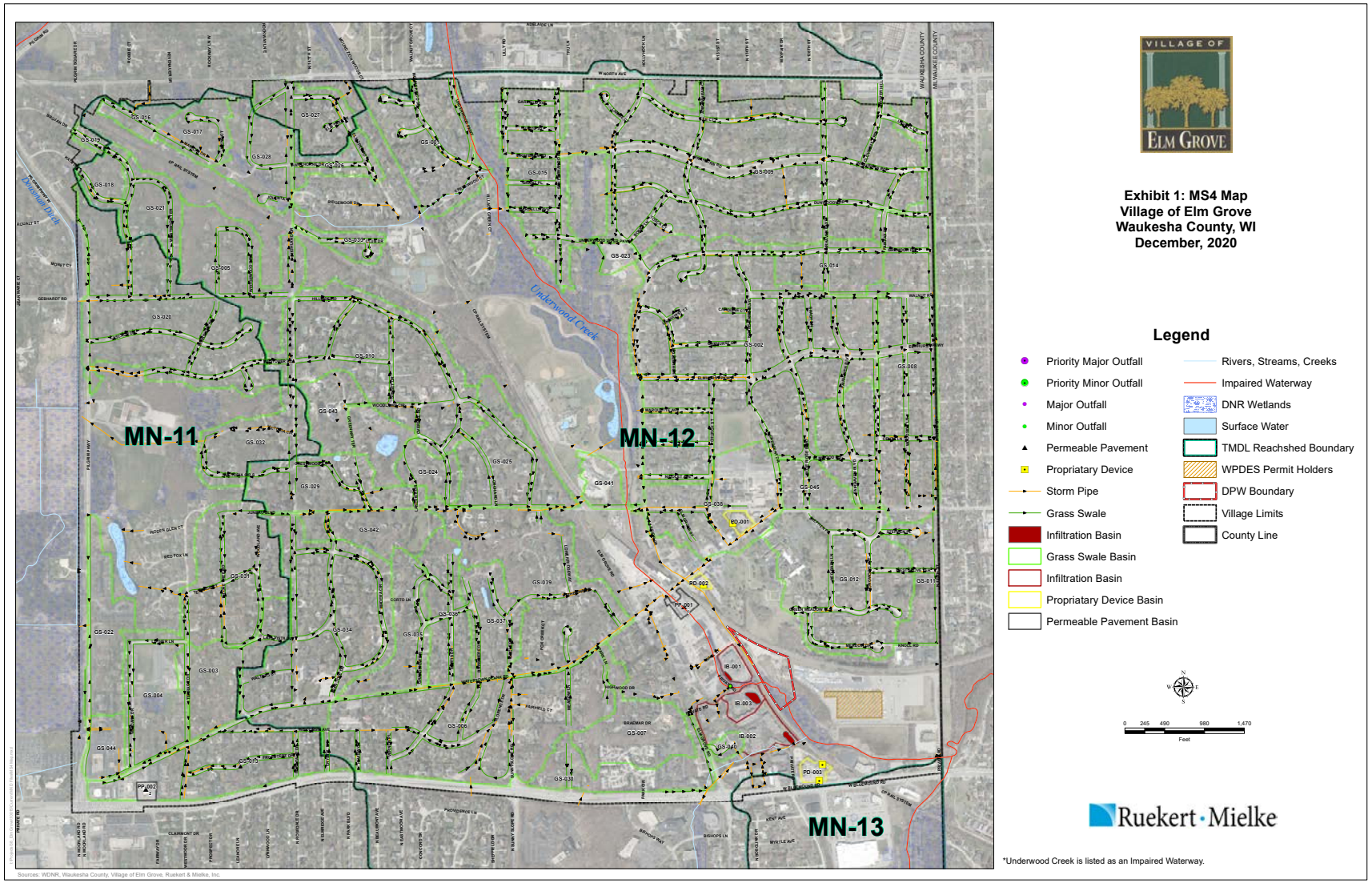
City of New Berlin MS4 Map



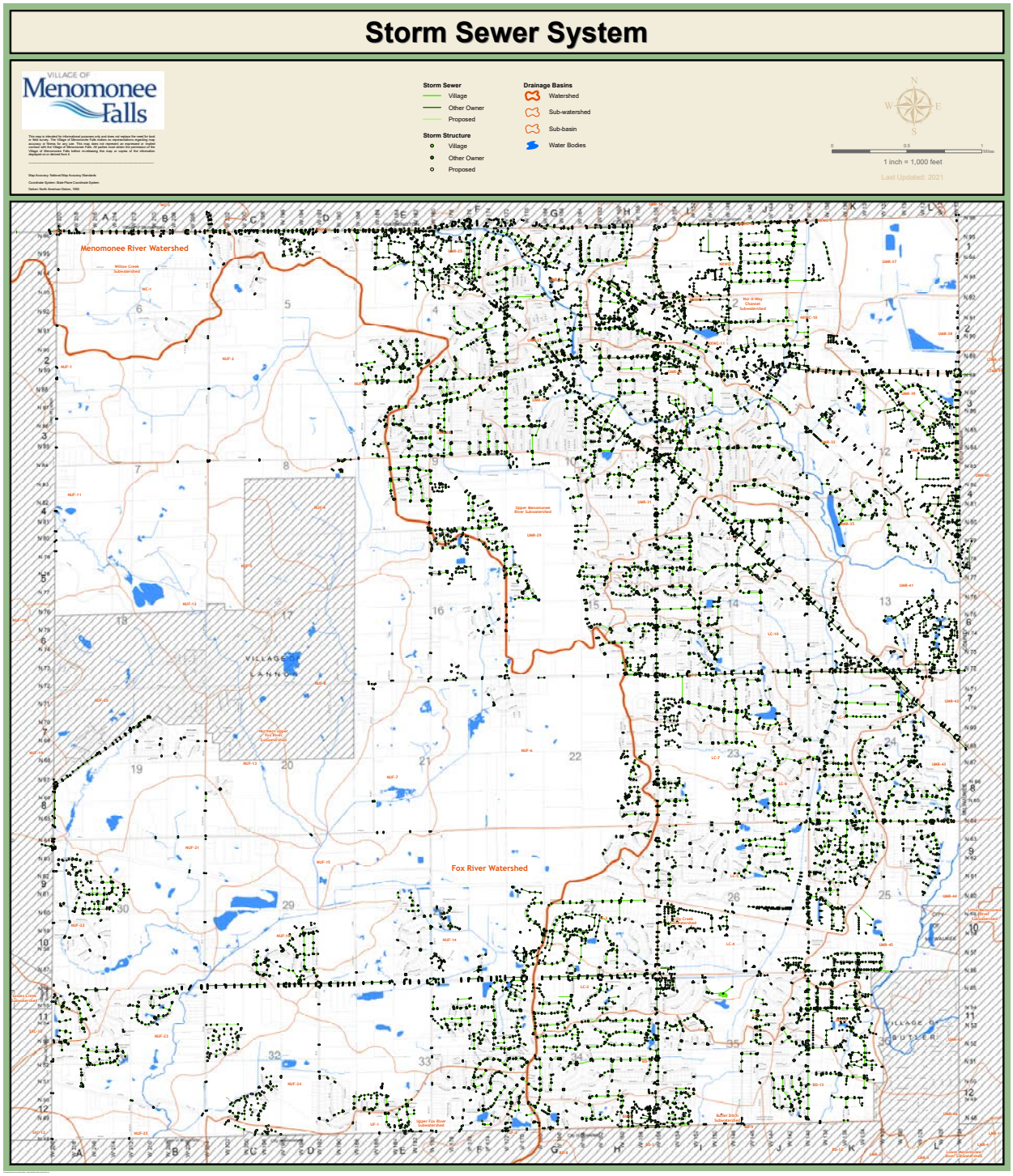
Town of Brookfield MS4 Map



Village of Elm Grove MS4 Map



Village of Menomonee Falls MS4 Map



APPENDIX H. MONITORING METHODOLOGY

Per WDNR's proposed 2022 Wisconsin Consolidated Assessment and Listing Methodology (WisCALM), water quality sampling efforts in the watershed will be representative of current water quality conditions and inclusive of a wide range of weather and flow conditions. Water Quality monitoring for this plan will include:

1. Annual sampling dates spread over representative seasonal periods and,
2. Samples collected under a wide range of weather and flow conditions.

TOTAL PHOSPHORUS (TP)

Water quality sampling will follow WDNR's protocols for Total Phosphorus (TP) and will address seasonality, timing and frequency of sample collection. Sampling protocols will also reflect USGS development of the TP criteria [s. NR 102.06(3) Wis. Adm. Code]. Surface waters will be sampled monthly over a 6-month period from May through October, approximately 30 days apart. If samples are missed, samples collected in different months over multiple years may be combined to create a complete annual data set.

Where multiple years of data are available, the three most recent years of data will be used for making water quality assessments. Total Phosphorus assessments will also be completed in consultation with WDNR staff. Study-specific or project related targeted sampling activities are not appropriate for assessment of attainment of the applicable TP water quality criterion. Appropriate statistical approaches are employed as outlined in WisCALM to achieve a 95% confidence interval around the mean for water quality assessment.

TOTAL SUSPENDED SOLIDS

There are no sampling standards or Water Quality criteria for streams in WDNR WISCALM guidance for total suspended solids (TSS). However, a TSS goal of 12 mg/L is used for surface waters by the Milwaukee River Total Maximum Daily Load (TMDL) approved by US EPA in 2018. TSS will be monitored indirectly through turbidity testing conducted by Milwaukee Riverkeeper (in NTUs), by MMSD (in FNUs), and other stakeholders. Turbidity monitoring or TSS sampling/assessments will be completed in consultation with WDNR staff. TSS could also be monitored at a select group of sites to help assess progress toward TMDL implementation. Also, Suspended Sediment Concentration (SSC) may be used in lieu of TSS concentrations - https://water.usgs.gov/osw/pubs/WRIR00-4191.pdf - to evaluate suspended solids concentrations within Menomonee River watershed streams.

The TSS monitoring approach and methods will be revisited every 3-5 years, and/or if State Water Quality Standards are promulgated for TSS.

FECAL COLIFORM/BACTERIA

Bacteria monitoring is a time intensive and costly endeavor, and there are many different indicators and ways to monitor it. For the purposes of this Plan, we will use existing sources of bacteria data and assess how to adjust sampling design in the future as science changes and resources become more available. As of 2021, comprehensive bacteria monitoring is not currently funded. Monitoring for bacteria is necessary to evaluate compliance with the bacteria TMDL, and assessments of TMDL progress will be completed in consultation with WDNR staff every 3-5 years. In addition, methods and monitoring protocols used shall be revisited every 3-5 years

Milwaukee Riverkeeper Baseline Monitoring:

Milwaukee Riverkeeper volunteers currently collect bacteria samples to determine total coliform and *E. coli* at a selection of monitoring sites in the watershed, using 3M coliscan products, as piloted by and recommended by the Wisconsin Water Action Volunteers Program. Volunteer collect 1 ml samples of river water, plate that sample on the 3M "gel" product, and then incubate that sample for 24 hours. Colonies of total coliform and E. coli show up as different colors and can be counted to determine a number of colonies, and this number is multiplied by 100 to come up with a colony number per 100 ml samples. More information on the sampling protocol and methodologies of the program can be found here: https://www.milwaukeeriverkeeper.org/wp-content/uploads/2018/08/BacteriaMonitoring_Manual.pdf

AND

http://cels.uri.edu/docslink/ww/BacteriaWorkshop/EColiManual.pdf

MMSD Bacteria Monitoring:

The Milwaukee Metropolitan Sewerage District (MMSD) conduct monthly baseline monitoring for fecal coliform as part of their monitoring programs. This data is available at their website at: https://www.mmsd.com/what-we-do/water-quality/monitoring-data

MMSD data is also available of the federal cooperative Water Quality Portal: http://www.waterqualitydata.us/portal/

In addition, MMSD also conducts and/or funds select research on bacteria and pathogen loading in the area waterways, and some of these reports can be found here: https://www.mmsd.com/what-we-do/water-quality/pathogens-bacteria-reports

Stormwater Sampling:

Historically, MMSD, Milwaukee Riverkeeper, and Sandra McLellan's Lab at the University of Wisconsin-School of Freshwater Sciences (UWM-SFS) have conducted sampling for *E. coli*, fecal coliform, and *Enterococcus* in stormwater outfalls discharging from the Menomonee River. A summary of this sampling is included in this Plan. When water samples exceeded 1,000 colony

forming units per 100 ml, addition monitoring for human specific strains of Bacteroides and Lachnospiraceae were conducted using polymerase chain reaction (PCR) and a quantitative PCR (qPCR). Well over 60% of stormwater outfalls in the lower Menomonee were found to be positive for human bacteria, which indicates sewage pollution is getting into the stormwater system and eventually into the river. Historically, MMSD conducted additional sampling efforts in the storm sewer system to identify sources of contamination. In addition, Milwaukee Riverkeeper contracted with Environmental Canine Services to conduct sampling within the drainage areas of stormwater outfalls found to be positive for human sewage.

As part of implementation of the Bacteria TMDL, municipalities in the Menomonee River Watershed, and entire Milwaukee River Basin, will have to develop methodologies to monitor bacteria from their stormwater systems and begin to conduct this monitoring in their new permits. As of 2021, several Menomonee River municipalities have begun to conduct bacteria monitoring at a subset of their outfalls using a similar protocol to the Milwaukee Riverkeeper and Water Action Volunteer protocol for community volunteers. This monitoring will help them develop a better idea of thresholds, which would trigger more find and fix efforts as part of illicit discharge detection and elimination requirements. More information on these requirements can be found in the Group Permit for the Menomonee River municipalities (Appendix F). The Group Permit has an Appendix (B) that details these bacteria monitoring requirements.

Monitoring for Bacteria Communities Using Genetic Sequencing:

UWM-SFS has access now to an Ilumina MySeq genetic sequencing technology can be used to assess bacteria presence/absence and levels, as well as identify the types of bacteria as part of bacteria source analysis work. In Appendix J, there is a summary of analysis of bacteria microbial communities conducted by Ryan Newton at UWM-SFS as part of a grant obtained by Milwaukee Riverkeeper from Fund for Lake Michigan. Milwaukee Riverkeeper collected a variety of water samples from streams with good and bad water quality, and the Newton lab analyzed those samples for different bacteria communities by analyzing the genetic sequences with Ilumina MySeq. This study was set up to determine whether bacteria community diversity differed in streams based on water quality, whether microbial diversity could be correlated with other water quality parameters, and to better understand bacteria communities in the Milwaukee River Basin. Several sites in the Menomonee River were included as part of this study. Research found that bacteria differed in good and poor water quality, and were quite different based on land use, and for streams found in urban and rural communities. Microbial diversity did correlate with dissolved oxygen, temperature, and pH. The sites were also graded for sewage contamination, as the presence of certain bacteria communities indicated the presence of sewage to greater and lesser extents. This tool could be used in the future to better understand sources of bacterial contamination, which could help identify solutions to reducing bacteria loading to rivers. It can also identify bacteria that are endemic to freshwater systems. This work has now been published (2021) and can be found here:
https://www.academia.edu/53787158/Human_Fecal_Contamination_Corresponds_to_Changes_i

n the Freshwater Bacterial Communities of a Large River Basin?email_work_card=interaction-paper

PROPOSED PROTOCOL FOR BACTERIA SAMPLING

Funding currently doesn't exist to establish any new bacteria monitoring in the Menomonee River Watershed or Milwaukee River Basin. Below is a proposed protocol that could be implemented in the future if funding is found to better understand baseline bacteria loading, how it changes seasonally, and to assess whether bacteria levels are changing as part of TMDL implementation efforts and other regulatory requirements.

Surface water and stormwater outfall grab samples will be collected from the Menomonee River (N:5), Kinnickinnic (KK) River (N:4) and Milwaukee River (N:1). A total of 10 samples will be collected during dry weather and wet weather conditions (weather permitting). Sampling may also occur, if funding allows, at additional locations selected based on previous work conducted by Milwaukee Riverkeeper (MRK), Milwaukee Metropolitan Sewerage District (MMSD), and the McLellan Lab at the University of Wisconsin-Milwaukee School of Freshwater Sciences (UWM-SFS).

Samples will be collected five (5) times each month over the period of three (3) select months (April, July, October) to monitor seasonal fluctuations of bacteria. Select samples will be collected from up-gradient surface water samples, near source area "hot-spot" areas near select outfalls, and down-gradient samples at the confluence of the Menomonee and KK River with the Milwaukee.

Sample Collection

Samples will be collected using a surface water sample collection chamber, a 20-foot metal pole with an adjustable arm and a 500mL Nalgene sample bottle attached to the end, and transported in a clean 1L Nalgene bottle. Bottle will be rinsed 2-3 times at each station prior to final sample collection. Sample collection chamber will be rinsed between each sample collection with DI/MQ water. Free flowing surface water samples will be collected from the area adjacent to the suspected source area (i.e., stormwater outfall, point-source discharge location). Samples will be place in a cooler on ice or held at 4º C until laboratory analysis is performed. Samples will be labeled with sample location (i.e. watershed denomination Menomonee (MN-), Kinnickinnic (KK-), Milwaukee (MKE-)), location number, flow condition (i.e. wet weather (W), dry weather (D)), and sample collection date. For example: MN1-W 04-10-14.

Methodology

All water samples will be analyzed within 12 hours using the USEPA 9222.b membrane filter method for Fecal Coliform enumeration (USEPA 2008). Due to the unknown concentration of fecal coliforms, *E. coli*, and Enterococci contamination present in the samples, graduated volume(s) of sample to be filtered will vary from 100ml, 10ml and 1ml. If contaminant

concentrations appear to be high, filtration volumes may be adjusted. Following filtration procedures, plates will be incubated for 18+ hours at 44.5°C and colony forming units (CFUs) will be counted and recorded. Plate counts exceeding 200 CFUs/100 ml sample will be documented as positive results.

Results will be characterized according to the water quality criteria for fecal coliforms identified in s. NR 102.04(5), Wis. Adm. Code: (a) Bacteriological guidelines: the membrane filter fecal coliform count may not exceed 200 CFUs/100 ml as a geometric mean based on not less than 5 samples per month, nor exceed 400 CFUs/100 ml in more than 10% of all samples during any month ("Water Quality Standards", 2010).

Results will also be characterized according to the water quality standards for *E. coli* recommended by the EPA and adopted by the WDNR. Levels may not exceed 235 CFU/100mL for a single sample. Also, the membrane filter *E. coli* count may not exceed 126 CFU/100mL for the monthly geometric mean based on not less than 5 samples per month. WDNR recently adopted new recreational use standards for bacteria, but these haven't changed the target organisms or target levels to a great extent.

Quantitative Polymerase Chain Reaction (qPCR)

All water samples will be filtered within 12 hours for DNA extraction. A volume of 200ml of sample would be filtered onto a 0.22 µm pore size, 47 mm nitrocellulose filter and stored at - 80°C. The frozen filters are broken into small fragments using a metal spatula. DNA is extracted using the MPBIO FastDNA® SPIN Kit for Soil (MP Biomedicals, Santa Anna, CA) and DNA eluted using 150 ul of DES.

Quantitative PCR can be carried out using an Applied Biosystems StepOne Plus ™ Real- Time PCR System Thermal Cycling Block (Applied Biosystems; Foster City, CA) with Taqman hydrolysis probe chemistry. UWM-SFS uses previously published primers and probe for human Bacteroides (Kildare et al. 2007) with the exception that the HF183F was used as the forward primer (Bernard and Fields 2000). UWM-SFS also has access now to an Ilumina MySeq genetic sequencing technology that could also be used to assess bacteria presence/absence and levels, as well as identify the types of bacteria as part of bacteria source analysis work.

Data Analysis

Fecal coliforms, *E. coli*, and Enterococci concentrations per 100 ml will be recorded for each sample, along with weather conditions, site location/TMDL reach, and any significant site parameters, such as proximity to a sewer outfall, etc. Data analysis will be completed using Excel or a statistics software package such as Stata or SPSS. The geometric mean will be determined for each 30-day sampling period, and ANOVA will be used to calculate statistically significant variances among sampling sites and conditions, in order to better isolate potential sources of fecal contamination. The WDNR bacteria standard dictates a 95% data confidence level (WDNR, 2015).

Depending on the preliminary results of the analysis, including number of initial samples and standard deviations, further sampling may be needed to ensure at least 95% confidence in the results. Wider variations in fecal coliform readings will necessitate a greater number of samples for analysis, for example. Further sampling and analysis may also be needed for identification of suspected bacterial hot spots, unexpected results, and outliers.

If expanded bacterial monitoring is increased via additional funds within the watershed, such assessments would be completed in consultation with WDNR staff, with sampling methods and protocols be revisited every 3-5 years.

APPENDIX I. SWWT RESPECT OUR WATERS (ROW) HOUSEHOLD SURVEY, PUBLIC POLICY FORUM 2011; UNIVERSITY OF WISCONSIN WHITEWATER'S FISCAL AND ECONOMIC RESEARCH CENTER 2016-17

Public Policy Forum
moving the region forward

Research Brief

VOLUME 99, NUMBER 1 JANUARY 2011

Ambivalent Attitudes Toward Protecting the Region's Waterways

Support for government protections, mixed feelings about individuals' roles

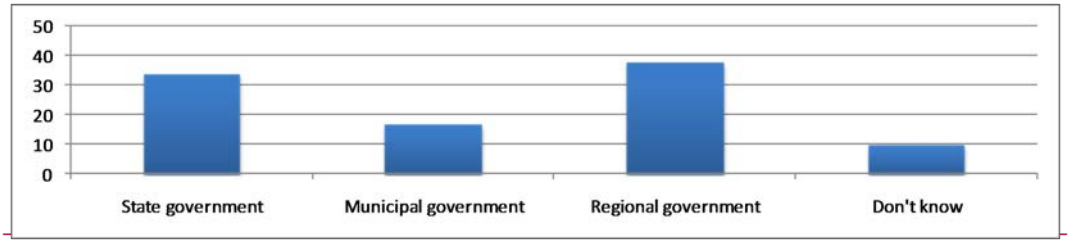
A new survey of nearly 400 residents of the Milwaukee, Kinnickinnic, and Menomonee River watersheds shows general support for government actions to protect water resources, but mixed views on which level of government should be implementing such actions. The survey, designed and analyzed by the Public Policy Forum and commissioned by the Southeast Wisconsin Watersheds Trust, also indicates that local environmental groups may have an important role to play in educating the public about water issues.

Respondents were asked a series of questions designed to elicit their views and understanding of critical water resource issues. The survey shows residents are split on whether water resource management and quality issues should be governed by regional water governance districts or the state. Municipal governments are not favored for the role (**Chart 1**).

When asked about the effectiveness of specific local government actions, most respondents viewed the actions as at least somewhat effective. The role of individuals in protecting local waterways is seen as less important, in that just four percent of respondents agree they "have a responsibility to future generations to protect the region's water resources." Nevertheless, respondents report having taken actions or a willingness to take action to conserve water or protect water quality.

These contradictions in attitudes may reflect the fact that few residents spend time recreating on local rivers or lakes, and that many do not know where stormwater runoff goes after it leaves their neighborhoods. Environmental organizations, which are viewed as the most trustworthy sources of information on water issues, have an opportunity to improve residents' knowledge and understanding of water issues.

Chart 1: Which level of government should be responsible for managing and improving water quality and water use in southeast Wisconsin?



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Research by:
Anneliese Dickman, Research Director
Rob Henken, President

Research funded by:

In partnership with:
Southeast Wisconsin Watersheds Trust

***Research Brief* underwritten by:**
Badger Meter

Data and methodology

The 15-minute telephone survey was conducted by Advantage Research from October 5 -19, 2010. Respondents were selected by random digit dialing of exchanges and cell phone numbers located in 47 zip codes in Milwaukee, Waukesha, Washington, Ozaukee, Sheboygan, and Fond du Lac Counties within the Milwaukee, Kinnickinnic, and Menomonee River watersheds. The survey contained 15 opinion questions plus several questions about the respondent's demographics and characteristics. Only adults over age 18 were surveyed.

The 388 completed surveys are fairly representative of the estimated characteristics of the population within these three watersheds. By our estimates, the survey sample over-represents people over age 60 and under-represents wealthier households (**Table 1**). The survey responses were weighted to better reflect the region on these measures, but the weighting did not significantly change the results. The unweighted responses are presented in this *Research Brief*.

The population within each watershed is as follows: Menomonee River watershed, 336,700; Kinnickinnic River watershed, 145,000; and Milwaukee River watershed, 485,000. Thus, a sample of 388 respondents representing a total population of 966,700 people results in a margin of error of plus or minus 4.97% at a confidence level of 95% – meaning that there is a 95% probability that the survey results are accurate within 4.97% in either direction.

Table 1: Representativeness of the survey sample

Percent of population	Survey Sample	Watershed (estimated)
Milwaukee Co.	71	71
Waukesha Co.	13	13
Washington Co.	8	7
Sheboygan Co.	4	4
Ozaukee Co.	2	2
Fond du Lac	2	2
Spanish speakers	1	8
60 or over	43	16
White	72	72
Female	59	51
Household income $50,000 or greater	32	49

Watershed estimates from 2005-2009 American Communities Survey, U.S. Census Bureau

Knowledge of watershed geography

Survey respondents are fairly knowledgeable about watershed geography, although a significant number of people are uncertain about some aspects.

Most respondents, including most in Milwaukee and Waukesha Counties, report that stormwater runs off their property and into a storm sewer drain in the street after a rain or snow storm. (See **Chart 2**.) About a fifth of all respondents don't know where that stormwater goes once it leaves their neighborhood. (See **Chart 3**.) Going "into a river or lake without being treated" is the most frequent response of residents of all counties except Milwaukee.

When asked what type of waterway is closest to their home, the most frequent response was "Lake Michigan," including 32% of Waukesha County residents. (See **Chart 4**.) In all counties except Milwaukee and Washington, more people answered, "A stream or river" than any other option. In Milwaukee County more people offered, "Lake Michigan," while in Washington County more report living closest to an inland lake.

Interestingly, despite the large portion of respondents who report living closest to a river or stream, the portion of people who have been out on the water in the past year was relatively low, as discussed on the following page.

Chart 2: ***After it rains or the snow melts, where does the runoff go after it leaves your property?***

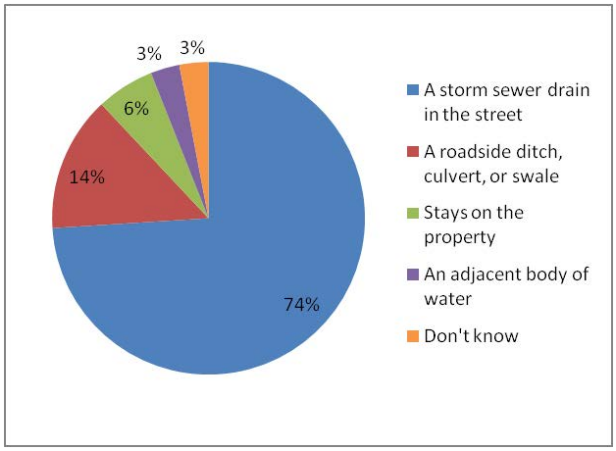


Chart 3: ***Where does this runoff go after it leaves your neighborhood?***

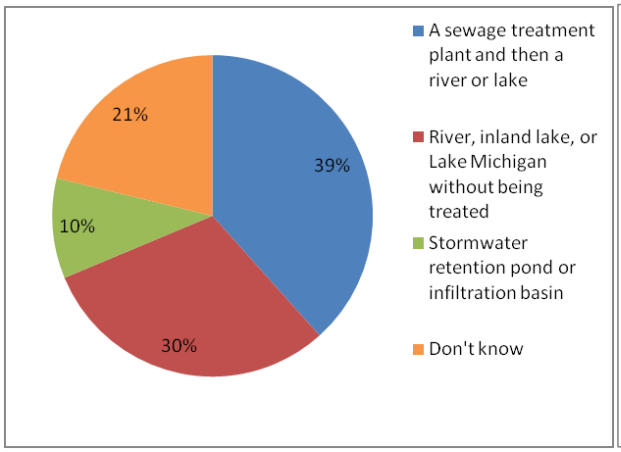
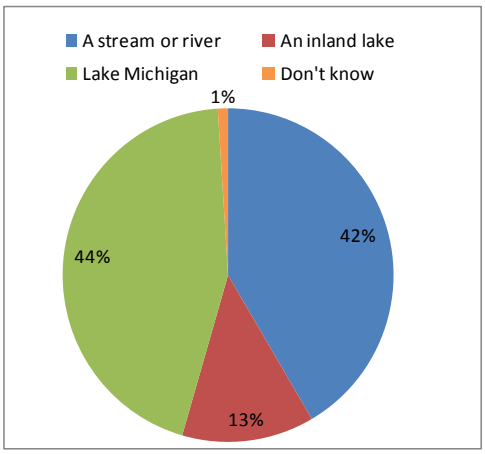


Chart 4: ***What is the closest body of water to your home?***



Water-based recreation

Chart 5 shows the percentage of survey participants that have participated in several water-based recreational activities over the past year. The only activity in which more than half of respondents have participated is walking, bird-watching or appreciating nature near a river, lake or stream.

This was the only survey question in which age is a significant explanatory variable. Those over age 60 are less likely to have participated in any of these activities. Even among the younger age groups, however, with the exception of beach-going among 65% of 18-39 year olds, none of the activities have been conducted by a majority of people over the past year.

In addition, less than a fourth of respondents (23%) agree that "rivers and lakes are an important part of my family's recreational activities."

Opinions on the other questions in the survey do not vary significantly according to participation in water-based recreational activities, indicating that participation in these activities is not related to opinions or perceptions of water issues.

Water quality perceptions and concerns

When asked to judge water quality on a five-point scale, with 5 representing "excellent" and 1 representing "extremely poor," respondents judge the region's water quality to be slightly above average.

Specifically, "the quality of water in the inland lakes, rivers, and streams in southeastern Wisconsin," averages 3.3 among respondents, as does "the quality of water in Lake Michigan." Both inland waters and Lake Michigan average highest scores from Ozaukee County residents and lowest scores from Milwaukee County residents. African-American respondents award the lowest scores among all sub-groups of respondents, rating both types of waters slightly below average at 2.95.

Table 2 shows a list of possible future water problems in the region. Sewer overflows, water quality in surface waters, and water quality in ground water rank first, third, and fourth most concerning. Thus, despite feeling the current water quality in the region is slightly above average, most respondents are concerned water quality will be a problem in the future. Flooding also ranks high in the list of possible problems.

Chart 5: ***Over the past year, have you gone...***

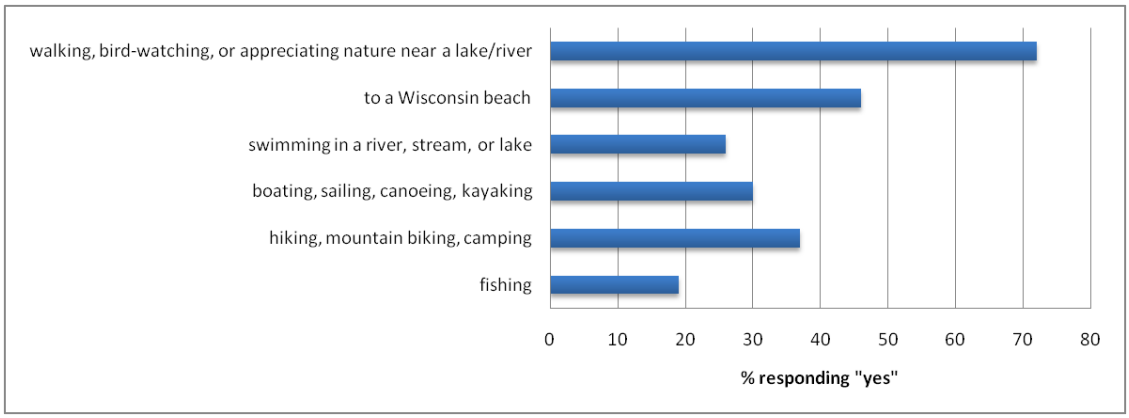


Table 2: ***Which of the following will be a water problem for southeast Wisconsin during the next decade? Will … be a problem?***

% responding "yes"	
Sewer overflows into Lake Michigan	80
Flooding	71
Water quality in lakes and rivers	66
Water quality in underground water sources	57
Climate change	46
Water shortages or low water levels	45
Water availability for new commercial or housing developments	45

Interestingly, the concern about water quality is not reflected in respondents' opinions about the value of clean water to the region. Just 14% of respondents agree that "the quality of water affects property values in my community" and just 4% agree that "water is a key part of the region's economic vitality."

Water pollution sources

Concern about sewer overflows remained high when respondents were asked about various contributors to water quality problems. A large majority of respondents feel sewer overflows are a major problem. (See **Table 3**.) Also ranking high among the list of problems is "industrial waste discharged into waterways." These two contributors are forms of *point source* pollution, as they cause pollution to enter waterways at a specific point and come from a specific source.

Non-point source pollution in the form of "runoff after rain or snow" is seen as less of a problem. Soil erosion also is considered a minor problem, as is waste from pets and geese.

None of the factors probed in the survey are viewed as not contributing to water quality problems by a majority of respondents.

Table 3: ***To what extent do the following contribute to water quality problems in rivers, streams, and lakes in your community?***

% responding…	major contributor	minor contributor
Discharge or overflow from sewage treatment plants or deep tunnels	71	21
Improper disposal of used motor oil, antifreeze, or other hazardous household wastes	53	35
Fertilizers and pesticides from lawns	49	39
Industrial waste discharged into waterways	64	23
Runoff after rain or snow melt from streets, rooftops, driveways, and parking lots	39	48
Flushing unwanted or expired prescription drugs down the toilet or drain	49	37
Fertilizers, such as manure, and pesticides from farms	53	32
Pet waste, geese droppings, or other animal waste	29	55
Air pollution from industries and power plants	42	41
Soil erosion from construction sites	31	49
Soil erosion from farmland	28	52

As a follow-up to this question, perceptions of non-point source pollution were tested by asking the extent to which stormwater runoff contributes to water quality problems in the region. (See **Table 4**, next page.)

The problem for which the most respondents view stormwater as a *major* contributor is not a water quality problem, but flooding. About half of respondents, however, also see stormwater runoff as a major contributor to several water quality problems: weed and algae growth in waterways, bacteria and viruses in waterways, making local fish less safe to eat, beach closings, and negative impacts on fish habitats. Of all the problems probed, only the question of increased temperatures in lakes and streams resulted in a significant (12%) portion of respondents answering "don't know."

Concerns about flooding echo throughout the survey responses and may be related to the fact that roughly half of all respondents agree with the statement, "Basements in my neighborhood are likely to flood during a major storm." When the opinions of flood-prone respondents are compared to those who do not agree that their neighborhood is likely to flood, however, there is not a statistically significant difference in opinion.

Table 4: ***To what extent does stormwater runoff from populated land contribute to each of the following problems?***

% responding…	runoff is major contributor	runoff is minor contributor
Flooding	63	26
Weed and algae growth in rivers and lakes	52	34
Making local fish less safe to eat	53	31
Delivery of bacteria and viruses into rivers and streams	53	30
Negative impacts on habitat for other wildlife	42	39
Beach closings and swimming advisories	50	31
Negative impacts on fish habitats	47	33
Poor quality drinking water	41	37
Increased temperatures in lakes and streams	26	44

Effectiveness of government action

While the majority of respondents do not see government actions to protect the region's water sources as being "very effective," most do believe these actions are at least "somewhat effective."

In contrast to respondents' relatively minor concern about soil erosion (**Table 3**), government efforts to combat erosion by regulating construction and vegetation along stream banks and lake shores are seen as quite effective (**Table 5**).

Regulations to protect and restore wetlands also are seen as highly effective by about half of respondents, as are efforts to prevent or remove invasive aquatic species.

Efforts to combat non-point source pollution from salt– and pesticide-laden stormwater runoff are viewed as effective, but not necessarily "very effective." Requiring developers to reduce the amount of hard pavements in their projects is deemed effective by just over half of respondents. Finally, about half of respondents see using increased water fees as an effective way to fund water quality improvements.

When asked whether they agree that "Southeast Wisconsin is a leader in water resource protection," more than a fourth of respondents say they do not know. Half of respondents feel the region is not a leader in this area (**Chart 6**).

Table 5: ***How effective are the following types of policies or actions by local governments in helping protect your community's lakes, rivers, and streams?***

% responding...	very effective	somewhat effective
Requiring building crews to prevent soil erosion during construction	45	39
Requiring natural vegetation along river and stream banks	47	36
Reducing use of salt on roads and highways	40	41
Frequent street sweeping and leaf and yard waste collection	38	42
Restricting new construction on wetlands or open spaces	47	32
Restoring damaged wetlands	47	32
Preventing or removing invasive aquatic species in rivers and lakes	45	30
Offering tax incentives to encourage homeowners to use less water	31	36
Requiring developers to reduce hard surfaces, by using narrower streets, porous pavement, or green roofs	28	39
Increasing homeowners' water fees to fund water quality improvements	16	39

Effectiveness of individual actions

The survey also asked a series of questions to gauge respondents' views on the effectiveness of individual actions to address water quality and water resource issues, as well as their participation or willingness to participate in such actions.

Tables 6-8 on the following pages highlight respondents' views.

Chart 6: ***"Southeast Wisconsin is a leader in water resource protection"***

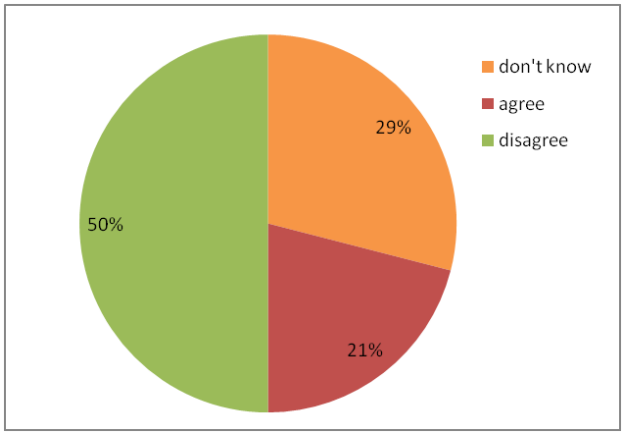


Table 6: ***How effective are the following types of actions by citizens like yourself in helping protect your community's lakes, rivers, and streams?***

% responding…	very effective	somewhat effective
Participating in river or beach clean-up days	54	37
Reducing the amount of pesticides, fertilizer and weed killer used on the garden or lawn	54	36
Conserving water at home by using efficient appliances and fixtures	55	33
Cleaning up pet waste	51	34
Reducing the amount of salt used in the winter	43	41
Participating in river and wetland restoration projects	47	37
Conserving water at home by using less for household tasks	43	39
Composting leaves and yard waste and leaving grass clippings on the lawn	42	40
Installing a rain barrel or rain garden to collect rain from the downspout	39	37
Repairing or replacing privately-owned lateral lines running from the house to the street sewer	44	32
Using less water at home during major storms	35	36

Table 7: ***Which of these actions do you do, or are you willing to do?***

% responding…	already do it	willing to do it	need more info	not willing to do it
Participating in river or beach clean-up days	10	37	16	30
Reducing the amount of pesticides, fertilizer and weed killer used on the garden or lawn	58	16	4	4
Conserving water at home by using efficient appliances and fixtures	69	20	3	5
Cleaning up pet waste	45	6	1	3
Reducing the amount of salt used in the winter	53	18	4	10
Participating in river and wetland restoration projects	9	35	20	29
Conserving water at home by using less for household tasks	71	17	4	7
Composting leaves and yard waste and leaving grass clippings on the lawn	60	12	4	7
Installing a rain barrel or rain garden to collect rain from the downspout	16	31	15	23
Repairing or replacing privately-owned lateral lines running from the house to the street sewer	9	15	25	17
Using less water at home during major storms	52	26	9	8

Table 8: Respondents' actions versus respondents' feelings on effectiveness

	% responding...		Ranked by...	
	effective	already do/ willing to do	effectiveness	action
Participating in river or beach clean-up days	91	47	1	8
Reducing the amount of pesticides, fertilizer and weed killer used on the garden or lawn	90	74	**2**	**4**
Conserving water at home by using efficient appliances and fixtures	88	89	**3**	**1**
Cleaning up pet waste	85	51	4	7
Reducing the amount of salt used in the winter	84	71	**5**	**6**
Participating in river and wetland restoration projects	84	44	5	10
Conserving water at home by using less for household tasks	82	88	7	2
Composting leaves and yard waste and leaving grass clippings on the lawn	82	72	**7**	**5**
Installing a rain barrel or rain garden to collect rain from the downspout	76	47	**9**	**8**
Repairing or replacing privately-owned lateral lines running from the house to the street sewer	76	24	**9**	**11**
Using less water at home during major storms	71	78	10	3

On the whole, most survey respondents feel specific actions taken by individuals are at least somewhat effective in protecting local waterways. Meanwhile, roughly half of respondents feel actions such as river/beach clean-up days, reducing pesticide use, using water-efficient household appliances, cleaning up pet waste, and river/ wetland restoration projects are very effective ways to protect local water resources. (See **Table 6**.)

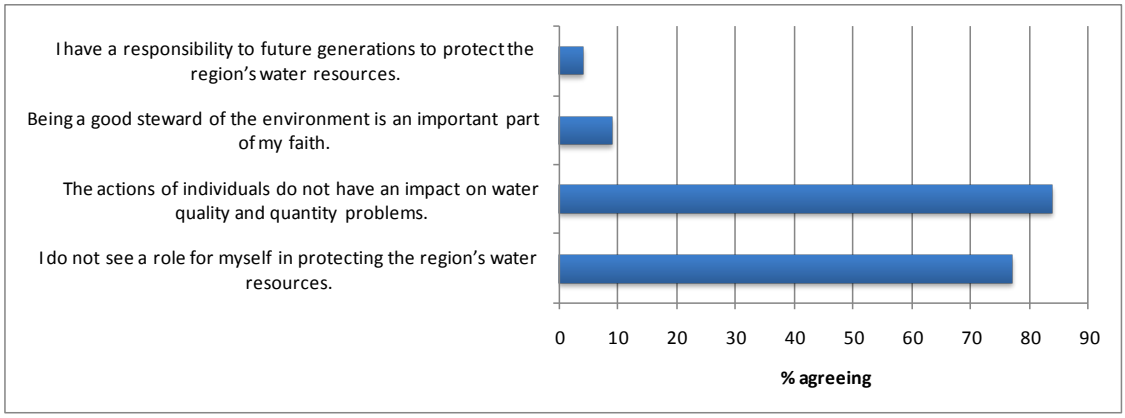
Actions seen as less effective include use of rain barrels and using less water at home during major storms.

Respondents also were asked whether they currently perform any of these actions and, if not, whether they might be willing to do so. In general, most respondents are willing take action to protect local waterways (**Table 7**). The actions they are willing to take are not necessarily those they deem most effective, as shown in **Table 8**. For example, despite seeing participation in river and beach clean-up days as a very effective action, less than half of respondents say they do so, or are willing to do so.

Actions that do align with perceptions of effectiveness include two aimed at reducing non-point pollution: reducing use of pesticides/ fertilizer and reducing use of salt. In addition, using water-efficient appliances at home is seen as both effective and doable.

Actions seen as both less effective and less doable include two that would combat non-point source pollution in stormwater runoff (reducing yard waste and using rain barrels) and one that would combat sewer overflows (repairing sewer lateral lines).

Chart 7: Opinions about individual responsibility



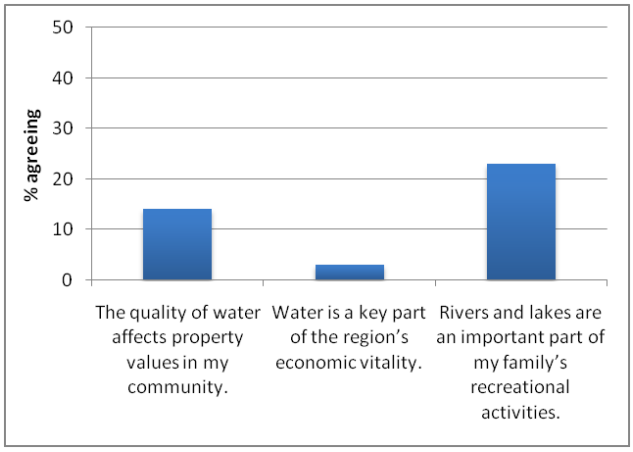
Values

The general mismatch between effectiveness and actionability may not be surprising given the responses to several questions aimed at measuring respondents' sense of individual responsibility toward water resource protection.

Chart 7 shows most respondents do not feel a responsibility to future generations to protect the region's water resources, and that being a good steward of the environment is not an important part of their faith. In addition, most respondents say the actions of individuals do not have an impact on water problems, and they do not see a role for themselves in protecting the region's water resources.

These responses may be explained by respondents' feelings toward water as a regional amenity. **Chart 8** shows that few respondents see water quality as having an impact on property values or as a key part of the region's economy. More respondents—but still less than a quarter—indicate rivers and lakes are important to their family life.

Chart 8: Opinions about water's value



Sources of information

The low value placed on water resources by survey respondents may present an important opportunity for environmental and conservation groups. Such groups garner substantial trust as a source of information about water issues. State and local officials also are seen as reliable sources of information by roughly a third of respondents (**Chart 9**).

With regard to how respondents seek information on water issues, a majority indicate they are most likely to seek such information on the Internet (**Chart 10**).

Chart 9: ***Of the following, who do most trust for information about water issues and water resources?***

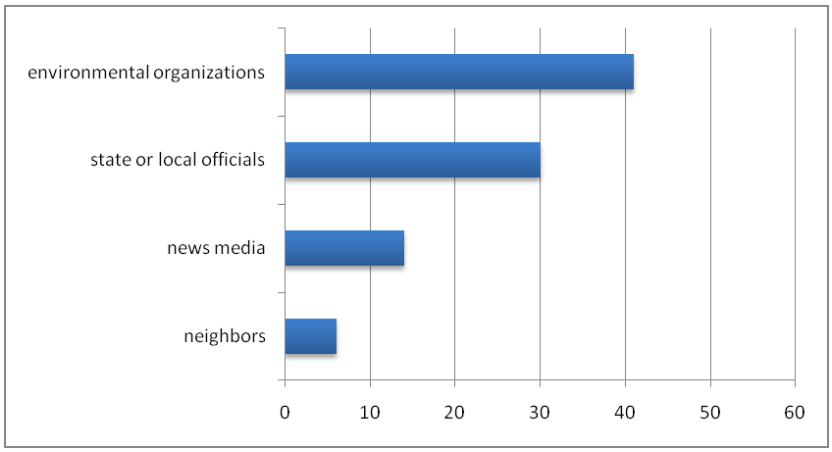
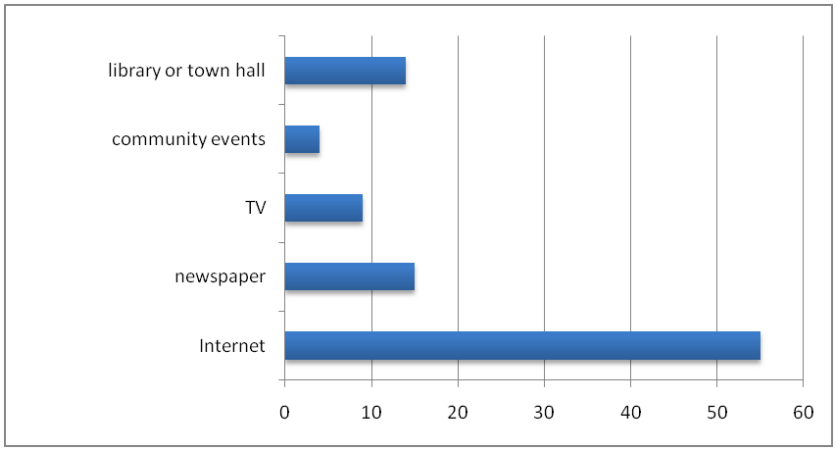


Chart 10: ***Of the following, where would you be most likely to look for information on water and other environmental issues?***



Views on Southeastern Wisconsin Watersheds: Responses from Urban/Suburban Residents

Summary Report

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Executive Summary

This report is intended to summarize new survey data to evaluate water quality outreach and education efforts in the Greater Milwaukee Watersheds. The survey was sent to 3,000 homeowners living in the area.

Survey respondents were more highly educated than the average individuals living in the counties, and may have higher household incomes. It is possible that knowledge regarding water quality issues may be found more often among survey respondents compared to the general population. Indeed, even if there were no education or income differences, respondents to any water quality survey may tend to be those who know and care about the issues, suggesting some bias to the results.

The results of the survey find that 45% of respondents believe the quality of water used for recreational purposes is 'good' or 'excellent', with 78% placing the quality of drinking water at those levels. When asked about specific problems in their area with water for recreational purposes, the issues attracting at least a 'moderate' level of severity included *Algae blooms* (58%); *Polluted/closed beaches and swimming areas* (46%); and *Contaminated fish* (42%).

In terms of the importance of water quality, 81% of respondents 'agree' or 'strongly agree' that it affects *community quality of life* and 75% that it affects *economic stability*. In terms of personal responsibility, only 42% 'agree' or 'strongly agree' that *I would be willing to pay more to improve lakes, rivers, or streams*, but 95% 'agree' or 'strongly agree' that it is their *personal responsibility to help protect water quality*, with 77% agreeing that *I would be willing to change the way I care for my yard to improve water quality*.

When surveyed about the severity of nine specific pollutants, the only item attracting a majority viewing one of these as a 'moderate' or 'severe' problem was 65% for *Nutrients from fertilizers in local streams*. When asked about 15 specific sources for these types of pollutants, the only item attracting a majority agreeing it was a 'moderate' or 'severe' problem was 54% for *Lawn fertilizers and pesticides*.

When asked about nine water quality improvement practices around the home, at least half of respondents reported engaging in *Proper disposal of yard debris* (78%), *Recycling motor oil* (75%), *Directing downspouts away from paved surfaces* (66%), *Properly disposing of pet waste* (54%), and *Applying pesticides and herbicides at manufacturer's guidelines for your lawn* (48%). Still, the most common response regarding three practices was that they were aware of but not using *rain barrels* (63%), *Soil testing* (54%), or a *rain garden* (51%). Out of a list of seven possible reasons why the respondents could not further improve water quality practices around the home, only *Cost* (58%) attracted a majority, with at least 'some' or 'a lot' responses. The survey results find that only 9% had ever used a *Rain garden*, but 77% reported 'maybe' or 'would' consider using; 81% reported currently managing *Yard waste*, with an overlapping 36% willing to improve their use of fertilizer; 18% had ever used a *Rain barrel*, with 65% 'maybe' or 'would' consider using; 63% of dog owners currently clean up *Pet waste* immediately,

with 65% of the remainder at least 'maybe' willing to consider doing so; and 80% of respondents had their automobile or truck inspected regularly for leaks, with 85% fixing any leaks found immediately.

The final section of the survey asked which public service announcement efforts had 'definitely' reached them, and the main provider of this information. The most common responses included *stories addressing stormwater runoff* (40%), *water pollution caused by stormwater runoff* (36%), *ways homeowners potentially contributed to water pollution* (35%), and *ways homeowners can help improve water quality* (34%). Main providers of information included the Wisconsin Department of Natural Resources (40%), and their local city government (31%).

One interpretation of these results is that most respondents are concerned with water quality, and are willing to undertake some actions to improve water quality, so long as these are not financially costly. Not surprisingly, respondents seem most aware of issues that are both visible and close to home, including disposal of yard waste, recycling of motor oil, downspout positioning, fertilizer use, and pet waste. Perhaps the lowest cost initiative which would be utilized by many respondents involves reducing the incidence of over-fertilized gardens and lawns, since over-fertilization involves an unnecessary cost. Rain barrel utilization is currently low, but interest in this water quality improvement device is reasonably high, suggesting a small public subsidy to homeowners installing rain barrels may generate an increase in their utilization.

Introduction

This report presents results of a survey of urban and suburban residents in the Greater Milwaukee Watershed area. The study was conducted by the University of Wisconsin Whitewater's (UWW) Fiscal and Economic Research Center (FERC). The information is intended to help focus water quality outreach and education efforts and provide a baseline for future research. 3,000 surveys were mailed to homeowners, with the mailing list provided by Mailers Haven. 202 households responded.

Results

The survey included eleven sections, measuring demographics, yard and household practices as well as knowledge, attitudes and beliefs regarding water resource issues for the Root Pike watershed.

1. Rating Water Quality

This section asked respondents to rate local water quality for two separate purposes, the quality of local waters in rivers, streams, and lakes for the purposes of swimming, fishing, and other recreational activities (kayaking, etc.) and the quality of drinking water. Respondents generally perceived the water quality in their local rivers, streams, and lakes to be 'okay' to 'good.' The vast majority of respondents believed their quality of drinking water was 'good' or 'excellent.'

1. Overall, how would you rate the quality of the water in your area?

	Poor (0)	Okay (1)	Good (2)	Excellent (3)	Don't Know (4)	No Opinion (5)
Overall, how would you rate the quality of the water in your local rivers, streams, and lakes for purposes of swimming, fishing, and other recreational activities (kayaking, etc.)?	13%	37%	41%	4%	6%	>1%
Overall, how would you rate the quality of your drinking water?	4%	16%	45%	35%	1%	0%

2. Your Water use

Of these activities, which is the most important to you?

Canoeing / kayaking / other boating: 16%
Picnicking / family activities near water: 18%
Eating fish caught locally: 16%
Swimming: 15%
Fish habitat / fishing: 20%
Scenic beauty / enjoyment: 31%

Do you know where the rain water goes when it runs off your property?

Yes: 86%
No: 14%

Where does the rain water go when it runs off of your property?

Gutter: 12%
Ditch: 16%
Wastewater Treatment Plant: 10%
Local Rivers: 19%
Lake Michigan: 18%
Storm Sewers: 25%

This section asked about awareness of water run off for individual properties and water use activities. The vast majority of respondents indicated that they were aware where rain water runs off their properties with 25% indicating rain water ran off their property into storm sewers. Scenic beauty / enjoyment was indicated to be the most important activity by respondents with 31% and the rest fairly equally distributed from 15% to 20%.

3. Consequences of Poor Water quality

Respondents were asked to rate the severity of the consequences of poor water quality in their area. Available choices ranged from 'not a problem' to 'severe problem,' with 'don't know' and 'no opinion' as additional options for each.

Several of the consequences listed in the survey were perceived as a 'moderate' to 'severe' problems by respondents. These were: *Algae blooms* (58%); *Polluted/closed beaches and swimming areas* (46%);

and *Contaminated fish* (42%). The three sources with the highest percentage in the 'not a problem' and 'slight problem' categories were: *Odor* (54%); *Reduced beauty of rivers and streams* (51%); *Reduced opportunities for water activities such as boating, canoeing, and fishing* (51%).

3. Poor water quality can lead to a variety of consequences for communities.
In your opinion, how much of a problem are the following issues in your area?

	Not a Problem (0)	Slight Problem (1)	Moderate Problem (2)	Severe Problem (3)	Don't Know (4)	No Opinion (5)
Contaminated drinking water	50%	22%	12%	5%	11%	>1%
Polluted / closed beaches & swimming areas	18%	31%	37%	9%	4%	2%
Contaminated fish	16%	22%	31%	11%	18%	2%
Increase in water / sewage bill	26%	17%	30%	10%	8%	10%
Loss of desirable fish and wildlife species	13%	21%	26%	19%	18%	3%
Reduced beauty of rivers and streams	18%	33%	30%	11%	6%	2%
Reduced opportunities for water activities such as boating, canoeing, and fishing	23%	28%	29%	8%	10%	3%
Algae blooms	8%	19%	34%	24%	15%	>1%
Odor	24%	30%	25%	8%	12%	2%
Lower property values	32%	21%	13%	6%	21%	7%

4. General Water Quality Attitudes

Section three of the questionnaire measured respondents' agreement with a battery of statements regarding water quality and local and personal actions. In general, respondents expressed strongly positive attitudes toward water resource protection. Several highlights are:

- Most respondents 'agree' or 'strongly agree' that *community quality of life* (81%) and *economic stability* (75%) depend on good water quality. When personalized to *I would be willing to pay more to improve lakes, rivers, or streams*, the percent of 'agree' and 'strongly agree' drops significantly (42%).
- A strong majority 'agree' to 'strongly agree' that it is their *personal responsibility to help protect water quality* (95%).

While there is a significant majority in agreement that they have a role in maintaining water quality, a smaller number would be willing to pay to improve water quality. This does not necessarily call into question commitment, as many respondents feel that there are yard care actions they can implement that do not cost anything. This is supported by a large percentage of respondents (77%) stating they 'agree' or 'strongly agree' that they *would be willing to change the way I care for my yard to improve water quality*.

4. What is your level of agreement with the following statements?

	Strongly Disagree (0)	Disagree (1)	Neither Agree or Disagree (2)	Agree (3)	Strongly Agree (4)	No Opinion (5)
The economic stability of my community depends upon clean lakes, rivers, and streams	3%	7%	14%	44%	31%	3%
The way that I care for my yard can influence water quality in lakes, rivers and streams	>1%	1%	6%	51%	39%	1%
It is my personal responsibility to help protect water quality	1%	>1%	2%	57%	38%	1%
What I do on my property doesn't have much impact on overall water quality	31%	42%	11%	11%	4%	>1%
Yard-care practices (on individual lots) do not have an impact on local water quality	36%	50%	6%	6%	1%	1%
My actions can have an impact on lakes, rivers, and streams	1%	2%	4%	60%	29%	1%
I would be willing to pay more to improve lakes, rivers, and streams	4%	16%	33%	33%	9%	4%
I would be willing to change the way I care for my yard to improve water quality	>1%	5%	17%	61%	16%	2%
The quality of life in my community depends on good water quality in local streams, rivers and lakes	1%	6%	10%	47%	34%	3%

5. Types of Water pollutants

Respondents were asked to identify which pollutants were problematic in their area. Available choices on the questionnaire for each ranged from 'not a problem' to 'severe problem,' and 'don't know' and 'no opinion' as additional options for each. Respondents showed a high degree of uncertainty regarding problems in their area, with nearly half of the types of water pollutants having *don't know* as their most common response. Over thirty percent of respondents indicated that they did not know how much of a problem salt, bacteria and viruses, and phosphorus were in their area. This was the highest percentage of response for all of these categories. For those respondents that did not answer 'don't know,' the following pollutants were most frequently identified as a 'severe problem': *Invasive aquatic plants and animals, nutrients, trash and debris, and phosphorus*. Of least concern was *organic matter* and *dirt and soil* in local streams.

5. Below is a list of water pollutants that are generally present in water bodies to some extent. In your opinion, how much of a problem are the following pollutants in your area?

	Not a Problem (0)	Slight Problem (1)	Moderate Problem (2)	Severe Problem (3)	Don't Know (4)	No Opinion (5)
Dirt and Soil in local streams	15%	25%	30%	12%	18%	1%
Nutrients from fertilizers in local streams	4%	19%	35%	30%	14%	0%
Phosphorus in local streams	5%	17%	25%	22%	30%	1%
Bacteria and viruses in local streams (such as E. coli)	9%	15%	25%	19%	32%	1%
Salt in local streams	14%	16%	17%	11%	41%	2%
Invasive aquatic plants and animals	5%	19%	25%	34%	17%	1%
Oil or antifreeze from cars and trucks	14%	22%	16%	17%	31%	1%
Trash and debris	9%	25%	34%	23%	10%	0%
Organic matter, such as fallen trees, branches, grass clippings, leaves	17%	34%	27%	8%	15%	1%

6. Sources of Water Pollution

This section surveyed the perceived severity of eighteen potential sources of water pollution. Available choices on the questionnaire for each ranged from 'not a problem to 'severe problem' and 'don't know' as an additional option for each. For each of the following categories, respondents most commonly indicated that they 'don't know' how much of a problem it is for their area: *Discharges from industry* (22%); *Improper disposal of household Construction sites* (20%); *waste* (20%); *Soil erosion from farm fields* (19%) and *Manure from farm animals* (18%).

Only two pollutants, *Discharge from sewage treatment plants* (25%); and *Agricultural fertilizers and pesticides* (25%), were most commonly identified as 'severe problem'. Respondents most commonly identified the following six sources as a 'moderate problem': *Street salts* (36%); *Stormwater runoff from streets, highways, and/or parking lots* (36%); *Lawn fertilizers and pesticides* (34%); *Droppings from geese, ducks, and other waterfowl* (32%); *Discharges from storm sewers* (27%); and *Discharges from industry into streams and lakes* (25%).

Combining 'moderate problem' and 'severe problems' categories, the following were rated highest by respondents: *Lawn fertilizers and pesticides* (54%); *Stormwater runoff from streets, highways, and/ or parking lots* (52%); *Street salt and sand* (52%); *Discharges from sewage treatment plants* (46%). The three sources with highest percentages in the 'not a problem' and 'slight problem' categories combined were: *Pet Waste* (57%); *Grass clippings and leaves* (57%); and *Soil erosion from construction sites* (49%).

6. The items listed below are sources of water quality pollution across the country. In your opinion, how much of a problem are the following sources in your area?

	Not a Problem (0)	Slight Problem (1)	Moderate Problem (2)	Severe Problem (3)	Don't Know (4)	No Opinion (5)
Discharges from industry into streams and lakes	13%	20%	25%	19%	22%	1%
Discharges from sewage treatment plants	13%	20%	22%	24%	19%	1%
Soil erosion from construction sites	14%	35%	20%	10%	20%	1%
Soil erosion from stream farm fields	11%	29%	22%	17%	19%	2%
Lawn fertilizers and pesticides	5%	27%	34%	20%	13%	2%
Grass clippings and leaves	21%	36%	18%	4%	18%	3%
Discharges from storm sewers	12%	24%	27%	16%	18%	3%
Improper disposal household waste (batteries, medications, chemicals, etc.)	12%	24%	23%	18%	20%	2%
Improper disposal of used motor oil and antifreeze	13%	26%	20%	15%	24%	2%
Manure from animal farms	13%	25%	23%	19%	18%	2%
Stormwater runoff from streets, highways, and/or parking lots	9%	28%	36%	16%	10%	1%
Street salt and sand	5%	29%	36%	16%	12%	2%
Droppings from geese, ducks, and other waterfowl	11%	31%	32%	10%	13%	2%
Pet waste (such as dogs or cats)	17%	40%	17%	4%	19%	2%
Agricultural fertilizers and pesticides	6%	24%	24%	25%	18%	2%

7. Practices to Improve Water Quality

Section seven asked respondents to provide their level of familiarity with nine practices designed to improve water quality. Choices ranged from 'never heard of it' to 'currently use it.'

Respondents most commonly chose 'currently use it' for the following practices:

- Proper disposal of yard debris (78%)
- Recycling motor oil (75%)
- Directing downspouts away from paved surfaces (66%)
- Properly disposing of pet waste (54%)
- Applying pesticides and herbicides at manufacturer's guidelines for your lawn (48%)

The most common response for the following practices was 'Know how to use; not using it':

- Using rain barrels (63%)
- Soil testing (54%)
- Using a rain garden (51%)

7. Please indicate which statement most accurately describes your level of experience with each practice listed below.

	Never Heard Of It (0)	Somewhat Familiar (1)	Aware How to Use it; Not Using it (2)	Currently Using it (3)
Applying pesticides and herbicides at manufacturer's guidelines for your lawn	4%	16%	31%	48%
Using phosphate free fertilizer	18%	23%	36%	22%
Properly disposing of pet waste	9%	13%	23%	54%
Using rain barrels	4%	15%	63%	19%
Recycling motor oil	4%	9%	11%	75%
Directing downspouts away from paved surfaces	6%	10%	16%	66%
Using a rain garden	24%	15%	51%	9%
Proper disposal of yard debris	4%	8%	9%	78%
Soil testing	16%	23%	54%	6%

8. Making Management Decisions

In general, how much does each issue limit your ability to change your household & lawn care practices (such as those in Question 6)?

	Not at All (0)	A Little (1)	Some (2)	A lot (3)	Don't Know (4)	No Opinion (5)
Cost	17%	20%	39%	19%	3%	3%
My own physical abilities	42%	17%	27%	12%	2%	2%
The need to learn new skills or techniques	31%	23%	31%	7%	7%	3%
Legal restriction on my property	47%	6%	16%	6%	22%	4%
Not having access to the necessary equipment that I need	38%	13%	27%	6%	12%	4%
Lack of available information about the practice	30%	16%	26%	10%	14%	3%
Concerns about resale value	42%	14%	21%	11%	7%	5%

This section was designed to determine which factors (constraints) most strongly limit respondents' general ability to change runoff management and lawn care practices. Options ranged from 'not at all' to 'a lot', and included a 'don't know' choice.

Grouping the 'some' to 'a lot' responses together, respondents most commonly identified *Cost* (58%). These constraints were the least influential in changing practices (responses of 'not at all' and 'a little'): *My own physical abilities* (59%); *Legal restriction on my property* (53%); *Not having access to the necessary equipment that I need* (51%); and *Lack of available information about the practice* (46%).

9. Constraints for Specific Practices

Rain Garden: A rain garden is a garden that is designed to absorb and filter stormwater. It is usually designed to collect stormwater from a house or structure.

Do you have or have you had a rain garden?

Yes	Currently Use	Do Not Currently Use	No	Never Used
9%	3%	2%	70%	17%

How familiar are you with rain gardens?

Never Heard of It	Somewhat Familiar With it	Know How To Install, Not Doing It	Have Installed A Rain Garden
35%	45%	12%	8%

Are you willing to try utilizing a rain garden?

Yes	Maybe	No	Already Have One
24%	53%	18%	5%

How much do the following factors limit your ability to build a rain garden (or limited, if you already have one)?

	Not at All (0)	A Little (1)	Some (2)	A lot (3)	Don't Know (4)	No Opinion (5)
Lack of information skills	21%	15%	28%	29%	4%	4%
Time required	17%	18%	29%	18%	12%	5%
Cost	18%	13%	28%	21%	16%	4%
The features of my property do not support it	17%	8%	15%	22%	33%	4%
Physical or health limitations	46%	12%	20%	12%	8%	3%

Yard Waste Management: Yard waste management means keeping grass clippings and leaves out of roads, ditches, and gutters.

Do you manage your yard waste by keeping grass clippings out of street, etc.?

Yes	Maybe	Currently Do	No	Never Have	Currently Do It
81%	3%	8%	6%	2%	2%

How familiar are you with yard waste management?

Never Heard Of It	Somewhat Familiar With It	Know How To Manage, Not Doing It	Currently Managing Yard Waste
4%	25%	3%	68%

Are you willing to manage your use of fertilizer?

Yes	Already Managing It	No	Maybe
36%	51%	4%	7%

Downspouts and rain barrels: Downspouts should be aimed at pervious areas like gardens, lawns, and pervious paved areas and not down driveways or onto sidewalks. A rain barrel installed on a downspout can hold back stormwater.

How familiar are you with rain barrels?

Never Heard Of Them	Somewhat Familiar With Them	Know How To Install, Not Doing It	Have Installed A Rain Barrel
6%	49%	28%	18%

Are you willing to try utilizing a rain barrel?

Yes	Maybe	No	Already Have One
25%	40%	22%	13%

Pet Waste: Dog poop is a major pollutant in runoff. When it reaches our rivers and lakes, poop uses oxygen as it decays and sometimes releases ammonia, both of which can kill fish. Pet poop also contains nutrients that encourage weed and algae growth. Most importantly, pet waste carries diseases, which make water unsafe for swimming or drinking.

Do you own a dog?

Yes	No
43%	56%

How often do you clean up your pet's waste?

Always	In Nice Weather	Rarely	Most Of The Time	When People Will Be In My Yard	Never
63%	2%	3%	16%	3%	12%

Are you willing to clean up your pet's waste every time?

Yes	Maybe	No	I Already Do
56%	9%	16%	20%

Auto & Truck Care: How we care for our vehicles has an impact on water quality. Leaking oil and other fluids along with runoff from washing cars in the driveway lead to an increase in pollutant in our waterways.

Do you have your car inspected for leaks regularly?

Yes	Somewhat Regularly	I Don't Own A Car	No	I'm Not Sure
80%	12%	1%	7%	>1%

When a leak is discovered, how long does it usually take you to get it fixed?

I Get It Fixed As Soon As Possible	I Get It Fixed If It Causes Problems With How My Car Runs	I Don't Own A Car	I Get It Fixed When I Can Afford It	I Don't Worry About It Or Get It Fixed
85%	6%	>1%	8%	>1%

The section asked for detailed information regarding awareness, use, and constraints related to five specific practices: rain gardens, yard waste management, downspouts, pet waste and auto and truck care.

Rain Garden: A rain garden was defined as 'a garden that is designed to absorb and filter stormwater.' Most people (87%) responded 'no' or 'never used' when asked if they have or had a rain garden, though only 35% of the respondents have 'never heard of it,' with 45% indicating they were 'somewhat familiar with it.' Over 75% of the respondents indicated 'Maybe' or 'Yes' they were willing to use a rain garden. Roughly one third of respondents answered, they 'Don't know' whether their property could support a rain garden, and one third suggest, that lack of information skills limited their ability to build a rain garden 'A lot.' Physical limitations were the least important constraint, with 46% responding it was 'not at all' a limitation.

Yard Waste: The definition provided for this practice was 'keeping grass clippings and leaves out of the roads, ditches, and gutters.' Although 89% of the respondents state that they are currently managing yard waste, 29% of them are either 'Somewhat familiar with it' or 'Never heard of it'. 43% of the respondents answered, 'Maybe' or 'Yes' they were willing to manage their yard waste.

Downspouts and rain barrels: This practice involved the usage of rain barrels. When asked how familiar they were with rain barrels over 49% of respondents express they were 'somewhat familiar with them'. 6% of respondents claimed they had 'never heard of them,' while 18% claim to 'have installed a rain barrel.' 65% of respondents indicated they would be willing to try utilizing a rain barrel.

Pet Waste: Respondents were asked if they owned a dog, with 43% indicating they did. When asked how often they clean up their pet's waste, 63% claim to 'always' clean up their pet's waste, with 12% indicating they never clean up their pet's waste.

Auto & Truck Care: Survey respondents were asked about aspects of their vehicle care, with 92% of respondents indicating 'yes' or 'somewhat regularly' when asked how often they had their vehicles inspected for leaks. 85% of respondents indicated 'I get it fixed as soon as possible' when asked how long does it usually take to get their vehicle fixed when a leak is found.

10. About You and Your Property

What is your gender?

Male	Female
50%	50%

What year were you born?

> 1930's *Age 77+	1940's *Age 67-76	1950's *Age 57-66	1960's *Age 47-56	1970's *Age 37-46	1980's *Age 36 & Under
7%	19%	34%	24%	12%	4%

* At Time of Survey

What is the highest level of education you have completed?

Less Than High School	High School Diploma Or Equivalent	Some College	2 Year Associate's Degree	4 Year Bachelor's Degree	Graduate Degree
1%	15%	16%	16%	30%	23%

What is your annual household income level?

Less than $24,999	$25,000 to 49,999	$50,000 to 74,999	$75,000 to 99,999	$100,000 or More
5%	18%	24%	18%	34%

A series of questions were asked regarding the respondent and his or her property.
Information about respondents and their property:

- Less than one percent have an education below high school graduate level, with 15% having a HS diploma. Respondents to the survey were well educated, with 30% having a four-year degree and a large number of graduate degrees (23%). Those figures are above U.S. Census estimates of education for Racine County, where 12.1% of adults do not have a HS diploma, and only 23.4% have a Bachelor's degree or above.[1] Similarly, in Kenosha County, 10.3% of adults do not have a HS diploma, and 24.3% hold a Bachelor's degree or above.[2]

1 - Education and household income figures for Racine from U.S. Census: census.gov/quickfacts/table/PST045215/55101 December 4, 2016. Demographic data for Milwaukee area: http://www.choosemilwaukee.com/index.php?submenu=DataStatistics&src=gendocs&ref=DataStatistics&category=Data Maps

2 - Education and household income figures for Kenosha from U.S. Census: census.gov/quickfacts/table/PST045215/55059 December 4, 2016.

- Roughly 34% of respondents have a household income of over $100,000, while 24% have a household income below $49,999. The median category for income was '$55,000 to $74,999, which fits or is higher than U.S. Census figures. Those estimates place median household income in Racine in 2014 of $55,000, with a similar figure of $54,700 for Kenosha.

These differences suggest that respondents tended to be more highly educated than the average adult living in the area, and may have higher incomes.

11. Information Acquisition

11a. Please look at the loose leaf image provided, Sparkles the Water Spaniel, which represents a public awareness campaign that has run over the past four years. Then answer the questions below:

	Definitely Not (0)	Don't Think So (1)	Don't Know (2)	I Think So (3)	Definitely Have (4)
Do you recall seeing or hearing related advertising about water pollutions caused by stormwater runoff (storms that ultimately carry yard or street pollutant into lakes, rivers, & streams)?	16%	25%	5%	18%	36%
Are you aware of any advertising that carries the message, "Respect Our Waters?" (as seen above)	12%	28%	8%	24%	27%
Do you recall watching, reading, or hearing any news stories that address stormwater runoff?	7%	16%	9%	29%	40%
Do you recall seeing, reading or hearing the Respect Our Water message at any community events (fairs, festivals, farmer's markets, etc.)?	18%	37%	14%	16%	14%
Through advertising or news stories, have you learned of ways homeowners potentially contributed to water pollution?	8%	17%	9%	31%	35%
Through advertising or news stories, have you learned of ways homeowners can help improve water quality?	7%	17%	11%	31%	34%

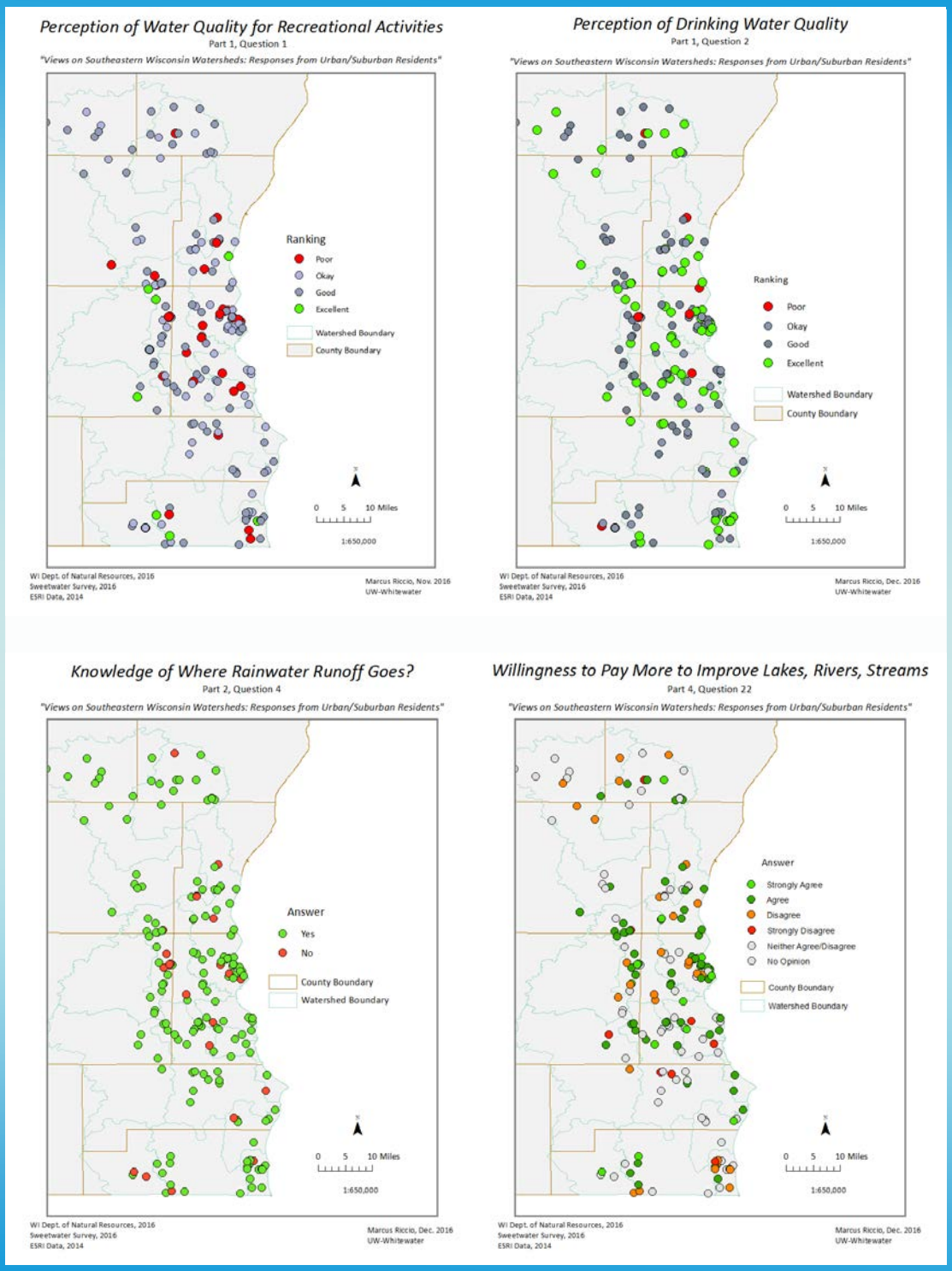
11b. People receive information about water quality though many different sources. From which of these sources have you received information about water quality, and to what extent did the source assist you in education and awareness regarding the issue?

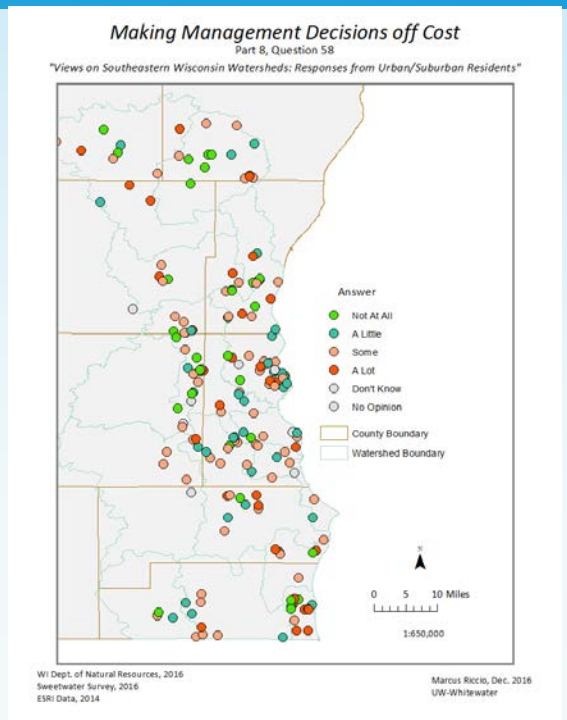
	Not at All (0)	A Little (1)	Some (2)	A lot (3)	Don't Know (4)
Respect Our Waters	46%	16%	19%	8%	11%
Southeast Wisconsin Watersheds Trust Inc. (aka Sweet Water)	68%	8%	5%	1%	19%
Root Pike Watershed Initiative Network	72%	7%	5%	1%	15%
Your Local School or College	63%	10%	11%	4%	12%
Your Local Home & Garden Center	50%	20%	16%	2%	11%
Your Local City Government	37%	22%	26%	5%	10%
Your County Government	48%	16%	20%	3%	13%
UW Extension	50%	18%	17%	3%	12%
Wisconsin Department of Agriculture, Trade and Consumer Protection	53%	17%	11%	2%	18%
Wisconsin Department of Natural Resources	30%	22%	29%	11%	9%
The United States Environmental Protection Agency	48%	15%	19%	3%	16%
Political Organizations, such as League of Conservation Voters	61%	10%	7%	4%	18%

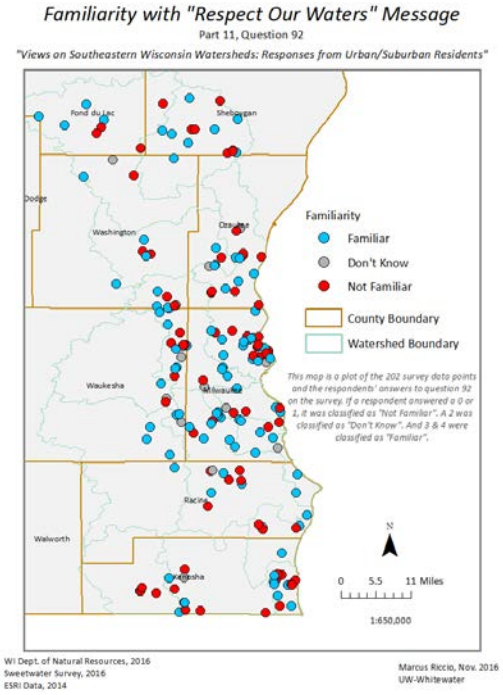
Respondents were asked if they recalled seeing information regarding water quality regarding 6 different areas. Most respondents responded with the majority 'I Think so' or 'Definitely Have' to the following five areas:

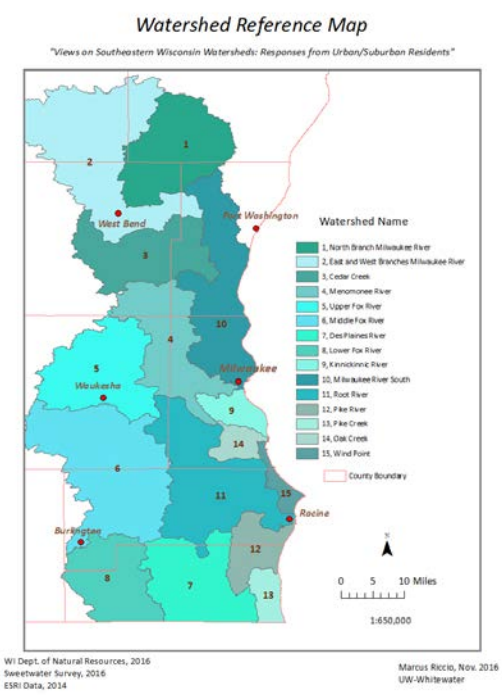
1. *Recall seeing or hearing related advertising about water pollution caused by stormwater runoff (54%)*
2. *Aware of any advertising that carries the message "Respect our Water?" (51%)*
3. *Recall watching, reading, or hearing any news stories that address stormwater runoff (69%)*
4. *Advertising or news stories, have you learned of ways homeowners potentially contributed to water pollution (66%)*
5. *Have you learned of ways homeowners can help improve water quality (65%).*

Respondents were also asked to what extent did the information about water quality come from 22 different sources. Respondents indicated that these sources did not assist in the education and awareness regarding the issue: *Root Pike Watershed Initiative Network* (72%); *your local school or college* (63%); *Political organizations* (61%); *Wisconsin Department of Agriculture, Trade and Consumer Protection* (53%); *UW Extension* (50%; and *your local home and garden center* (50%).


Perception of Water Quality for Recreational Activities
Part 1, Question 1
"Views on Southeastern Wisconsin Watersheds: Responses from Urban/Suburban Residents"
Ranking
Poor
Okay
Good
Excellent
Watershed Boundary
County Boundary
0 5 10 Miles
1:650,000
WI Dept. of Natural Resources, 2016
Sweetwater Survey, 2016
ESRI Data, 2014
Marcus Riccio, Nov. 2016
UW-Whitewater
Perception of Drinking Water Quality
Part 1, Question 2
"Views on Southeastern Wisconsin Watersheds: Responses from Urban/Suburban Residents"
Ranking
Poor
Okay
Good
Excellent
Watershed Boundary
County Boundary
0 5 10 Miles
1:650,000
WI Dept. of Natural Resources, 2016
Sweetwater Survey, 2016
ESRI Data, 2014
Marcus Riccio, Dec. 2016
UW-Whitewater
Knowledge of Where Rainwater Runoff Goes?
Part 2, Question 4
"Views on Southeastern Wisconsin Watersheds: Responses from Urban/Suburban Residents"
Answer
Yes
No
County Boundary
Watershed Boundary
0 5 10 Miles
1:650,000
WI Dept. of Natural Resources, 2016
Sweetwater Survey, 2016
ESRI Data, 2014
Marcus Riccio, Dec. 2016
UW-Whitewater
Willingness to Pay More to Improve Lakes, Rivers, Streams
Part 4, Question 22
"Views on Southeastern Wisconsin Watersheds: Responses from Urban/Suburban Residents"
Answer
Strongly Agree
Agree
Disagree
Strongly Disagree
Neither Agree/Disagree
No Opinion
County Boundary
Watershed Boundary
0 5 10 Miles
1:650,000
WI Dept. of Natural Resources, 2016
Sweetwater Survey, 2016
ESRI Data, 2014
Marcus Riccio, Dec. 2016
UW-Whitewater


Making Management Decisions off Cost
Part 8, Question 58
"Views on Southeastern Wisconsin Watersheds: Responses from Urban/Suburban Residents"
Answer
Not At All
A Little
Some
A Lot
Don't Know
No Opinion
County Boundary
Watershed Boundary
0 5 10 Miles
1:650,000
WI Dept. of Natural Resources, 2016
Sweetwater Survey, 2016
ESRI Data, 2014
Marcus Riccio, Dec. 2016
UW-Whitewater


Familiarity with "Respect Our Waters" Message
Part 11, Question 92
"Views on Southeastern Wisconsin Watersheds: Responses from Urban/Suburban Residents"
Fond du Lac
Sheboygan
Dodge
Washington
Ozaukee
Waukesha
Milwaukee
Racine
Walworth
Kenosha
Familiarity
Familiar
Don't Know
Not Familiar
County Boundary
Watershed Boundary
This map is a plot of the 202 survey data points and the respondents' answers to question 92 on the survey. If a respondent answered a 0 or 1, it was classified as "Not Familiar". A 2 was classified as "Don't Know". And 3 & 4 were classified as "Familiar".
0 5.5 11 Miles
1:650,000
WI Dept. of Natural Resources, 2016
Sweetwater Survey, 2016
ESRI Data, 2014
Marcus Riccio, Nov. 2016
UW-Whitewater


Watershed Reference Map
"Views on Southeastern Wisconsin Watersheds: Responses from Urban/Suburban Residents"
West Bend
New Washington
Milwaukee
Waukesha
Racine
Burlington
Watershed Name
1, North Branch Milwaukee River
2, East and West Branches Milwaukee River
3, Cedar Creek
4, Menomonee River
5, Upper Fox River
6, Middle Fox River
7, Des Plaines River
8, Lower Fox River
9, Kinnickinnic River
10, Milwaukee River South
11, Root River
12, Pike River
13, Pike Creek
14, Oak Creek
15, Wind Point
County Boundary
0 5 10 Miles
1:650,000
WI Dept. of Natural Resources, 2016
Sweetwater Survey, 2016
ESRI Data, 2014
Marcus Riccio, Nov. 2016
UW-Whitewater

Appendix:

It is notable that there is strong consistency between the survey results for the 2010 survey and the 2016-2017 survey. Those means that have changed may be partially due to the larger sample size of the most recent survey. The response mean change that may be of greatest interest is the perceived consequences of poor water quality on lowering property values with the 2010 survey mean (1.0) indicating that it was not viewed as a problem with a 2016-2017 survey mean (1.8) moving strongly towards the belief that poor water quality is a slight problem for property value. Other notable changes from the 2010 to 2016-2017 survey results include changes in views of how much a problem salt in local streams was perceived to be, changing from a mild belief that it is a slight problem (2.4) to a mild belief that it is a moderate problem (2.8). The amount of experience indicated by survey respondents using rain barrels has increased from being somewhat familiar (2.6) in 2010 to knowing how to use a rain barrel but not using it (3.0) in 2016-2017, suggesting that a lack of familiarity with the use of rain barrels is no longer a driving factor in their implementation. The survey results in general suggest very little change in respondent mean beliefs about water quality from 2010 to present.

(Note: Each mean value removes respondents who responded "Don't Know" or "No Opinion")
Comparison of 2010 survey mean results to 2016-2017 survey mean results:

Question	**2016-2017 Mean**	2010 Mean
Your Water Use:	-	-
Do you know where the rain water goes when it runs off your property?	**.86**	.7
Consequences of Poor Water Quality: Poor water quality can lead to a variety of consequences for c ommunities. In your opinion, how much of a problem are the following issues in your area?	-	-
Contaminated drinking water	**1.7**	2.1
Polluted / closed beaches & swimming areas	**2.3**	2.6
Contaminated fish	**2.5**	2.8
Increase in water / sewage bill	**2.3**	2.7
Loss of desirable fish and wildlife species	**2.6**	2.8
Reduced beauty of rivers and streams	**2.4**	2.5
Reduced opportunities for water activities such as boating, -canoeing, and fishing	**2.2**	2.4
Odor	**2.2**	2.5
Lower property values	**1.8**	1.0
General Water Quality Attitudes: What it your level of agreement with the following statements?	-	-
The economic stability of my community depends upon clean lakes, rivers, and streams	**4.1**	3.9
The way that I care for my yard can influence water quality in lakes, rivers and streams	**4.3**	4.1

Appendix Continued...

Question	**2016-2017 Mean**	2010 Mean
It is my personal responsibility to help protect water quality	**4.3**	4.2
What I do on my property doesn't have much impact on overall water quality	**2.1**	2.2
Yard-care practices (on individual lots) do not have an impact on local water quality	**1.9**	2.0
My actions can have an impact on lakes, rivers, and streams	**4.2**	3.9
I would be willing to pay more to improve lakes, rivers, and streams	**3.3**	2.9
I would be willing to change the way I care for my yard to improve water quality	**3.9**	3.8
The quality of life in my community depends on good water quality in local streams, rivers and lakes	**3.7**	3.9
Types of Water Pollutants: Bellow is a list of types of water pollutants that are generally present in water bodies to some extent. In your opinion, how much of a problem are the following pollutants in your area?	-	-
Dirt and Soil in local streams	**2.5**	2.3
Nutrients from fertilizers in local streams	**3.0**	3.0
Phosphorus in local streams	**2.6**	3.0
Bacteria and viruses in local streams (such as E. coli)	**2.9**	3.0
Salt in local streams	**2.4**	2.8
Invasive aquatic plants and animals	**3.1**	3.2
Oil or antifreeze from cars and trucks	**2.5**	2.7
Trash and debris	**2.8**	3.0
Organic matter, such as fallen trees, branches, grass clippings, leaves	**2.3**	2.4
Sources of Water Pollution: The items listed below are sources of water quality pollution across the country. In your opinion, how much of a problem are the following sources in your area?	-	-
Discharges from industry into streams and lakes	**2.6**	2.7
Discharges from sewage treatment plants	**2.7**	3.0
Soil erosion from construction sites	**2.8**	2.5
Soil erosion from stream farm fields	**2.6**	2.7
Lawn fertilizers and pesticides	**2.8**	2.9
Grass clippings and leaves	**2.1**	2.1
Discharges from storm sewers	**2.6**	2.9
Improper disposal household waste (such as batteries, -medications, chemicals, fluorescent light bulbs, etc.)	**2.7**	2.7

Appendix Continued...

Improper disposal of used motor oil and antifreeze	**2.5**	2.7
Manure from animal farms	**2.7**	2.6
Storm water runoff from streets, highways, and/or parking lots	**2.7**	2.8
Street salt and sand	**2.7**	2.9
Droppings from geese, ducks, and other waterfowl	**2.5**	2.8
Pet waste (such as dogs or cats)	**2.1**	2.2
Agricultural fertilizers and pesticides	**2.9**	3.0
Practices to Improve Water Quality: Please indicate which statement most accurately describes your level of experience with each practice listed below.	-	-
Applying pesticides and herbicides at manufacturer's guidelines for your lawn	**3.2**	3.2
Using phosphate free fertilizer	**2.6**	2.6
Properly disposing of pet waste	**3.2**	3.0
Using rain barrels	**3.0**	2.6
Recycling motor oil	**3.5**	3.5
Directing downspouts away from paved surfaces	**3.4**	3.5
Making Management Decisions: In general, how much does each issue limit your ability to change you household and lawn care practices?	-	-
Cost	**2.4**	2.4
My own physical abilities	**2.5**	2.9
The need to learn new skills or techniques	**2.9**	2.7
Legal restriction on my property	**3.3**	3.0
Not having access to the necessary equipment that I need	**3.1**	3.0
Lack of available information about the practice	**2.8**	2.6
Concerns about resale value	**2.5**	2.7
Constraints for Specific Practices: How much do the following factors limit your ability to build a rain garden (or limited, if you already have one)?	-	-
Lack of information skills	**2.7**	2.5
Time required	**2.6**	2.4
Cost	**2.6**	2.7
The features of my property do not support it	**2.7**	2.4
Physical or health limitations	**2.0**	1.9
About You and Your Property:	-	-
What is your gender?	**.5**	.35

APPENDIX J. MICROBIAL COMMUNITY ASSESSMENT FOR THE MILWAUKEE RIVER BASIN 2017, DR. RYAN MILLER, UNIVERSITY OF WISCONSIN-MILWAUKEE SCHOOL OF FRESHWATER SCIENCES

Overview

Goals:

1. **To evaluate the utility of microbial community metrics for water quality monitoring**
2. **To determine sources, coupling, and timing of sediment and fecal coliform loads in the Milwaukee harbor**

Can the microbial composition of the Milwaukee River watershed inform more efficient monitoring & pollutant mitigation strategies?

4

Overview

Research Questions:

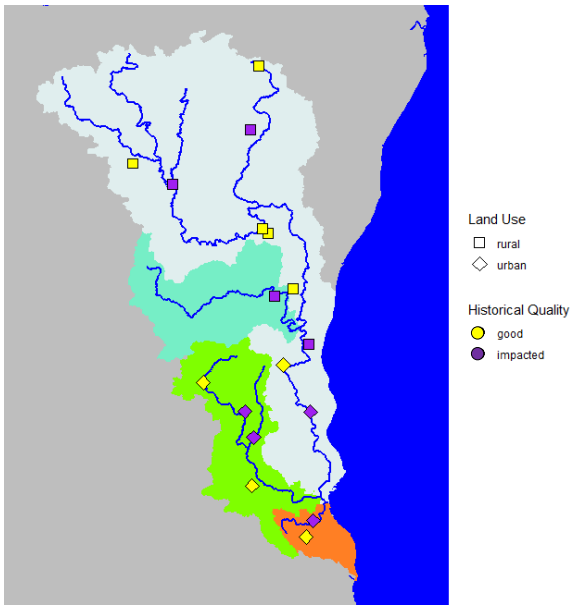
1. **Does bacterial community diversity differ in streams with "good" versus "impacted" water quality?**
2. **What traditional water quality parameters correlate with microbial community diversity in streams?**
3. **How are freshwater and fecal-associated bacteria dispersed throughout the Milwaukee River basin?**

9

Methods: Sampling locations

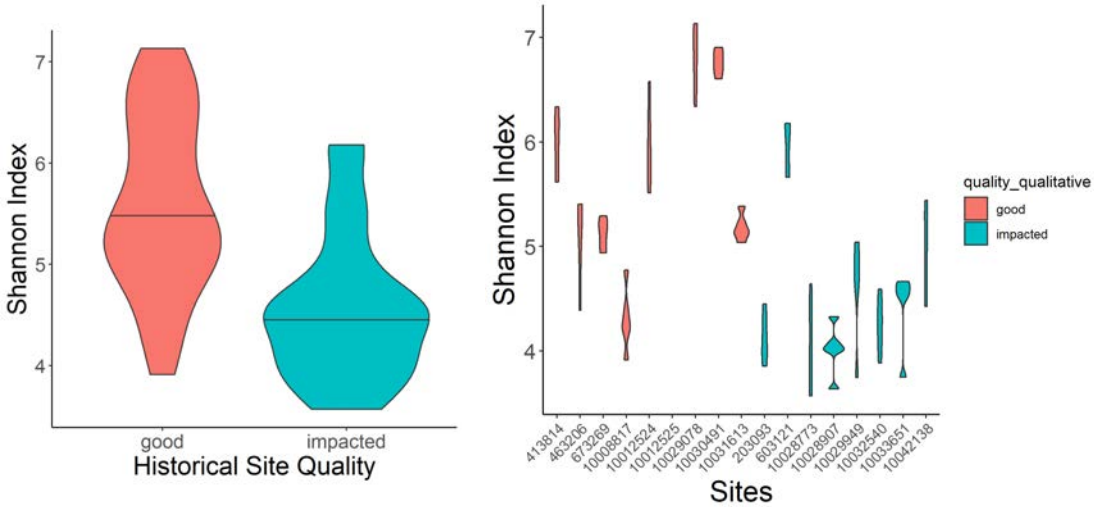
- **16 total sampling locations**
- **Sampled on 5 days in summer 2017 by UWM & Milwaukee Riverkeeper citizen scientists**

Sample Site Breakdown			
		Surrounding Land Use	
		Rural	Urban
Water Quality	Impacted	4 Sites	4 Sites
	Good	4 Sites	4 Sites

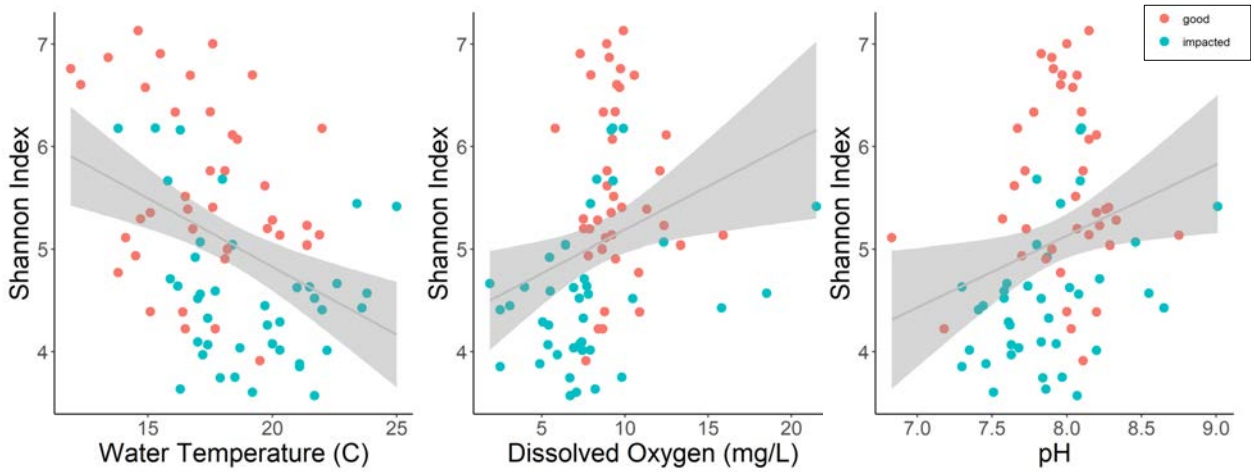


11

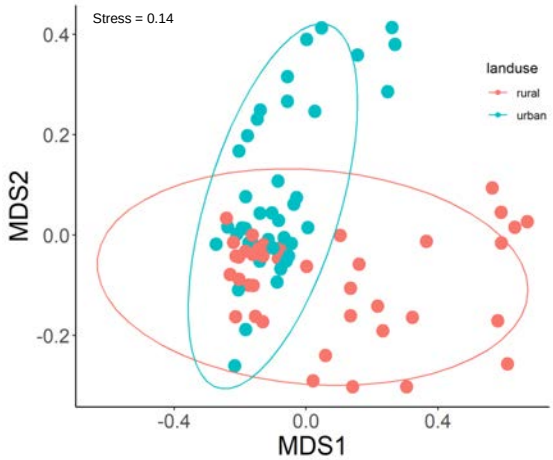
Alpha diversity is generally lower at impacted sites and is generally consistent at individual sites across time



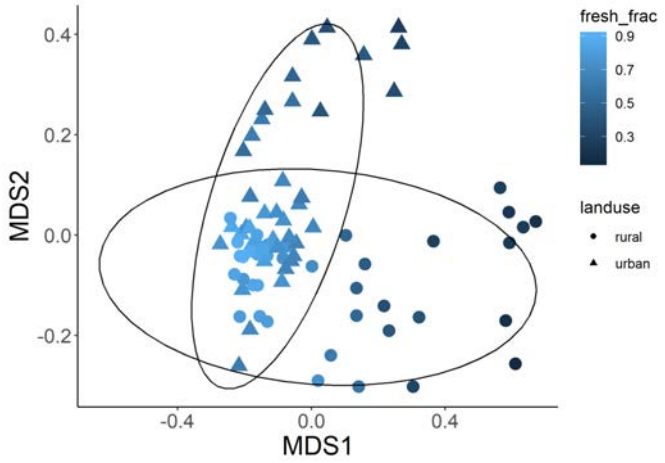
Alpha diversity correlates with typical measures of stream quality



Beta diversity differs between dominant land uses

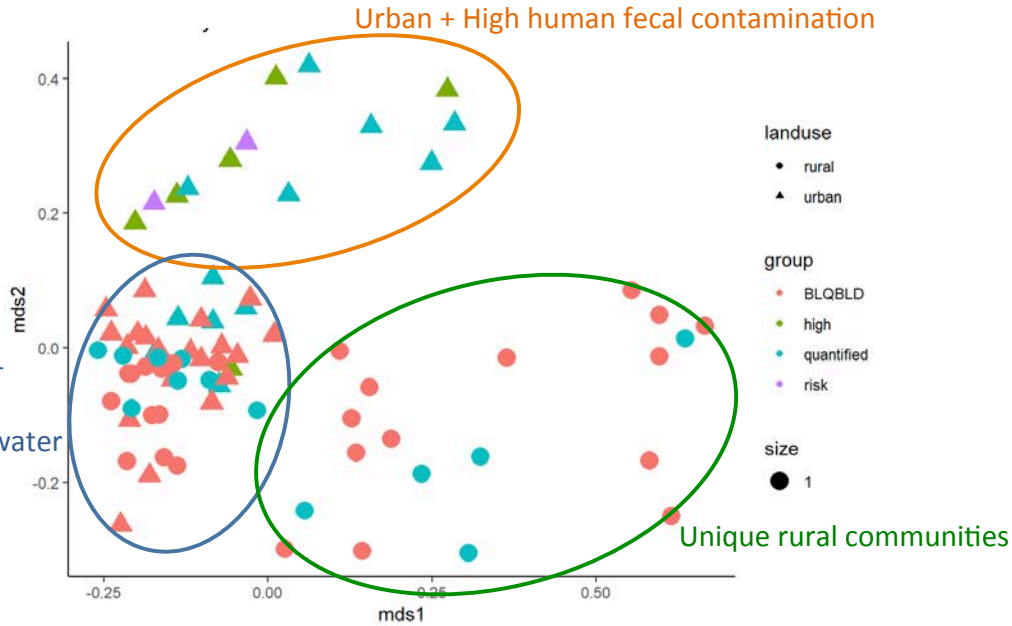


Urban & rural land use communities are most similar when dominated by freshwater organisms



High human fecal contamination is related to shifts in urban bacterial communities

Human fecal contamination measured with standard qPCR assays



Grading the Milwaukee Area Rivers for Sewage Contamination

Bacterial genera and (# of sequences) used for sewage tracking

Prevotella (1), *Arcobacter* (4), *Cloacibacterium* (1), *Bacteroides* (1), *Acinetobacter* (1),

Sewage Contamination Level Scoring

<1 in 1000 seq. = very low
1 in 500 to 1000 seq. = low
1 in 200 to 500 seq. = moderate
1 in 100 to 200 seq. = high
>1 in 100 seq. = very high

Very low = 4
Low = 3
Moderate = 2
High = 1
Very high = 0

	Sewage bacteria contamination						
Site	very low	low	moderate	high	very high	score	Grade
Batavia Creek at South 28th			2	3		7	C
Cedar Creek at Covered Bridge	5					20	A+
Dretzka Park Crrek at W Bradley Road		1	2		2	7	C
East Branch Milwaukee River at CTH S	1	4				16	A-
Indian Creek DS Bradley Road	2	1	1	1		14	B
KK River DS of 6th St				1	4	1	F
Little Menomonee River at Milwaukee		2	2		1	10	C+
Mole Creek at Maple Road	2	2	1			16	A-
Nichols Creek DS of CTH N				1	4	1	F
Pigeon Creek at Highland Road		1	4			11	B-
Riveredge Creek at Hawthorne			5			10	C+
Ulao Creek at Bonniwell	1	2	1			12	B
Underwood Creek at GRavel Shoals			1	1	3	3	D
Unnamed Tributory - W Townline Rd			3	1		7	C
Willow Creek		1	4			11	B-
Wilson Park Creek, 20th & Wilson					5	0	F

Overview

Research Questions:

1. **Does bacterial community diversity differ in streams with "good" versus "impacted" water quality?**
   Yes
2. **What traditional water quality parameters correlate with microbial community diversity in streams?**
   DO, temperature, & pH → typical markers for ecological quality
3. **How are freshwater and fecal-associated bacteria dispersed throughout the land uses of the Milwaukee River basin?**
   Site-specific distributions; non-freshwater taxa explain land-use distinctions

22

APPENDIX K. WDNR AGRICULTURAL CONVERSION ESTIMATE FOR THE MENOMONEE RIVER WATERSHED

Menomonee Watershed - WDNR Ag Acres Conversion Estimate (WDNR 2021)

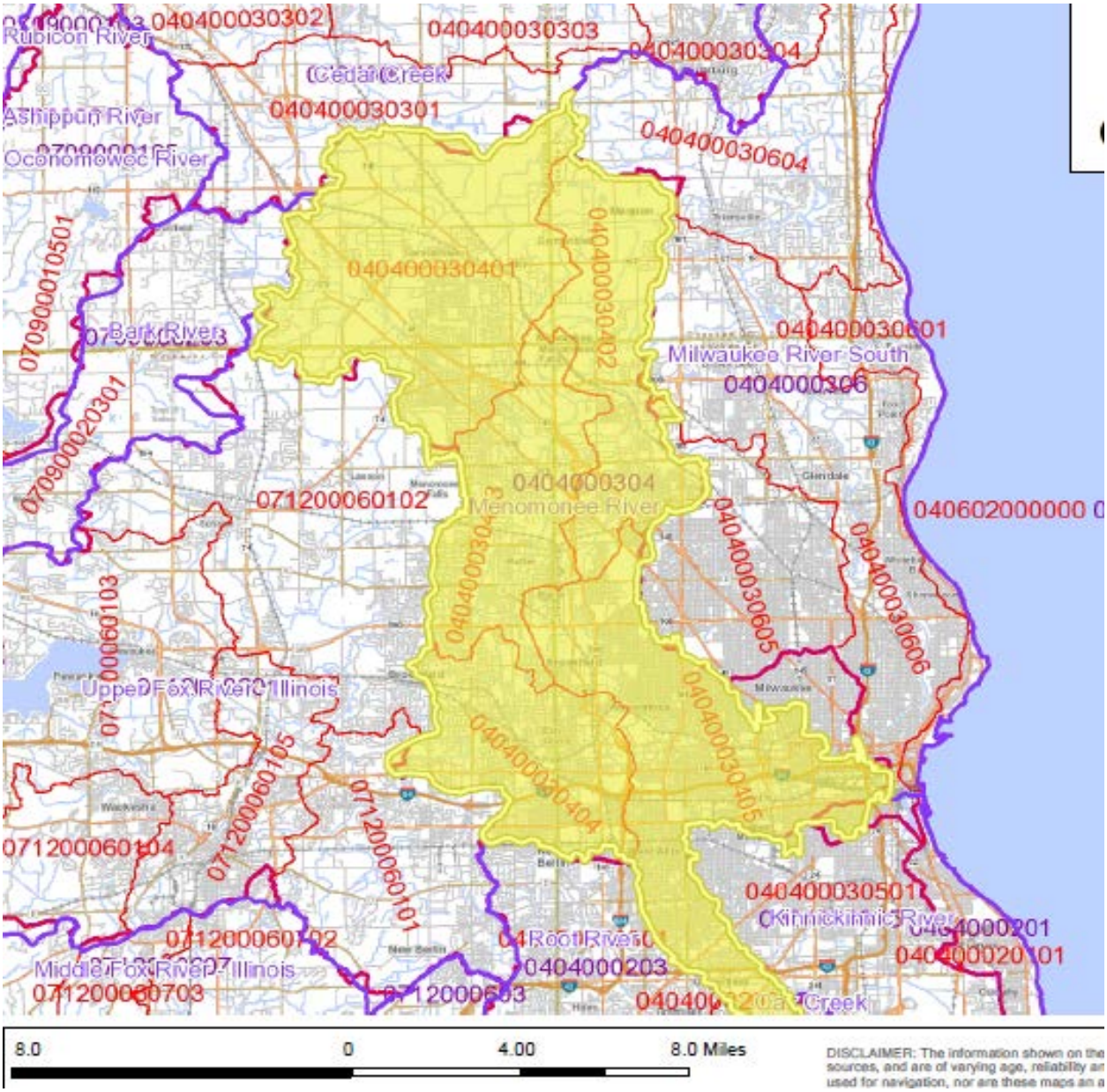
=Revised/increased Remain Ag acres per Washington County – Paul Sebo

HUC 10	**404000304**			
HUC 12	**01**			
TMDL Reach	**Section**	**Total Ag Acres**	**Ag Acres Convert**	**Ag Acres Remain**
1	1-6	280	0	280
1	7,9-13	1450	10	1420
1	8	600	120	480
1	14-16	960	140	820
1	21-24	500	160	340
1	26-29	280	280	0
1	32-35	200	200	0
1	3,4,9,10,15	0	0	0
2	8	200	200	0
2	17-19	405	405	0
3	16	175	175	0
3	17, 19-21	50	50	0
4	29-32	250	250	0
4	25,36,1,6	450	450	0
5	1,2,30,35,36	270	270	0
5	19, 23-26	95	95	0
Total		**6165**	**2805**	**3340**
HUC 12	**02**			
TMDL Reach	**Section**	**Total Ag Acres**	**Ag Acres Convert**	**Ag Acres Remain**
9	7	120	0	120
9	8	0	0	0
9	13	5	0	5
9	16	55	55	0
9	17	380	0	380
9	18	440	0	440
9	19	580	0	580
9	20	560	160	300
9	21	55	55	0
9	28	25	25	0
9	29	290	90	200
9	30	160	40	120
9	31	430	330	100
9	32	190	190	0
9	33	120	120	0
9	36	15	15	0

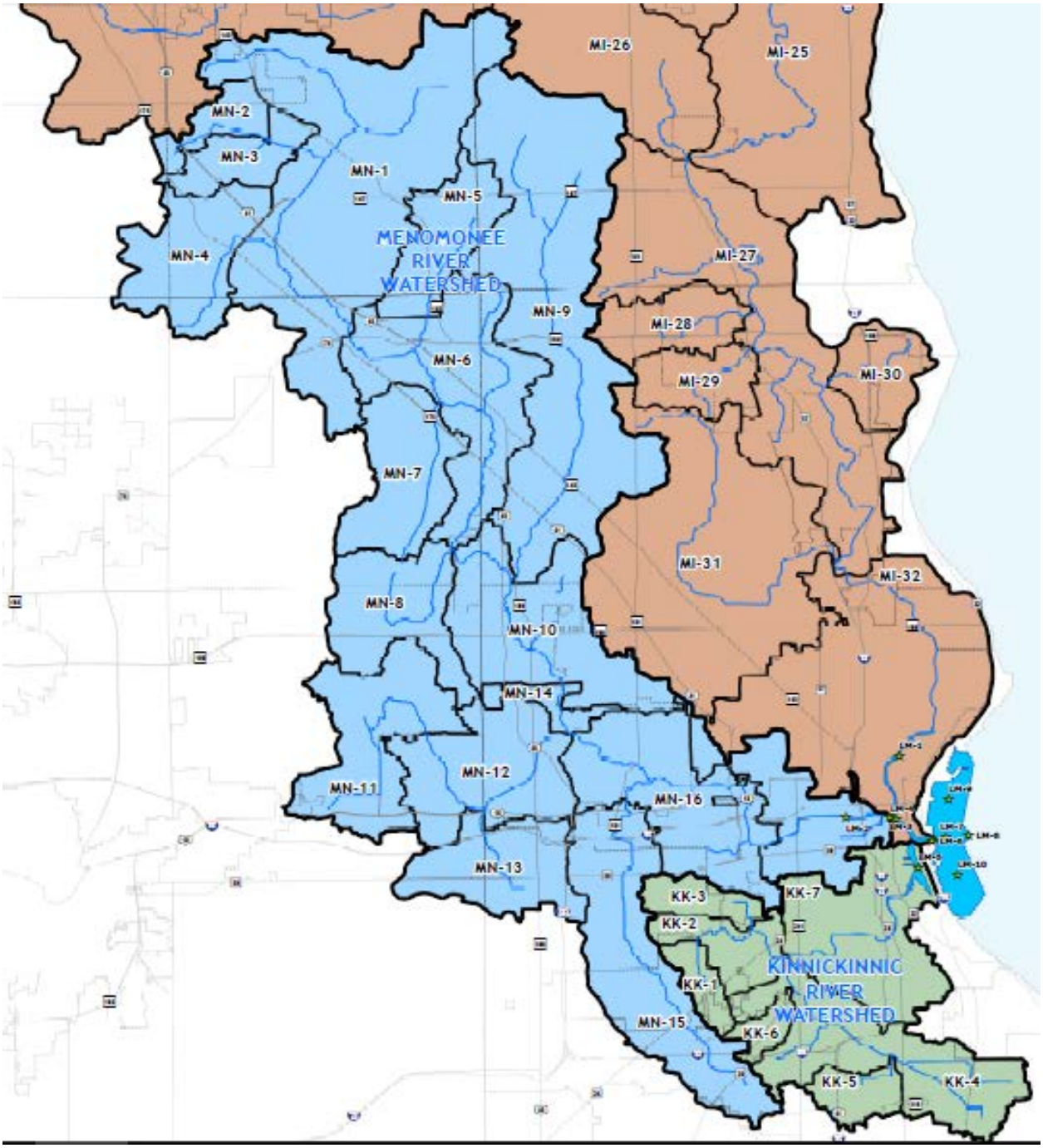
9	4,5,6,7,8,9,13,16-21, 24,25,28-32	35	35	0
Total		**3460**	**1115**	**2245**
HUC 12	**03**			
TMDL Reach	**Section**	**Total Ag Acres**	**Ag Acres Convert**	**Ag Acres Remain**
6	36, 1-3, 6-7, 10-12, 13	0	0	0
6	18-19, 24-25, 30	0	0	0
7	13, 14, 15, 23, 24	0	0	0
7	22	30	30	0
8	34-36, 1-3, 10-12	0	0	0
Total		**30**	**30**	**0**
HUC 12	**04**			
TMDL Reach	**Section**	**Total Ag Acres**	**Ag Acres Convert**	**Ag Acres Remain**
11	27	120	120	0
11	22	20	20	0
11	15	20	20	0
12	13, 17-20, 23-26, 29, 30	0	0	0
13	31, 32, 35, 36, 1, 2, 5, 6	0	0	0
Total		**160**	**160**	**0**
HUC 12	**05**			
TMDL Reach	**Section**	**Total Ag Acres**	**Ag Acres Convert**	**Ag Acres Remain**
12	13, 17-20, 23-26, 29, 30	0	0	0
16	15, 16, 20-22, 26-28	0	0	0
16	34-36, 1, 2	0	0	0
Total		**0**	**0**	**0**

REFERENCE MAPS FOR AGRICULTURAL CONVERSIONS

HUC12 Map for Menomonee River Watershed



TMDL Reaches for Menomonee River Watershed



APPENDIX L. WNDR SNAPPLUS AGRICULTURAL ANALYSIS FOR REMAINING AGRICULTURAL LAND IN THE MENOMONEE RIVER WATERSHED

Cg-Cg-O/As-A-A-A (Reach MN-1) 30% - Washington Cty

HmB2	0.32
HmC2	0.37
Hu	0.31

Soil Type - HmB2					Soil Type - HmC2					Soil Type - Hu				
Year	MB Tillage (lbs P/acre)	Fall Chisel Disk Tillage lbs P/acre	MB Tillage Soil Loss tons/acre	FCD Tillage Soil Loss tons/acre	Year	MB Tillage (lbs P/acre)	Fall Chisel Disk Tillage lbs P/acre	MB Tillage Soil Loss tons/acre	FCD Tillage Soil Loss tons/acre	Year	MB Tillage (lbs P/acre)	Fall Chisel Disk Tillage lbs P/acre	MB Tillage Soil Loss tons/acre	FCD Tillage Soil Loss tons/acre
2014	5	5.6	2.5	1.1	2014	9.9	8.5	5.5	2.3	2014	1.2	1.7	0.0	0.0
2015	5.9	6.1	3	1.2	2015	11.7	9.4	6.6	2.6	2015	1.2	1.8	0.0	0.0
2016	2.5	2	0.9	0.4	2016	4.1	2.8	1.9	0.9	2016	1	0.9	0.0	0.0
2017	0.8	0.9	0.3	0.3	2017	1.1	1.1	0.6	0.6	2017	0.3	0.3	0.0	0.0
2018	0.9	1.1	0.4	0.4	2018	1.2	1.4	0.7	0.7	2018	0.3	0.4	0.0	0.0
2019	0.6	0.7	0.2	0.2	2019	0.7	0.8	0.3	0.3	2019	0.2	0.3	0.0	0.0
Total	15.7	16.4	7.3	3.6	Total	28.7	24.0	15.6	7.4	Total	4.2	5.4	0.0	0.0
AVG	2.6	2.7	1.2	0.6	AVG	4.8	4.0	2.6	1.2	AVG	0.7	0.9	0.0	0.0
WTAVG	0.8	0.9	0.4	0.2	WTAVG	1.8	1.5	1.0	0.5	WTAVG	0.2	0.3	0.0	0.0

Rot Avg P (lbs/acre)	0.8	**Soil Loss Avg tons/acre**	0.3

p loss	0.42	0.40	0.82
soil loss	0.20	0.10	0.30

Cs-Cs-Cs-Cs(Reach 21) 20% - Washington Cty

Soil Type: Hochiem (HmB2)					Soil Type HmC2					Soil Type Hu				
Year	MB Tillage (lbs P/acre)	Fall Chisel Disk Tillage lbs P/acre	MB Tillage Soil Loss tons/acre	FCD Tillage Soil Loss tons/acre	Year	MB Tillage (lbs P/acre)	Fall Chisel Disk Tillage lbs P/acre	MB Tillage Soil Loss tons/acre	FCD Tillage Soil Loss tons/acre	Year	MB Tillage (lbs P/acre)	Fall Chisel Disk Tillage lbs P/acre	MB Tillage Soil Loss tons/acre	FCD Tillage Soil Loss tons/acre
2014	8.5	5.4	3.4	5.7	2014	16.3	10.9	7.5	12.2	2014	1.6	0.4	0.1	0.1
2015	8.6	5.3	3.4	5.7	2015	16.4	10.7	7.5	12.2	2015	1.6	0.4	0.1	0.1
2016	8.6	5.2	3.4	5.7	2016	16.6	10.6	7.5	12.2	2016	1.7	0.4	0.1	0.1
2017	8.8	5.1	3.4	5.7	2017	16.7	10.4	7.5	12.2	2017	1.7	0.3	0.1	0.1
Total	34.5	21	13.6	22.8	Total	66	42.6	30.0	48.8	Total	6.6	1.5	0.4	0.4
AVG	8.6	5.25	3.4	5.7	AVG	16.5	10.7	7.5	12.2	AVG	1.7	0.4	0.1	0.1
WTAVG	2.8	1.7	1.1	1.8	WTAVG	6.1	3.9	2.8	4.5	WTAVG	0.5	0.1	0.0	0.0

Rot Avg P (lbs/acre)	1.5	**Soil Loss Avg tons/acre**	1.0

p loss	0.94	0.57	1.51
soil loss	0.39	0.64	1.03

Cg-Cs-Sb-Wh (Reach 21) 20% - Washington County

Soil Type: HmB2 - 32% - 4% slope					Soil Type: HmC2 - 37% - 9% slope					Soil Type: Hu - 31% - 1% slope				
Year	MB Tillage (lbs P/acre)	Fall Chisel Disk Tillage lbs P/acre	MB Tillage Soil Loss tons/acre	FCD Tillage Soil Loss tons/acre	Year	MB Tillage (lbs P/acre)	Fall Chisel Disk Tillage lbs P/acre	MB Tillage Soil Loss tons/acre	FCD Tillage Soil Loss tons/acre	Year	MB Tillage (lbs P/acre)	Fall Chisel Disk Tillage lbs P/acre	MB Tillage Soil Loss tons/acre	FCD Tillage Soil Loss tons/acre
2014	6.9	6	4.9	4	2014	15.4	12.6	12.1	9.5	2014	1	0.8	0.1	0.1
2015	5.3	3.3	3.8	2.1	2015	11.8	6.6	9.3	4.9	2015	0.7	0.6	0.1	0
2016	4.8	2.9	5.3	2.6	2016	11.1	6	13.1	6.3	2016	0.4	0.5	0.1	0
2017	5.4	4.2	3.2	2.1	2017	10.5	7.4	7.6	4.7	2017	1.5	1.5	0.1	0
Total	22.4	16.4	17.2	10.8	Total	48.8	32.6	42.1	25.4	Total	3.6	3.4	0.4	0.1
AVG	5.6	4.1	4.3	2.7	AVG	12.2	8.2	10.5	6.4	AVG	0.9	0.9	0.1	0.0
WTAVG	1.8	1.3	1.4	0.9	WTAVG	4.5	3.0	3.9	2.3	WTAVG	0.3	0.3	0.0	0.0

Below field slope to Water 0-2%

Below field slope to Water 2.1-6%

Below field slope to Water 0-2%

Rot Avg P (lbs/acre)	1.1	**Soil Loss Avg - tons/acre**	0.9
p loss	0.66	0.46	1.12
soil loss	0.53	0.32	0.85

Sc-Sb-Peas (Reach 21) 30% - Washington Cty

Soil Type: HmB2			Soil Type HmC2			Soil Type Hu		
Year	MB Tillage (lbs P/acre)	MB Tillage Soil Loss tons/acre	Year	MB Tillage (lbs P/acre)	MB Tillage Soil Loss tons/acre	Year	MB Tillage (lbs P/acre)	MB Tillage Soil Loss tons/acre
2014	7.8	9.7	2014	16.7	21	2014	0.4	0.1
2015	3.4	4.1	2015	7.2	9	2015	0.2	0.1
2017	8.6	10.6	2017	18.4	23.4	2017	0.4	0.2
Total	19.8	24.4	Total	42.3	53.4	Total	1	0.4
AVG	6.6	8.13	AVG	14.1	17.8	AVG	0.3	0.1
WTAVG	2.1	2.6	WTAVG	5.2	6.6	WTAVG	0.1	0.0

Rot Avg P (lbs/acre)	2.2	**Soil Loss Avg tons/acre**	2.8
p loss	2.23		
soil loss	2.77		

	TMDL Baseline	TMDL LA AG-NPS	TMDL Reduction Target
Reach MN-1 Avg lbs P/acre	5.7	46%	3.1
Reach MN-1 Avg ton/acre	4.9	46%	2.7

Paul Sebo recommended crop rotation % changes for MN-1

Rotation 1 – Cg-Cg-O-As-A-A-A - change from 40% to 30%
Rotation 2 – Cg-Cs-Sb-Wh – change from 35% to 20%
Rotation 3 – Cs-Cs-Cs-Cs – keep at 20%
Rotation 4 - Sc-Sb-Peas - change from 5% to 30%

FUTURE - New/Additional Cropland Practices TMDL Reach MN-01 has 46% TP and TSS Reduction Goal

MB Tillage and Fall Chisel Disk Tillage to No till
Cover Crops - 1 out of 2 corn years for Cg-Cg-O/As-A-A-A and Cg-Cs-Sb-Wh rotations; 2 out of 4 corn years for Cs-Cs-Cs-Cs; 2 out of 3 years for Sc-Sb-Peas rotations
Filter Strips (edge of field)

Cg-Cg-O/As-A-A-A (Reach 21) 30% - Washington Cty

HmB2	0.32
HmC2	0.37
Hu	0.31

Soil Type - HmB2					Soil Type - HmC2					Soil Type - Hu				
Year	MB Tillage to No till (lbs P/acre)	Fall Chisel Disk Tillage to No Till (lbs P/acre)	MB Tillage to No Till Soil Loss (tons/acre)	FCD Tillage to No Till Soil Loss (tons/acre)	Year	MB Tillage to No till (lbs P/acre)	Fall Chisel Disk Tillage to No Till (lbs P/acre)	MB Tillage to No Till Soil Loss (tons/acre)	FCD Tillage to No Till Soil Loss (tons/acre)	Year	MB Tillage to No till (lbs P/acre)	Fall Chisel Disk Tillage to No Till (lbs P/acre)	MB Tillage to No Till Soil Loss (tons/acre)	FCD Tillage to No Till Soil Loss (tons/acre)
2014	1.4	3.7	0.1	0	2014	1.5	3.7	0.1	0	2014	0.8	1.6	0.0	0.0
2015	1.5	3.6	0.1	0	2015	1.6	3.7	0.1	0.1	2015	0.9	1.5	0.0	0.0
2016	1.4	1.3	0	0	2016	1.4	1.4	0.1	0	2016	0.8	0.8	0.0	0.0
2017	0.3	0.4	0	0	2017	0.5	0.4	0.1	0	2017	0.2	0.2	0.0	0.0
2018	0.5	0.5	0.1	0.1	2018	0.4	0.5	0.1	0.1	2018	0.2	0.2	0.0	0.0
2019	0.3	0.4	0.1	0	2019	0.4	0.5	0.1	0.1	2019	0.2	0.2	0.0	0.0
Total	5.4	9.9	0.4	0.1	Total	5.8	10.2	0.6	0.3	Total	3.1	4.5	0.0	0.0
AVG	0.9	1.7	0.1	0.0	AVG	1.0	1.7	0.1	0.1	AVG	0.5	0.8	0.0	0.0
WTAVG	0.3	0.5	0.0	0.0	WTAVG	0.4	0.6	0.0	0.0	WTAVG	0.2	0.2	0.0	0.0
Reduce AVG	1.7	1.1	1.2	0.6		3.8	2.3	2.5	1.2		0.2	0.2	0.0	0.0
Reduce WT AVG	0.5	0.3	0.4	0.2		1.4	0.9	0.9	0.4		0.1	0.0	0.0	0.0
Percent Reduce	65.6%	39.6%	94.5%	97.2%		79.8%	57.5%	96.2%	95.9%		26.2%	16.7%	0.0%	0.0%

Rot Avg P (lbs/acre)	0.3	**Soil Loss Avg tons/acre**	0.0

p loss	0.12	0.21	0.33
soil loss	0.01	0.00	0.01

Cs-Cs-Cs-Cs(Reach 21) 20% - Washington Cty

Soil Type: Hochiem (HmB2)					Soil Type HmC2					Soil Type Hu				
Year	MB Tillage to No till (lbs P/acre)	Fall Chisel Disk Tillage to No Till (lbs P/acre)	MB Tillage to No Till Soil Loss (tons/acre)	FCD Tillage to No Till Soil Loss (tons/acre)	Year	MB Tillage to No till (lbs P/acre)	Fall Chisel Disk Tillage to No Till (lbs P/acre)	MB Tillage to No Till Soil Loss (tons/acre)	FCD Tillage to No Till Soil Loss (tons/acre)	Year	MB Tillage to No till (lbs P/acre)	Fall Chisel Disk Tillage to No Till (lbs P/acre)	MB Tillage to No Till Soil Loss (tons/acre)	FCD Tillage to No Till Soil Loss (tons/acre)
2014	4.9	2.1	1.7	0.3	2014	5.5	3.8	3.7	0.5	2014	1.7	0.4	0	0
2015	4.9	1.7	1.4	0.2	2015	5.3	3	2.9	0.4	2015	1.7	0.3	0	0
2016	5	1.8	1.7	0.3	2016	5.6	3.4	3.7	0.5	2016	1.8	0.3	0	0
2017	5	1.5	1.4	0.2	2017	5.4	2.8	2.9	0.4	2017	1.8	0.2	0	0
Total	19.8	7.1	6.2	1.0	Total	21.8	13.0	13.2	1.8	Total	7	1.2	0.0	0.0
AVG	5.0	1.775	1.55	0.3	AVG	5.5	3.3	3.3	0.5	AVG	1.8	0.3	0.0	0.0
WTAVG	1.6	0.6	0.5	0.1	WTAVG	2.0	1.2	1.2	0.2	WTAVG	0.5	0.1	0.0	0.0

Rot Avg P (lbs/acre)	0.6	**Soil Loss Avg tons/acre**	0.2
p loss	0.41	0.19	0.60
soil loss	0.17	0.02	0.20

Cg-Cs-Sb-Wh (Reach MN-1) 20% - Washington County

Soil Type: HmB2 - 32% - 4% slope					Soil Type: HmC2 - 37% - 9% slope					Soil Type: Hu - 31% - 1% slope				
Year	MB Tillage to No till (lbs P/acre)	Fall Chisel Disk Tillage to No Till (lbs P/acre)	MB Tillage to No Till Soil Loss (tons/acre)	FCD Tillage to No Till Soil Loss (tons/acre)	Year	MB Tillage to No till (lbs P/acre)	Fall Chisel Disk Tillage to No Till (lbs P/acre)	MB Tillage to No Till Soil Loss (tons/acre)	FCD Tillage to No Till Soil Loss (tons/acre)	Year	MB Tillage to No till (lbs P/acre)	Fall Chisel Disk Tillage to No Till (lbs P/acre)	MB Tillage to No Till Soil Loss (tons/acre)	FCD Tillage to No Till Soil Loss (tons/acre)
2014	2	2.1	0.7	0.7	2014	3	3.1	1.4	1.5	2014	0.8	0.9	0.1	0.1
2015	1.1	1.1	0.1	0.1	2015	1.2	1.2	0.2	0.3	2015	0.6	0.6	0.1	0
2016	0.7	0.7	0.4	0.4	2016	1	1.1	0.7	0.8	2016	0.2	0.2	0.1	0
2017	1.6	1.8	0.7	0.7	2017	2.5	2.8	1.4	1.5	2017	0.7	0.7	0.1	0
Total	5.4	5.7	1.9	1.9	Total	7.7	8.2	3.7	4.1	Total	2.3	2.4	0.4	0.1
AVG	1.4	1.4	0.5	0.5	AVG	1.9	2.1	0.9	1.0	AVG	0.6	0.6	0.1	0.0
WTAVG	0.4	0.5	0.2	0.2	WTAVG	0.7	0.8	0.3	0.4	WTAVG	0.2	0.2	0.0	0.0
Reduce AVG	4.3	2.7	3.8	2.2		10.3	6.1	9.6	5.3		0.3	0.3	0.0	0.0
Reduce WT AVG	1.4	0.9	1.2	0.7		3.8	2.3	3.6	2.0		0.1	0.1	0.0	0.0
Percent Reduce	75.9%	65.2%	89.0%	82.4%		84.2%	74.8%		83.9%		36.1%	29.4%	0.0%	0.0%

Rot Avg P (lbs/acre)	0.3	**Soil Loss Avg - tons/acre**	0.1
p loss	0.13	0.14	0.27
soil loss	0.05	0.05	0.11

Sc-Sb-Peas (Reach MN-1) 35% - Washington Cty

Soil Type: HmB2					Soil Type HmC2					Soil Type Hu				
Year	MB Tillage to No till + Cvr (lbs P/acre)	MB Tillage to Filter Strip (lbs P/acre)	MB Tillage to No till + Cvr Soil Loss (tons/acre)	MB Tillage to Filter Strip Soil Loss (tons/acre)	Year	MB Tillage to No till (lbs P/acre)	MB Tillage to No till + Cvr (lbs P/acre)	MB Tillage to No till + Cvr Soil Loss (tons/acre)	MB Tillage to Filter Strip Soil Loss (tons/acre)	Year	MB Tillage to No till + Cvr (lbs P/acre)	MB Tillage to Filter Strip (lbs P/acre)	MB Tillage to No till + Cvr Soil Loss (tons/acre)	MB Tillage to Filter Strip Soil Loss (tons/acre)
2014	0.6	1.5	0.5	0.6	2014	1	2.5	1	1.2	2014	0.1	0.3	0	0
2015	0.4	0.7	0.2	0.3	2015	0.5	1.2	0.3	0.6	2015	0.1	0.1	0	0
2017	0.8	1.6	0.8	0.8	2017	1.4	2.7	1.5	1.3	2017	0.1	0.2	0	0
Total	1.8	3.8	1.5	1.7	Total	2.9	6.4	2.8	3.1	Total	0.3	0.6	0.0	0
AVG	0.6	1.3	0.50	0.6	AVG	1.0	2.1	0.9	1.0	AVG	0.1	0.2	0.0	0.0
WTAVG	0.2	0.4	0.2	0.2	WTAVG	0.4	0.8	0.3	0.4	WTAVG	0.0	0.1	0.0	0.0

Rot Avg P (lbs/acre)	0.2	**Soil Loss Avg tons/acre**	0.2

p loss	0.20	
soil loss	0.18	

	TMDL Reduction	% Reduction
Reach MN-1 Avg lbs P/acre	1.4	71%
Reach MN-1 Avg ton/acre	0.5	88%

	% Acres with No Till + Cover Crop Practices				
Area Weighted Avg	**0%**	**25%**	**50%**	**75%**	**100%**
Reach MN-1 Avg lbs P/	4.8	4.0	3.1	2.3	1.4
Reach MN-1 Avg ton/a	4.2	3.3	2.4	1.4	0.5
				65%	
				2.6	
				1.8	

	TMDL Baseline	TMDL LA AG-NPS	TMDL Reduction Target
Reach MN-1 Avg lbs P/acre	4.8	46%	2.6
Reach MN-1 Avg ton/acre	4.2	46%	2.3

OuB	0.46
OuB2	0.30
MtA	0.24

Cg-Cg-O/As-A-A-A (Reach MN-9) 30% - Ozaukee Cty

Soil Type - OuB					Soil Type - OuB2					Soil Type - MtA				
Year	MB Tillage (lbs P/acre)	Fall Chisel Disk Tillage lbs P/acre	MB Tillage Soil Loss tons/acre	FCD Tillage Soil Loss tons/acre	Year	MB Tillage (lbs P/acre)	Fall Chisel Disk Tillage lbs P/acre	MB Tillage Soil Loss tons/acre	FCD Tillage Soil Loss tons/acre	Year	MB Tillage (lbs P/acre)	Fall Chisel Disk Tillage lbs P/acre	MB Tillage Soil Loss tons/acre	FCD Tillage Soil Loss tons/acre
2014	6.4	6.9	3.2	1.3	2014	6.3	6.8	3.2	1.3	2014	4	5.8	1.7	0.7
2015	7.7	7.4	3.9	1.5	2015	7.6	7.4	3.9	1.5	2015	4.7	6.2	2.0	0.8
2016	3	4.5	1.2	0.3	2016	2.9	4.5	1.2	0.3	2016	2.2	4.7	0.6	0.2
2017	0.8	1	0.3	0.3	2017	0.8	1	0.4	0.3	2017	0.8	0.9	0.2	0.2
2018	0.9	1.1	0.4	0.4	2018	0.9	1.1	0.4	0.4	2018	0.9	1.1	0.3	0.3
2019	0.6	0.7	0.2	0.2	2019	0.6	0.7	0.2	0.2	2019	0.6	0.8	0.1	0.1
Total	19.4	21.6	9.2	4	Total	19.1	21.5	9.3	4.0	Total	13.2	19.5	4.9	2.3
AVG	3.2	3.6	1.5	0.7	AVG	3.2	3.6	1.6	0.7	AVG	2.2	3.3	0.8	0.4
WTAVG	1.5	1.7	0.7	0.3	WTAVG	1.0	1.1	0.5	0.2	WTAVG	0.5	0.8	0.2	0.1

Rot Avg P (lbs/acre)	1.0	**Soil Loss Avg tons/acre**	0.3

p loss	0.45	0.53	0.97
soil loss	0.20	0.09	0.29

Cs-Cs-Cs-Cs(MN-9) 20% - Ozaukee Cty

Soil Type - OuB					Soil Type - OuB2					Soil Type - MtA				
Year	MB Tillage (lbs P/acre)	Fall Chisel Disk Tillage lbs P/acre	MB Tillage Soil Loss tons/acre	FCD Tillage Soil Loss tons/acre	Year	MB Tillage (lbs P/acre)	Fall Chisel Disk Tillage lbs P/acre	MB Tillage Soil Loss tons/acre	FCD Tillage Soil Loss tons/acre	Year	MB Tillage (lbs P/acre)	Fall Chisel Disk Tillage lbs P/acre	MB Tillage Soil Loss tons/acre	FCD Tillage Soil Loss tons/acre
2014	11.3	8.1	4.4	7.8	2014	11.3	8	4.3	7.7	2014	7.3	4.5	4	2.3
2015	11.4	8	4.4	7.8	2015	11.4	7.9	4.3	7.7	2015	7.3	4.4	4	2.3
2016	11.5	7.9	4.4	7.8	2016	11.3	7.8	4.3	7.7	2016	7.5	4.4	4	2.3
2017	11.6	7.8	4.4	7.8	2017	11.4	7.7	4.3	7.7	2017	7.5	4.4	4	2.3
Total	45.8	31.8	17.6	31.2	Total	45.4	31.4	17.2	30.8	Total	29.6	17.7	16.0	9.2
AVG	11.5	8.0	4.4	7.8	AVG	11.4	7.9	4.3	7.7	AVG	7.4	4.4	4.0	2.3
WTAVG	5.3	3.7	2.0	3.6	WTAVG	3.4	2.4	1.3	2.3	WTAVG	1.8	1.1	1.0	0.6

Rot Avg P (lbs/acre)	1.8	**Soil Loss Avg tons/acre**	1.1

p loss	1.04	0.71	1.75
soil loss	0.43	0.65	1.07

Cg-Cs-Sb-Wh (MN-9) 20% - Ozaukee Cty

Soil Type - OuB					Soil Type - OuB2					Soil Type - MtA				
Year	MB Tillage (lbs P/acre)	Fall Chisel Disk Tillage lbs P/acre	MB Tillage Soil Loss tons/acre	FCD Tillage Soil Loss tons/acre	Year	MB Tillage (lbs P/acre)	Fall Chisel Disk Tillage lbs P/acre	MB Tillage Soil Loss tons/acre	FCD Tillage Soil Loss tons/acre	Year	MB Tillage (lbs P/acre)	Fall Chisel Disk Tillage lbs P/acre	MB Tillage Soil Loss tons/acre	FCD Tillage Soil Loss tons/acre
2014	10.1	8.7	6.9	5.6	2014	9.9	8.6	6.8	5.5	2014	5.9	5.1	3.5	2.9
2015	7.5	4.2	5.2	2.7	2015	7.3	4.2	5.1	2.6	2015	4.4	2.7	2.7	1.4
2016	7.4	3.9	7.4	3.5	2016	7.3	3.8	7.2	3.5	2016	4	2.5	3.8	1.9
2017	7.1	4	4.3	2.7	2017	7.1	4	4.2	2.7	2017	4.9	2.9	2.2	1.5
Total	32.1	20.8	23.8	14.5	Total	31.6	20.6	23.3	14.3	Total	19.2	13.2	12.2	7.7
AVG	8.0	5.2	6.0	3.6	AVG	7.9	5.2	5.8	3.6	AVG	4.8	3.3	3.1	1.9
WTAVG	2.6	1.7	1.9	1.2	WTAVG	2.4	1.5	1.7	1.1	WTAVG	1.2	0.8	0.7	0.5

Below field slope to Water 0-2% | Below field slope to Water 2.1-6% | Below field slope to Water 0-2%

Rot Avg P (lbs/acre)	1.0	**Soil Loss Avg - tons/acre**	0.7
p loss	0.61	0.40	1.01
soil loss	0.44	0.27	0.71

Sc-Sb-Peas (MN-9) 30% - Ozaukee Cty

Soil Type - OuB			Soil Type - OuB2			Soil Type - MtA		
Year	MB Tillage (lbs P/acre)	MB Tillage Soil Loss tons/acre	Year	MB Tillage (lbs P/acre)	MB Tillage Soil Loss tons/acre	Year	MB Tillage (lbs P/acre)	MB Tillage Soil Loss tons/acre
2014	12.3	13.5	2014	12.1	13.2	2014	6.5	6.8
2015	5.3	5.7	2015	5.2	5.6	2015	2.8	2.9
2017	13.2	14.4	2017	13.1	14.2	2017	7.1	7.4
Total	30.8	33.6	Total	30.4	33.0	Total	16.4	17.1
AVG	10.3	11.2	AVG	10.1	11.0	AVG	5.5	5.7
WTAVG	4.7	5.2	WTAVG	3.0	3.3	WTAVG	1.3	1.4

Rot Avg P (lbs/acre)	2.7	**Soil Loss Avg tons/acre**	2.9
p loss	2.72		
soil loss	2.95		

	TMDL Baseline	TMDL LA AG-NPS	TMDL Reduction Target
Reach MN-9 Avg lbs P/acre	6.5	49%	3.3
Reach MN-9 Avg ton/acre	5.0	51%	2.5

Paul Sebo recommended crop rotation % changes for MN-1

Rotation 1 – Cg-Cg-O-As-A-A-A - change from 40% to 30%
Rotation 2 – Cg-Cs-Sb-Wh – change from 35% to 20%
Rotation 3 – Cs-Cs-Cs-Cs – keep at 20%
Rotation 4 - Sc-Sb-Peas - change from 5% to 30%

FUTURE - New/Additional Cropland Practices TMDL Reach MN-09 has 49% TP and 51% TSS Reduction Goal

MB Tillage and Fall Chisel Disk Tillage to No till
Cover Crops - 1 out of 2 corn years for Cg-Cg-O/As-A-A-A and Cg-Cs-Sb-Wh rotations; 2 out of 4 corn years for Cs-Cs-Cs-Cs; 2 out of 3 years for Sc-Sb-Peas rotations
Filter Strips (edge of field)

Cg-Cg-O/As-A-A-A (MN-9) 30% - Ozaukee Cty

	Soil Type - OuB					Soil Type - OuB2					Soil Type - MtA			
Year	MB Tillage to No till (lbs P/acre)	Fall Chisel Disk Tillage to No Till (lbs P/acre)	MB Tillage to No Till Soil Loss (tons/acre)	FCD Tillage to No Till Soil Loss (tons/acre)	Year	MB Tillage to No till (lbs P/acre)	Fall Chisel Disk Tillage to No Till (lbs P/acre)	MB Tillage to No Till Soil Loss (tons/acre)	FCD Tillage to No Till Soil Loss (tons/acre)	Year	MB Tillage to No till (lbs P/acre)	Fall Chisel Disk Tillage to No Till (lbs P/acre)	MB Tillage to No Till Soil Loss (tons/acre)	FCD Tillage to No Till Soil Loss (tons/acre)
2014	1.7	6.2	0.1	0	2014	1.7	6.2	0.1	0	2014	2	6.7	0.0	0.0
2015	1.9	6.3	0.1	0	2015	1.9	6.3	0.1	0	2015	2.1	6.7	0.1	0.0
2016	1.8	6.4	0.1	0	2016	1.8	6.4	0.1	0	2016	2	6.8	0.0	0.0
2017	0.3	0.4	0	0	2017	0.3	0.4	0	0	2017	0.4	0.5	0.0	0.0
2018	0.4	0.5	0.1	0.1	2018	0.4	0.5	0.1	0.1	2018	0.5	0.5	0.1	0.0
2019	0.4	0.5	0.1	0	2019	0.4	0.5	0.1	0	2019	0.4	0.5	0.0	0.0
Total	6.5	20.3	0.5	0.1	Total	6.5	20.3	0.5	0.1	Total	7.4	21.7	0.2	0.0
AVG	1.1	3.4	0.1	0.0	AVG	1.1	3.4	0.1	0.0	AVG	1.2	3.6	0.0	0.0
WTAVG	0.5	1.6	0.0	0.0	WTAVG	0.3	1.0	0.0	0.0	WTAVG	0.3	0.9	0.0	0.0
Reduce AVG	2.2	0.2	1.5	0.7		2.1	0.2	1.5	0.7		1.0	-0.4	0.8	0.4
Reduce WT AVG	1.0	0.1	0.7	0.3		0.6	0.1	0.4	0.2		0.2	-0.1	0.2	0.1
Percent Reduce	66.5%	6.0%	94.6%	97.5%		66.0%	5.6%	94.6%	97.5%		43.9%	-11.3%	95.9%	100.0%

Rot Avg P (lbs/acre)	0.7	**Soil Loss Avg tons/acre**	0.0
p loss	0.17	0.52	0.68
soil loss	0.01	0.00	0.01

Cs-Cs-Cs-Cs(MN-9) 20% - Ozaukee Cty

Soil Type - OuB					Soil Type - OuB2					Soil Type - MtA				
Year	MB Tillage to No till (lbs P/acre)	Fall Chisel Disk Tillage to No Till (lbs P/acre)	MB Tillage to No Till Soil Loss (tons/acre)	FCD Tillage to No Till Soil Loss (tons/acre)	Year	MB Tillage to No till (lbs P/acre)	Fall Chisel Disk Tillage to No Till (lbs P/acre)	MB Tillage to No Till Soil Loss (tons/acre)	FCD Tillage to No Till Soil Loss (tons/acre)	Year	MB Tillage to No till (lbs P/acre)	Fall Chisel Disk Tillage to No Till (lbs P/acre)	MB Tillage to No Till Soil Loss (tons/acre)	FCD Tillage to No Till Soil Loss (tons/acre)
2014	6.7	2.5	0.3	2.1	2014	6.7	2.5	0.3	2.1	2014	6.7	1.7	1.1	0.2
2015	6.6	2	0.2	1.7	2015	6.6	1.9	0.2	1.7	2015	6.8	1.4	0.9	0.1
2016	6.7	2.3	0.3	2.1	2016	6.7	2.3	0.3	2.1	2016	6.9	1.5	1.1	0.2
2017	6.7	1.8	0.2	1.7	2017	6.7	1.8	0.2	1.7	2017	6.9	1.2	0.9	0.1
Total	26.7	8.6	1	6.7	Total	26.7	8.5	1.0	7.6	Total	27.3	5.8	4.0	0.6
AVG	6.7	2.15	0.25	1.9	AVG	6.7	2.1	0.3	1.9	AVG	6.8	1.5	1.0	0.2
WTAVG	2.7	0.9	0.1	0.8	WTAVG	2.0	0.6	0.1	0.6	WTAVG	1.6	0.3	0.2	0.0

Rot Avg P (lbs/acre)	0.8	**Soil Loss Avg tons/acre**	0.2
p loss	0.63	0.18	0.82
soil loss	0.04	0.14	0.18

Cg-Cs-Sb-Wh (Reach MN-9) 20% - Ozaukee County

Soil Type - OuB					Soil Type - OuB2					Soil Type - MtA				
Year	MB Tillage to No till (lbs P/acre)	Fall Chisel Disk Tillage to No Till (lbs P/acre)	MB Tillage to No Till Soil Loss (tons/acre)	FCD Tillage to No Till Soil Loss (tons/acre)	Year	MB Tillage to No till (lbs P/acre)	Fall Chisel Disk Tillage to No Till (lbs P/acre)	MB Tillage to No Till Soil Loss (tons/acre)	FCD Tillage to No Till Soil Loss (tons/acre)	Year	MB Tillage to No till (lbs P/acre)	Fall Chisel Disk Tillage to No Till (lbs P/acre)	MB Tillage to No Till Soil Loss (tons/acre)	FCD Tillage to No Till Soil Loss (tons/acre)
2014	2	2.1	0.8	0.9	2014	2	2.1	0.8	0.9	2014	1.8	2	0.5	0.5
2015	0.9	0.9	0.1	0.1	2015	0.9	0.9	0.1	0.1	2015	1.1	1.1	0.1	0.1
2016	0.7	0.7	0.4	0.4	2016	0.7	0.7	0.4	0.4	2016	0.7	0.7	0.3	0.3
2017	1.6	1.5	0.8	0.9	2017	1.5	1.5	0.8	0.1	2017	1.4	1.3	0.5	0.6
Total	5.2	5.2	2.1	2.3	Total	5.1	5.2	2.1	1.5	Total	5	5.1	1.4	1.5
AVG	1.3	1.3	0.5	0.6	AVG	1.3	1.3	0.5	0.4	AVG	1.3	1.3	0.4	0.4
WTAVG	0.6	0.6	0.2	0.3	WTAVG	0.4	0.4	0.2	0.1	WTAVG	0.3	0.3	0.1	0.1
Reduce AVG	6.7	3.9	5.4	3.1		6.6	3.9	5.3	3.2		3.6	2.0	2.7	1.6
Reduce WT AVG	2.0	1.1	1.7	0.9		2.0	1.2	1.6	1.0		0.9	0.5	0.6	0.4
Percent Reduce	83.8%	75.0%	91.2%	84.1%		83.9%	74.8%		89.5%		74.0%	61.4%	88.5%	80.5%

Rot Avg P (lbs/acre)	0.3	**Soil Loss Avg - tons/acre**	0.1
p loss	0.13	0.13	0.26
soil loss	0.05	0.05	0.10

Sc-Sb-Peas (Reach MN-9) 35% - Ozaukee Cty

Soil Type - OuB					Soil Type - OuB2					Soil Type - MtA				
Year	MB Tillage to No till + Cvr (lbs P/acre)	MB Tillage to Filter Strip (lbs P/acre)	MB Tillage to No till + Cvr Soil Loss (tons/acre)	MB Tillage to Filter Strip Soil Loss (tons/acre)	Year	MB Tillage to No till (lbs P/acre)	MB Tillage to No till + Cvr (lbs P/acre)	MB Tillage to No till + Cvr Soil Loss (tons/acre)	MB Tillage to Filter Strip Soil Loss (tons/acre)	Year	MB Tillage to No till + Cvr (lbs P/acre)	MB Tillage to Filter Strip (lbs P/acre)	MB Tillage to No till + Cvr Soil Loss (tons/acre)	MB Tillage to Filter Strip Soil Loss (tons/acre)
2014	0.7	2.8	0.6	1.4	2014	0.8	2.9	0.6	1.4	2014	0.5	1.8	0.3	0.9
2015	0.3	1.3	0.2	0.6	2015	0.3	1.4	0.2	0.6	2015	0.2	0.8	0.1	0.4
2017	0.8	3.3	0.8	1.6	2017	0.8	3.5	0.8	1.6	2017	0.6	2.1	0.5	1
Total	1.8	7.4	1.6	3.6	Total	1.9	7.8	1.6	3.6	Total	1.3	4.7	0.9	2.3
AVG	0.6	2.5	0.53	1.2	AVG	0.6	2.6	0.5	1.2	AVG	0.4	1.6	0.3	0.8
WTAVG	0.3	1.1	0.2	0.6	WTAVG	0.2	0.8	0.2	0.4	WTAVG	0.1	0.4	0.1	0.2

Rot Avg P (lbs/acre)	0.2	**Soil Loss Avg tons/acre**	0.2

p loss	0.20
soil loss	0.17

	TMDL Reduction	% Reduction
Reach MN-9 Avg lbs P/acre	2.0	70%
Reach MN-9 Avg ton/acre	0.5	91%

	% Acres with No Till + Cover Crop Practices				
Area Weighted Avg	**0%**	**25%**	**50%**	**75%**	**100%**
Reach MN-9 Avg lbs P/	6.5	5.4	4.3	3.1	2.0
Reach MN-9 Avg ton/a	5	3.9	2.8	1.6	0.5
				70%	
				3.4	
				2.1	

	TMDL Baseline	TMDL LA AG-NPS	TMDL Reduction Target
Reach MN-9 Avg lbs P/acre	6.5	49%	3.3
Reach MN-9 Avg ton/acre	5.0	51%	2.5

APPENDIX M. COST ANALYSIS FOR AGRICULTURAL BMP INSTALLATION

The following costs were obtained through discussions with county Land and Water Management staff. These reflect current incentive payments per acre for the cropland practices modeled in SnapPlus*, hobby/horse operation practices and associated county staff costs for practice adoption. Maintenance costs will be borne by the farmers and are not calculated here.

MENOMONEE RIVER HUC 12 – 040400030401 (TMDL MN 1) COST ANALYSIS			
BMP	Cost/unit	# of units	Total cost
Control on barnyards			
Runoff Management or Manure Compost systems	$25,000/unit (average)	10	$250,000
Upland controls on cropland			
Nutrient Management Plans *	$40/acre	700 acres	$28,000
Reduced tillage combined with Cover crops *	$78/acre	2,100acres	$163,000
Upland controls on pastureland			
Prescribed Grazing	$50/acre	25 acres	$1,250
Use Exclusion	$50/acre	10 acres	$500
Staff/Technical Assistance to promote/adopt practices			
Washington County Staff/Technical Assistance	$16,500/yr	10 years	$165,000
Total Cost for all Practices and Staff			
$607,750			

MENOMONEE RIVER HUC 12 – 040400030402 (TMDL MN 9) COST ANALYSIS			
BMP	Cost/unit	# of units	Total cost
Control on barnyards			
Runoff Management or Manure Compost systems	$25,000/unit (average)	5	$125,000
Upland controls on cropland			
Nutrient Management Plans*	$40/acre	500 acres	$20,000
Reduced tillage combined with Cover crops	$78/acre	1,500 acres	$117,000
Upland controls on pastureland			
Prescribed Grazing	$50/acre	25 acres	$1,250
Use Exclusion	$50/acre	10 acres	$500
Staff/Technical Assistance to promote/adopt practices			
Washington County Staff/Technical Assistance	$9,000/yr	10 years	$90,000
Total Cost for all Practices in HUC12 – 040400030302			
$353,750			